

Initial Environmental Examination

May 2017

BAN: South Asia Subregional Economic Cooperation Dhaka – Northwest Corridor Road Project, Phase 2

Elenga – Hatikamrul Road

Prepared by Roads and Highways Department, Government of Bangladesh for the Asian Development Bank.

CURRENCY EQUIVALENTS

(As of 07 April 2017)
Currency unit – Bangladeshi Taka (Tk)
Tk 1.00 = \$ 0.012539
\$ 1.00 = Tk 79.75

ABBREVIATION

AADT	Annual Average Daily Traffic
AAQ	Ambient air quality
AAQM	Ambient air quality monitoring
ADB	Asian Development Bank
AH	Asian Highway
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BUET	Bangladesh University of Engineering and Technology
BOD	Biochemical oxygen demand
BOQ	Bill of quantity
CITES	Convention on International Trade of Endangered Species
COD	Chemical oxygen demand
CSC	Construction Supervision Consultant
DO	Dissolved oxygen
DPR	Detailed project report
ECC	Environmental Clearance Certificate
ECR	Environmental Conservation Rules
EA	Executing agency
EHS	Environment Health and Safety
EIA	Environmental impact assessment
EMOP	Environmental monitoring plan
EMP	Environmental management plan
GOB	Government of Bangladesh
GHG	Greenhouse gas
GIS	Geographical information system
GOB	Government of Bangladesh
GRC	Grievance redress committee
GRM	Grievance redress mechanism
HFL	Highest flood level
IA	Implementing Agency
MOEF	Ministry of Environment and Forests
NOx	Oxides of nitrogen
PAP	Project Affected Persons
PCU	Passenger Car Units
PD	Project Director
PM	Particulate Matter
PIU	Project Implementation Unit
PPE	Personal protective equipment
PPTA	Project Preparedness Technical Assistance
RHD	Roads and Highways Department
ROW	Right of way
RRTC	Road Research and Training Centre
SASEC	South Asia Subregional Economic Corridor

SO ₂	Sulphur Dioxide
SPM	Suspended Particulate Matter
SPS	ADB Safeguard Policy Statement, 2009
TA	Technical assistance
TDS	Total dissolved solids
TSS	Total Suspended Solids

WEIGHTS AND MEASURES

dB(A)	–	A-weighted decibel
ha	–	hectare
km	–	kilometre
km ²	–	square kilometre
KWA	–	kilowatt ampere
Leq	–	equivalent continuous noise level
µg	–	microgram
m	–	meter
MW (megawatt)	–	megawatt
PM 2.5 or 10	–	Particulate Matter of 2.5 micron or 10 micron size

NOTE

In this report, "\$" refers to US dollars.

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EXECUTIVE SUMMARY

A. Introduction

1. **Background:** The Government of Bangladesh is emphasizing on improved connectivity in the country. In line with this objective, the Government of Bangladesh (GOB) announced its National Land Transport Policy in 2004 defining long term (20 years) Road Master Plan (RMP). The RMP has identified many feasible and priority projects. One of priority roads identified is the Elenga – Hatikamrul road. This road is a vital link in the national highway network and forms a part of the Asian Highway Network complementing the government plans to increase trade with India.

2. The upgrading of the road will have its associated environmental impacts that require due consideration in project design for its mitigation and management based on detailed environmental assessment. This report presents the Environmental Impact Assessment (EIA) carried out to determine the likely significant environmental changes due to the project and crafts mitigation measures to avoid, minimize, or compensate these impacts.

3. The existing road suffers from inadequate capacities and lack of safety. The road is two lanes with no shoulders and no provision for slow moving vehicular traffic (SMVT) or non-motorized traffic (NMT). There are capacity constraints caused by congested junctions, markets, and community areas. The project will upgrade the road to a four-lane road with safety features, dedicated SMVT lane, flyovers at business junctions, and overpasses at intersections.

4. **Purpose of the Report:** This environmental impact assessment (EIA) is part of the process of compliance with the Government of Bangladesh and ADB guidelines in relation to Road Improvement Project under Subregional Road Transport Project Preparatory and Facility (Road Component: Package-1) and as part of the Second Phase of SASEC Dhaka – Northwest Corridor Road Project.

5. The EIA provides a road map to the environmental measures needed to prevent and/or mitigate negative environmental effects associated with the development project. The EIA also provides a detailed description of the direct and indirect environmental effects associated with the proposed project during key periods of work.

6. **Extent of the Study:** This EIA is carried out based on most up-to-date project details and detailed designs provided by the design team during the preparation of this report. The corridor of impact has been defined as 500 m on either side from the edge of the road alignment. However, the study area has been extended to 5 km wide area on both side of the alignment to analyse the land use, identify potential borrow areas and environmental sensitive areas. Geographical Information System (GIS) techniques have also been used based on recent satellite imageries of the project areas for above purposes. The impacts on ecologically sensitive areas (e.g. national parks, wildlife sanctuaries, biosphere reserve, and protected places) within 5 Km radius of the project areas have also been assessed.

7. **Approach and Methodology:** The study has been conducted in accordance with Environment Conservation Rules, 1997, Government of Bangladesh (GOB) EIA Guidelines (1997) and ADB Safeguard Policy Statement (2009). The study is based on both primary and secondary data and information. The primary data includes data collected from field observations and secondary data includes review of the Bangladesh statistical and relevant information from Government Departments. Discussions were held with stakeholders including government

officials, community representatives and a wide range of road users and roadside dwellers. The main purpose of this approach was to obtain a fair impression on the people's perceptions of the project and its environmental impacts.

B. Environmental Policy, Legal and Administrative Framework

8. Regulatory Requirements for the Project: The government has many regulatory requirements toward protection and conservation of both natural and social environment from adverse impact of projects and activities. Some of the pertinent requirements and guidelines are the following:

- GOB Environmental Policy, Regulations, and Guidelines
- National Environmental Policy, 1992
- National Environmental Management Action Plan, 1995
- Environmental Conservation Act (ECA), 1995
 - Environmental Conservation Act (Amendment 2000)
 - Environmental Conservation Act (Amendment 2002)
 - Environmental Conservation Act (Amendment 2010)
- Environmental Conservation Rules (ECR), 1997 and Amendments
- Bangladesh Climate Change Strategy and Action Plan
- Relevant other regulatory requirements for the project

9. Asian Development Bank Safeguard Policies, 2009: Asian Development Bank (ADB) has three safeguard policies that seek to avoid, minimize or mitigate adverse environmental impacts and social costs to third parties, or vulnerable groups as a result of development projects. Since the ADB Safeguard Policy Statement had been approved, it supersedes the Involuntary Resettlement Policy (1995), the Policy on Indigenous Peoples (1998), the Environment Policy (2002), and the second sentence of para. 73, and paras. 77–85, and 92 of the Public Communications Policy (2005).

10. Project Category: The ADB SPS addresses environmental concerns, if any, of a proposed activity in the initial stages of project preparation. For this, the ADB SPS categorizes the proposed components into A, B, or C to determine the level of environmental assessment required to address the potential impacts. The project has been categorized as B based on SPS. Stakeholder consultation was an integral part of the EIA, and an environmental management plan (EMP) specifying mitigation measures to be adhered to during implementation of the project has been prepared.

11. According to ECR Schedule 1, the project is red category because it involves construction, reconstruction, and extension of roads and bridges. In due course an environmental assessment must be prepared in the prescribed format and be submitted to the Department of Environment (DOE) for approval.

C. Description of the Project

12. Project Location: The Elenga - Hatikamrul Road, located north of Tangail City, will start at Elenga Junction (24°20'22" N and 89°55'28" E) near the intersection of N4 and N405. The project road will terminate at chainage 83+081 because of the Bangabandhu Bridge and will start again at chainage 90+700 at the West side of this bridge. The road will end at Hatikamrul (24°25'8.97"N and 89°33'6.97"E) of Sirajganj district. The total length is 41.7 km.

13. The road is a standard two-lane highway (two 3.65 m lanes, paved shoulders each 1.5 m and verges each 1.0 m). The road condition is varying in different sections. Pavement crack is one the main problems for this road. There are several sub-standard horizontal curves. Road passes through some commercial areas at Elenga, Kodda Moor and Hatikamrul.

14. **Project Components:** The project components and design standards are defined in the following table.

Table 1: Road Components and Design Standards for Elenga-Hatikamrul Road

Road Components	
Length	41.7 Km (including 7.6 Km Bangabandhu Bridge on Jamuna River and approach roads)
Alignment	Follow the existing road alignment including the bypass area for road widening and improvement. No new road construction or bypass is proposed
Flyovers	2 flyovers (Elenga Intersection and Koddar Moor Intersection)
Major Bridges	42 bridges/culverts of which 15 bridges (1 Major Bridge >100m in length over Fuljor River) and 27 culverts
Embankment Design	Embankment height established for 1m free board on 20-year frequency HFL Dredged river sand based, side slope 3 hor: 1 ver, 600mm compacted cladding layer and turf for slope stabilization.
Design Standard	
Speed	Design : 80 kph Posted : 70 kph
Horizontal Controls	Controlling Curve: Maximum Super Elevation: 0.06 m/m Minimum Curve Radius: 252 m Design Speed: 50 km/h
Cross-Section Elements	Travelled each lane: 3.65 m Cross Fall : 3 %
Structural design standards	Roads and Highways Department (RHD) Bridge Design Standard 2004 American Association of State Highway and Transportation Officials (AASHTO) Standards Specification

15. To support RHD's road sector development strategy and operation, a 10-storey Road Research and Training Centre (RRTC) building will be established within RHD Headquarter in Mirpur, Dhaka. The building will host RHD Training Centre and ICT; and Road Research and Laboratory. The Training Centre and ICT will comprise training / class rooms, conference room, network and computer training room, office, and living accommodation. The Road Research and Laboratory will include research centre, laboratory, equipment hall, office, computer laboratory, auditorium, and internal mosque.

16. The Road Operations Unit (ROU) will also be established and implemented initially along the Dhaka-Elenga-Hatikamrul-Rangpur (Dhaka-Northwest international trade corridor). The unit will focus on pilot good practices on overloading control, road asset management and road safety. The ROU will establish axle load control stations, required facilities and equipment, business models (operation plan and staffing plan), enforcement mechanism engaging other agencies, and safety provisions to reduce the safety vulnerability.

D. Description of the Environment

17. The existing baseline condition of environmental features in the locality of project site serves as the basis for identification, prediction and evaluation of impacts. The following section describes the baseline environment into three broad categories:

1. Physical Environment

18. **Temperature.** The highest temperature recorded at Tangail station was 37.5 °C in April and the lowest temperature was found in the month of January which was 7.7 °C. The average monthly temperature graphs show that the area face high temperature from March to May and lowest temperature during winter remains from December to February in the year.

19. **Rainfall.** Maximum rainfall occurs during May to September and the lowest rainfall occurs in November to February during winter season. Statistical data of 1991 to 2012 shows that the station experiences more than 300 mm rainfall in June and July months during monsoon. In the month of December and January of winter season around 10 mm rainfall occurred in the region of Tangail stations.

20. **Humidity** Humidity remains high in summer and comparatively low in winter season. The statistical data of humidity from 1991 to 2012 indicates that humidity in the area maximized in July to September in the year which is ranges from 80% to 85%. On the other hand, humidity falls 60% to 75% in February, March and April during the winter season in the considered area.

21. **Wind Speed.** Wind speed remained maximum with 3.3 knots in May and the minimum was 1.9 knots in the month of December for Tangail station.

22. **Physiographic Features.** The Elenga - Hatikamrul road alignment area lies mostly in the central part of the country and depends on the Jamuna River for freshwater supply. The Elenga - Hatikamrul road area is characterized by the floodplains of Jamuna in Tangail District and Teesta floodplain in the Sirajganj District. The entire road alignment runs through the following two physiographic units 2: Teesta floodplain and 4: Old Brahmaputra floodplain.

23. **Topography.** The general topography of the project area comprises floodplains in the majority of the road and terraces. The general topography of the project area slopes from north to south with elevation ranges from 16 m a.m.s.l to 15 m a.m.s.l.

24. **Soil.** The project road passes through three different soil formation zones. The general soil types of the project road area predominantly include the following: Non-calcareous Alluvium (1) and Grey floodplain soil (5). The nature and soil characteristics of these zones influence the crops and cropping patterns within the region. Human interventions and modifications in the drainage patterns have already affected the cropping calendar, crop diversity and introduction of new varieties and agricultural products.

25. **Seismicity.** As per the seismic zone map, project road falls under Zone II, which means medium seismic intensity. There is no evidence of major earthquakes in the project areas in the past.

26. **Surface Water.** Two major surface water bodies traverses the project area - Jamuna River and Fuljor River. The project road alignment crosses all the water bodies at several locations. The overall quality of surface water around the project site and its surroundings varies

throughout the year. Typically water quality improves during the monsoon due to the influx of fresh rainwater, and worsens during the dry season as water evaporates and the concentration of contaminants increases. The concentration levels of all the measured parameters for surface water were found within the acceptable limit set by the DoE, GoB for fishing water in both Jamuna and Fuljor River. River bed material (sand) of the Jamuna and Fuljor Rivers contains acceptable amount of Arsenic (As), Lead (Pb), Zinc (Zn) and Mercury (Hg) comparing with the standard of EU Directive 86/278/EEC for land application. That is why; sand from the two rivers can be used for developing project Road Embankment.

27. Ground Water. The groundwater resources in the project area are found in three separate aquifers. An upper aquifer: a surface layer consisting mainly of clay and silt, characterized by high porosity but low permeability; composite aquifer: an intermediate layer of mainly fine sand and clay characterized by high porosity and moderate permeability (possibility of providing water with hand pumps); and main aquifer: a deeper layer, containing mainly fine to coarse sand. The concentration levels of Mn, Fe, Cl⁻, Total Hardness, for the tube well of Gorilabari Village and Fuljor College Moor were found above or less within the acceptable limit set by the DoE, GoB for drinking water. However, TC and FC in the groundwater were not present and it was within the given standards. In case of Arsenic, both the samples contain higher amount than the standard drinking water quality which is hazardous for health.

28. Air Quality. The SPM and PM₁₀ concentrations exceeded the DoE allowable limit in the measured locations. There are two different sources of particulates matters; natural and human induced. The naturally generated particulates originates from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray. Human activities, such as the burning of fossil fuels in vehicles, power plants and various industrial processes also generate significant amounts of particulates. In the project area human activities are mainly responsible for the high concentration of SPM and PM₁₀.

29. Noise Level. Analysis of the day time noise data shows that the baseline noise around the project area varies from location to location. The highest day time equivalent noise levels recorded at Hatikamrul intersection, Ullapara, Sirajganj was 79.6 dBA. The highest night time equivalent noise levels also recorded at the same place for day time Hatikamrul intersection, Ullapara, Sirajganj was 79.1 dBA. The noise level at the four locations is above the standard set in Bangladesh Noise Pollution (Control) Rules, 2006 in both day and night time.

2. Biological Environment

30. Bio-ecological Zones. The project road alignment crosses the three bio-ecological zones: Teesta floodplain (4a), The Brahmaputra-Jamuna floodplain (4c) and Major Rivers (11).

31. Terrestrial Flora. The project influence area (PIA) is highland with mixed vegetation. Crops, vegetables are cultivated at the surrounding area mainly include rice, wheat, rabi crops and variety of homestead vegetables. According to the census and IOL survey completed in February-March 2014, a total of 31,450 trees of different sizes (large=3,432, medium= 7,318, small= 17,383 and saplings= 3,317) are standing within ROW of the road's alignment. A sizeable number of fruit trees with economic value have been observed in the PIA. The fruit trees include jackfruit, mangoes, litchi, banana, coconut, blackberry and timber trees that that include mehegoni, neem, epil-epil, koroï etc. Considerable number of trees and bushes in the PIA site provide habitat for birds and other animals. The composition of plant community includes low growing grasses, trees, herbs and shrubs. The data collected from the field survey suggests that the predominant species are those of cultivated vegetables and trees.

32. **Terrestrial Fauna.** The diversified habitat and ecosystem in the project area support various types of animals. Primary and secondary mode was adopted for identification of fauna. Most of the birds are identified through direct observation rather than from people. Most of the amphibians, reptiles and mammals were identified by using books and description of the local people during the field survey.

33. **Aquatic Flora.** Different types of aquatic flora species were recorded in the project areas. The most abundant hydrophytes in the project area are Kochuripana (*Eichhornia crassipes*), Topapana (*Pistia stratiotes*), Khudipana (*Lemna minor*) Pata Jhajii (*Vallisneria spiralis*), Shapla (*Nymphaea sp.*), Kolmi (*Ipomoea aquatica*), Helenchaa (*Enhydra fluctuant*), and Duckweed (*Spiredella sp.*). Numerous algae (e.g. *Spirogyra* and *Scytonema*) and amphibian plant, Dhol kolmi (*Ipomoea fistulosa*) are also found in the road side water bodies.

34. **Aquatic Fauna.** Fish is the most important aquatic fauna of the project areas, along with other groups. The aquatic fauna includes Prawns (*Macrobrachium spp.*), crabs, snails (Pila, Vivipara, Lymna etc.), freshwater mussels (*Lamellidens sp.*) etc. invertebrates and about 70 species of fish. Kolabang (*Rana tigrina*); Guishap (*Varanus bengalensis*) and Matia sap (*Enhydris enhydris*) are common. The aquatic birds are Pancowri (*Phalacro coraxcarto*), Kanibok (*Ardeo lagrayii*), Sadabok (*Egretta garzetta*), Borobok (*Egretta alba*), Machranga (*Halcyon pileata*), Dahuk (*Gallixrex cinerea*), and winter migratory birds Balihash (*Dendrocygna javanica*) and Chakha (*Tadorna ferruginea*).

35. **Wildlife Sanctuary.** In and around the project area some wildlife species were identified as locally vulnerable. The name of these vulnerable species is Bengal monitor and Bengal fox. Any construction must consider impacts on the rate of deforestation, loss of habitat, habitat fragmentation, and interruption of wildlife migration patterns. The Chalan Beel is one of the biggest wildlife sanctuaries are quite far from the project location and not within the 5 km buffer zone.

3. Socio-Economic Environment

36. **Housing and Settlement.** The entire alignment runs through an open place. Agricultural lands are found in both sides of the road, although there are few houses and bazars along the road. There are some large and small restaurants/refreshment centres situated in both sides of the RoW. Housing condition of the five upazilas (Kalihati, Sirajganj Sadar, Kamarkhand, Royganj and Ullapara) of the project is predominantly kutcha, semi pucca and pucca houses found in the semi-urban area. The average data about the main house of the dwelling households by type of structure shows that pucca and semi-pucca household structures remain higher in urban area comparing to the rural area and upazila. According to the resettlement survey, a total of 181,083 square feet primary structures of different types will be affected. A total of 8.87 ha of land will be acquired.

37. **Land Use.** Land use analysis was carried out along five-kilometre buffer zone from centreline of the Elenga-Hatikamrul road using optical satellite imageries. Agriculture area is in the dominant position along the project road which is 63.72%. A significant portion covers the river area which is 12.59%. The settlement area covers 20.66% and water bodies covers 3.03% respectively.

38. **Water Supply and Sanitation.** Tube wells are the most common source of drinking water in both the urban and rural areas. Tap water is accessible only in urban areas. Most households do not treat water prior to drinking. Sewage facilities are available in most of the urban areas. The

sanitary facilities are better in the semi-urban areas than the rural areas. Particularly, in the Sirajganj Sadar and Kamarkhand area have better sanitary facilities than the other upazilas along the road alignment.

39. Transport and Communication. The project road is connected with national highways, village roads, and railways in certain locations. The common types of transports are bus, truck, microbus, car, CNG, motorcycle, van and rickshaw. Mobile and wire telephone services are available in most of the areas. During the field survey, it is found that there are many roads crossing present in the Elenga-Hatikamrul road alignment which connect the adjacent villages to the highway.

40. Environmental Hotspots. The socio-cultural aspects include the educational institutions, hospitals/health centres, religious structures, cultural structures, burial grounds, cremation yards, market places, industrial structure, water bodies, etc., few of which would be affected directly and indirectly through implementation of the both routes. Such sites could be termed as Environmental Hotspots in relation to project activities and, hence, need to be dealt carefully during the construction phase. There are no archaeological and historic sites in the RoW of the Elenga-Hatikamrul road project. Among the cultural sites, four mosques, one school, three filling stations and one mazar (shrine) fall within the RoW of the road alignment.

E. Anticipated Environmental Impacts and Mitigation Measures

41. The current environmental assessment is based on the potential sensitive issues and impacts identified during site visits, consultation with local administrations, and the public. This section identifies the overall impacts on the physical, biological and socio-economic environment of the project area. An environmental impact is defined as any change to an existing condition of the environment. Identification of potential impacts has been done on the basis of baseline data collected from secondary and primary sources. Environmental impacts assessment was carried out considering present environmental setting of the project area, and nature and extent of the proposed activities.

42. Qualitative and quantitative techniques have been applied for direct and indirect impact identification. Impacts are classified as being insignificant, minor, moderate and major. Impacts are described in the sections below.

43. Some of the important impacts associated with the proposed project will be associated with land use (land acquisition), land stability (soil erosion), soil compaction and contamination, water availability, water quality of river/stream/canal, ground water contamination, waste and wastewater disposal, ambient air quality, ambient noise levels, vegetation, tree cutting (including social forestry tree), fauna (terrestrial and aquatic), drainage pattern, hydrology, climate change, socio economic, places of social/cultural importance (religious structures, community structure), construction material sourcing and occupational health and safety. Adequate mitigation measures are devised to mitigate/minimise all likely environmental impacts and the same have been presented along with the impacts.

44. To assess the likely impacts on the ambient air quality due to the proposed road project, CALINE-4, a line source model developed by the California Transport Department, was used to predict carbon monoxide (CO) and particulate matter (PM) concentrations on the road. The model was run to predict hourly average CO, PM_{2.5} and PM₁₀ concentrations generated from traffic movement on proposed highway.

45. Kerb side locations were selected to compare the model prediction with monitored locations. Compared with the actual measurements of PM_{2.5}, PM₁₀ and CO concentrations, the predicted concentrations of each pollutant is lower.

46. In addition, the spatial distribution of hourly average predicted CO, PM_{2.5} and PM₁₀, concentrations have been plotted for peak traffic hour which shows that pollutant concentrations is decreasing the farther away from the highway corridor. Therefore, the impacts of traffic movement at proposed highway project will not impact the surrounding atmosphere.

47. Noise pollution propagation generated from traffic was predicted using Canarina CUSTIC 3.2 software, where noise emission from vehicles along the proposed Elenga – Hatikamrul Road is modelled as steady state line source. Sensitive noise receptors along the corridor were identified such as educational institutions, health complexes and religious centres. Based on the model prediction, the predicted noise for the following sensitive receptors will be exceeded by 2040, compared to the current scenario: Bytunnur Jame Mosque, An-Noor Mosque, unnamed mosque, Sayadabad Mosque, Bangabandhu Setu Purbo Station, Bangabandhu Setu Poschim Station, Analiabari High School, Talimul Islam Madrasha, Jamuna Polytechnic Institute, Shohidul Bulbul Karigori College, and Simanto Bazar. Predicted noise levels ranged from 65.6-74.8 Leq.

48. Consultations were also held with people in the locality including those presently living in the project areas and Government authorities. Outcome of these consultations were used in impact assessment and devising mitigation measures.

F. Greenhouse Gases Emission and Climate Change Assessment

49. GHG emissions likely to be generated from the project roads have been computed using the Transport Emissions Evaluation Model for Projects (TEEMP)¹ developed by Clean Air Asia² was utilized to assess the CO₂ gross emissions with and without the project improvements. In terms of intensity, total CO₂ emissions at business-as-usual, with-project (without induced traffic) and with project (with induced traffic) scenarios were estimated at 712,882 tons/year, 305,460 tons/year and 404,370 tons/year, respectively. These values are significantly above the 100,000 tons CO₂e/year threshold³ set in ADB SPS 2009. ADB requires the borrower (the Government of Bangladesh through the Roads and Highways Department) to evaluate feasible and cost effective options to reduce or offset project related greenhouse gas emissions.

50. Climate change in Bangladesh indicate risks and vulnerabilities due to changes of temperature, rainfall, temperature and rainfall related extreme events, cyclones, floods, and sea level rise that will likely result to (1) higher annual precipitation and daily temperature; (2) greater temperature and rainfall extremes; (3) increased flooding, both in terms of extent and frequency; (4) increased cyclone and storm surges both in terms of extent and frequency; (5) low river flow during dry periods; and (6) sea level rise and increased salinity intrusion. Climate change adaptation measures include (1) Adaptation allowance of 0.37 m above flood level; (2) Additional 102.4 cm for road embankment; (3) Additional 37 cm in bridge above HFL; (4) Incorporation of longitudinal drains along total highway length and increasing the number of cross drainage per

¹ TEEMP is an excel-based, free-of-charge spreadsheet models to evaluate emissions impacts of transport projects.

²A network of 250 organizations in 31 countries established by the Asian Development Bank, World Bank, and USAID to promote better air quality and livable cities by translating knowledge to policies and actions that reduce air pollution and greenhouse gas emissions from transport, energy and other sectors.

³Page 38, Appendix I, footnote 10 of SPS 2009

unit distance; (5) Construction materials policy adaptation through the use of river sand rather than clayey agricultural soil for roadway embankment; (6) and using high quality asphalt pavement to adapt to increase in temperature.

G. Environmental Management Plan

51. Environmental Management Plan (EMP): On the basis of identification of the environmental impacts and recommended mitigation measures linked with the Elenga-Hatikamrul project activities, an EMP has been prepared which will be followed at the pre-construction, construction and operation stages. While preparing the EMP, medium and significant impacts are taken into consideration to recommend possible mitigation measures. A mitigation measure will be considered as successful when it complies with the Environmental Quality Standards (EQS), policies, legal requirements set by ADB SPS, 2009 and DoE environmental guidelines & other relevant GoB legal requirements. In absence of DoE's own EQS, other relevant international or other recognized organization's quality standard will be applied.

52. EMP Implementation Schedule: An implementation schedule has been sketched based on the environmental components that may be affected during the construction and operation of the project. Since project is likely to have impact on various components of environment, a comprehensive EMP implementation schedule covering terrestrial and aquatic ecology, soil erosion, drainage congestion, tree plantation, air quality, noise, and vibration are provided. Monitoring Plan has been separately suggested for pre-construction, construction and operation phase.

53. Environmental Monitoring Plan: Environmental monitoring is an essential tool for environmental management as it provides the basic information for rational management decisions. The purpose of the monitoring program is to ensure that the envisaged purposes of the project are achieved and result in desired benefits to the target population. To ensure the effective implementation of the mitigation measures, it is essential that an effective monitoring program be designed and carried out. Compliance monitoring will be conducted in accordance with the environmental mitigation measures and monitoring plan provided with this report.

54. Environmental Budget: The overall costs of the EMP will comprise:

- Environmental monitoring through sample collection and analysis;
- Any remedial measures necessary to reduce or avoid environmental damage;
- Designing and implementing all mitigating and enhancement measures;
- Supervision staff from RHD and consultants including direct costs and travel subsistence.

55. The total budget is estimated **US\$ 0.57 million.**

H. Institutional Arrangement, Capacity Building and Grievance Redress Mechanism

56. Institutional Arrangement: The Environmental Management Plan (EMP) implementation requires an organization support structure in the form of organizational requirements, training needs and plan, and information management system.

57. The Roads and Highways Department (RHD) is the Executing Agency (EA) and will be responsible for ensuring that all the provisions of the EMP are complied with. The RHD has the responsibility to ensure that the investment follows the legal requirements for environmental

assessment. The Environmental and Social Circle (ESC) headed by the Superintending Engineer, will be responsible for managing environment and social safeguards including safeguards related capacity building for all RHD projects, although they will not be involved in the day to day implementation of safeguards for specific projects.

58. The Project Implementation Unit (PIU) will be responsible for ensuring proper implementation of environment safeguards in their respective projects including implementation of the EMP and Environmental Monitoring Plan (EMoP), timely reporting and timely resolution of complaints and grievances.

59. The Additional Project Director under the PIU will serve as the Environmental Focal Person at the Project Headquarter level. At the site level an Assistant Engineer supporting the Project Manager will serve as the environmental focal person.

60. The Project Implementation Consultant (PIC) will provide support to the PIU for day to day monitoring and reporting on environmental safeguards. The PIC will be responsible for supervising the civil works contractor and to ensure the conformity of contractors with the relevant clauses in construction contracts and national regulations. The Contractor will implement the EMP and EMoP and obtain all environment related permits and clearances required for construction.

61. **Capacity Building:** In Bangladesh, the environmental assessment process is established, but environmental awareness and capability for implementation of EMP in infrastructure projects are still developing. The project implementation unit (PIU) of RHD had some officers in the Environmental and Social Circle department (ESC) that are delegated environmental duties. The delegated officers have responsibility to bring environmental issues to the notice of senior management. Typically, the delegated officers have been moved to different departments due to promotions and operational needs after about every 3 years, and they move on to other engineering departments in RHD. The status quo is that ESC engineering officers are delegated to check environmental assessments prepared by consultants. The IEEs and EMP are referred to the DOE in the Ministry of Environment and Forests (MOEF) for approval. The ESC in RHD is not directly involved with project implementation, but has more administrative responsibility to ensure environmental compliance and a general role to increase environmental awareness for RHD. It is therefore not clear if RHD/ESC has the capacity to check the adequacy of the developed EMP for this project.

62. **Grievance Redress Mechanism:** To facilitate the resolution of affected people's concerns, complaints, and grievances about the social and environmental performance of the project, a Grievance Redress Mechanism (GRM) is established which aims to provide a time bound and transparent mechanism to voice and resolve social and environmental concerns.

63. The Environment and Social Circle (ESC) of RHD shall make the public aware of the GRM through public awareness campaigns. The contact phone number of the respective SEC will serve as a hotline for complaints, and shall be publicized through the media and placed on notice boards outside their offices and at construction sites. The project information brochure will include information on the GRM and shall be widely disseminated throughout the project area by the Environmental Specialist/Engineer in the SEC, with support from the NGOs and communications firm. Grievances can be filed in writing or by phone with any member of the SEC.

I. Information Disclosure, Consultation and Participation

64. The discussions were primarily focused on receiving maximum inputs from the participants regarding their acceptability and environmental concerns arising out of the project. The purpose of this stakeholder consultation is to identify the views of major institutional and project affected persons (PAPs) stakeholders to the project area being examined, and to identify issues of relevance to the study, as well as any impacts which the project may have on project planned by the stakeholders, and to assess any mitigation measures which may be undertaken to minimize any adverse impacts of the proposals under consideration. This project will indeed be helpful for socio-economic development for central region of the country by timely transporting of essential goods and products required for agricultural and industrial development. Subsequently, stakeholder consultation is one of the important parts of the EIA to address the environmental aspects as well as socio-economic issues from stakeholders' point of view.

65. Public Consultations, Focus Group Discussions (FGDs), Government Officials, Non-government Organizations, Individual Local People have been conducted continuously during the EIA study in conformity with the ADB and DoE guidelines. Project staffs were carried out a series of stakeholder consultations at different locations of the project.

J. Conclusions and Recommendations

66. **Conclusions:** This environmental impact assessment (EIA) concludes that the environmental impacts will be manageable if the mitigation measures are implemented thoroughly. The EMP is based on the type, extent, and duration of the identified environmental impacts. The EMP has been prepared with close reference to best practices and in line with the ADB's Safeguards Policy Statement (SPS) and DoE environmental guidelines.

67. The project is classified 'B' in accordance with ADB's Safeguard Policy Statement 2009 requiring preparation of an Initial Environmental Examination Report. As per the Environmental Conservation Act, 1995 of Bangladesh, the project falls under Red category and requiring preparation of an EIA. This report is prepared keeping the ADB and GOB environmental requirements in consideration.

68. **Recommendations:** The EMP, its mitigation and monitoring programs, contained herewith shall be included within the Bidding documents for project works. The Bid documents state that the contractor shall be responsible for the implementation of the requirements of the EMP through his own Site Specific Environmental Management Plan which will adopt all of the conditions of the EMP and add site specific elements that are not currently known, such as the Contractors borrow pit locations. This ensures that all potential bidders are aware of the environmental requirements of the project and its associated environmental costs.

69. The EMP and all its requirements shall then be added to the contractor's contract, thereby making implementation of the EMP a legal requirement according to the contract. He shall then prepare his CEMP which will be approved and monitored by the Engineer/Environmental Specialist. To ensure compliance with the CEMP the contractor should employ a national environmental specialist to monitor and report project activities throughout the project construction phase.

70. RHD has Environmental and Social Circle but they need capacity building and practical exposure. Adequate training shall be imparted as proposed under environmental management plan to enhance the capability of concerned EA officials. It is recommended to update

environmental guidelines focused on effective implementation of mitigation measures. Performance indicators may also be developed as part of these guidelines to monitor and assess the effectiveness of the mitigation measures.

71. The Initial Environmental Examinations and Environmental Management Plans for the establishment of Research and Training Centre (RRTC) and Road Operations Unit (ROU) will be prepared by the Project Implementation Consultant (Supervision Consultant) after the detailed designs are prepared.

I. INTRODUCTION

A. Project Background and Rationale

1. Background

1. The Government of Bangladesh (GOB) is emphasizing on improved connectivity between each part of the country. In support with this objective the GOB announced its National Land Transport Policy in 2004 defining long term (20 years) Road Master Plan (RMP). The RMP has identified many feasible and priority projects. One of priority roads identified is the Elenga - Hatikamrul road. This road is a vital link in the national highway network and forms a part of the Asian Highway Network complementing the government plans to increase trade with India.

2. The present road suffers from inadequate capacities and lack of safety. The road is two lanes with no shoulders and no provision for slow moving vehicular traffic (SMVT) or non-motorized traffic (NMT). There are capacity constraints caused by congested junctions, markets, and community areas. The project will upgrade the road to a four lane road with safety features, dedicated SMVT lane, flyover at business junctions, and overpasses at intersections.

3. The upgrading of the road will have its associated environmental impacts that require due consideration in project design for its mitigation and management based on detailed environmental assessment. This report presents the Environmental Impact Assessment (EIA) carried out to determine the likely significant environmental changes due to the project and techniques mitigation measures to avoid, minimize, or compensate these impacts.

4. This EIA was prepared under the Technical Assistance for Subregional Road Transport Project Preparatory Facility (ADB Loan 2688-BAN) with the guidance of the Roads and Highways Department (RHD) which is the project's executing agency (EA). Considering ADB's Screening Checklist for Environmental Classification the proposed road have been categorized under Category B of ADB's environmental classification system. The required level of environmental assessment for Elenga-Hatikamrul with respect to Government of Bangladesh (GoB) requirements was established prior to commencing the assessments. Accordingly, as the road is proposed for developments are either national or regional roads which are in the Red List of GoB Environment Conservation Rules, 1997, the requirement is for preparation of EIA.

B. Purpose of the Report

5. This EIA is a part of the process of compliance with the Government of Bangladesh and ADB guidelines in relation to Road Improvement Project under Sub-regional Transport Project Preparatory and Facility (Road Component: Package-1) and as part of the Second Phase of SASEC Dhaka – Northwest Corridor Road Project.

6. Several activities that are likely to take place during the project implementation and the associated potential impacts have been analyzed in this present EIA. The EIA provides a road map to the environmental measures needed to prevent and/or mitigate negative environmental effects associated with the development project. The EIA also provides a detailed description of the direct and indirect environmental effects associated with the proposed project during key periods of work.

7. The Elenga - Hatikamrul road mainly passes through agricultural land and small portion through residential area. There are some small commercial places where business closely related

to passengers of the vehicle running on this road. This road crosses various water bodies, which are important from aquatic ecology perspective. Assessment has been carried out to identify the impacts of the proposed road improvement works on terrestrial and aquatic ecology, land use, air, and water and noise quality. An Environmental Management Plan (EMP) has been developed with suggestions to mitigate the potential impacts. Extensive consultations with the local people and persons from government officials undertaken as part of the EIA work have been considered for identifying the mitigation measures.

1. Extent of the Study

8. The most up-to-date information on project details and detailed designs provided by the design team has been considered in the preparation of this report. The impact area for the project activities has been categorized according to its extent on the surrounding environment. The corridor of impact has been defined as 500 m on either side from the edge of the road alignment. However, the study area has been extended to 5 km wide area on both side of the alignment to analyse the land use, identify potential borrow areas and environmental sensitive areas. Geographical Information System (GIS) techniques have also been used based on recent satellite imageries of the project areas for above purposes. The impacts on ecologically sensitive areas (e.g. national parks, wildlife sanctuaries, biosphere reserve, and protected places) within 5 Km radius of the project areas have also been assessed.

9. The scope of the EIA study has been confined to project related activities associated with design, construction (e.g. site clearing, earth borrowing, quarrying, material transportation, paving, camping) and operation stages. As per information available from design team, no additional facilities like toll plazas, truck plaza are proposed. Hence, no impacts assessment for such facilities was carried out. The TOR of the EIA is provided in the Appendix A and DoE approval of the TOR is provided in the Appendix B.

2. EIA Content

10. This EIA report comprises nine chapters, in consistent with the Government of Bangladesh guidelines and ADB's Safeguard Policy Statement, 2009. These chapters are:

1. Introduction
2. Policy, Legal and Administrative Framework
3. Description of the Project
4. Description of Existing Environment
5. Anticipated Environmental Impacts and Mitigation Measures
6. Environmental Management Plan
7. Institutional Arrangement, Capacity Building and Grievance Redress Mechanism
8. Information Discloser, Consultation and Participation and
9. Conclusion and Recommendations.

C. Approach and Methodology

1. Approach

11. The study has been conducted in accordance with Environment Conservation Rules, 1997, Government of Bangladesh (GOB) EIA Guidelines, 1997, and ADB Safeguard Policy Statement (2009). The study is based on both primary and secondary data and information. The primary data includes data collected from field observations and secondary data includes review

of the Bangladesh statistical and relevant information from Government Departments. Discussions were held with stakeholders including government officials, community representatives and a wide range of road users and roadside dwellers. The main purpose of this approach was to obtain a fair impression on the people's perceptions of the project and its environmental impacts.

12. Methodology. The following methodology was adopted for carrying out the EIA study of the proposed project:

13. Orientation. Meetings and discussions were held among the members of the EIA Consulting Team. This activity was aimed at achieving a common ground of understanding of various issues of the study.

14. Data Collections Planning. Subsequent to the concept clarification and understanding obtained in the preceding step, a detailed data acquisition plan was developed for the internal use of the EIA Consulting Team. The plan included identification of specific data requirements and their sources; determined time schedules and responsibilities for their collection; and indicated the logistics and other supporting needs for the execution of the data acquisition plan.

15. Data Collection. In this step, primary and secondary data were collected through field observations, environmental monitoring in the field, concerned departments and published materials to establish baseline profile for physical, biological and socioeconomic environmental conditions. Following activities were performed for data collection:

- Site Reconnaissance
- Analysis of Maps and Plans
- Literature Review
- Desk Research
- Public Consultations
- Field Observations, Data Collection & Studies
- Laboratory Analysis

2. Physical Environment

16. Information was collected on the existing physical environment, particularly as related to geology, topography, soils, hydrology and drainage, water quality, air quality and noise, etc.

17. Geology, Topography, Soils. Data related to geology, topography and soil was collected to establish the baseline of the project area and further to find out the impacts of the project during the construction and operational phases.

18. Hydrology and Drainage. Data related to hydrology and drainage was collected to identify the elements of the hydrological cycle that are likely to have impacts on the project and the possible impacts that the project could have on the hydrological regime. Field assessments included a determination and verification of all the existing inflows into the drain, assessment of drainage issues, interviews with local community members, and roundtable discussions with stakeholders.

19. Air Quality. Ambient air quality measurements are essential to provide a description of the existing conditions, to provide a baseline against which changes can be measured and to assist in the determination of potential impacts of the proposed construction on air quality

conditions. Ambient air quality was continuously monitored for Carbon Monoxide (CO), Sulphur Dioxide (SO₂), Oxides of Nitrogen (NO_x), Particulate Matter (PM₁₀ & PM_{2.5}), and other regular weather conditions for 24 hours. In order to monitor air quality at the different locations, the field investigation was undertaken on 22-30 March, 2017. The high volume sampler, Ecotech Model AAS 271 MINI has been used to collect particulate matters and Ecotech Model AAS 118 Gaseous Pollutions Sampler for gaseous measurement.

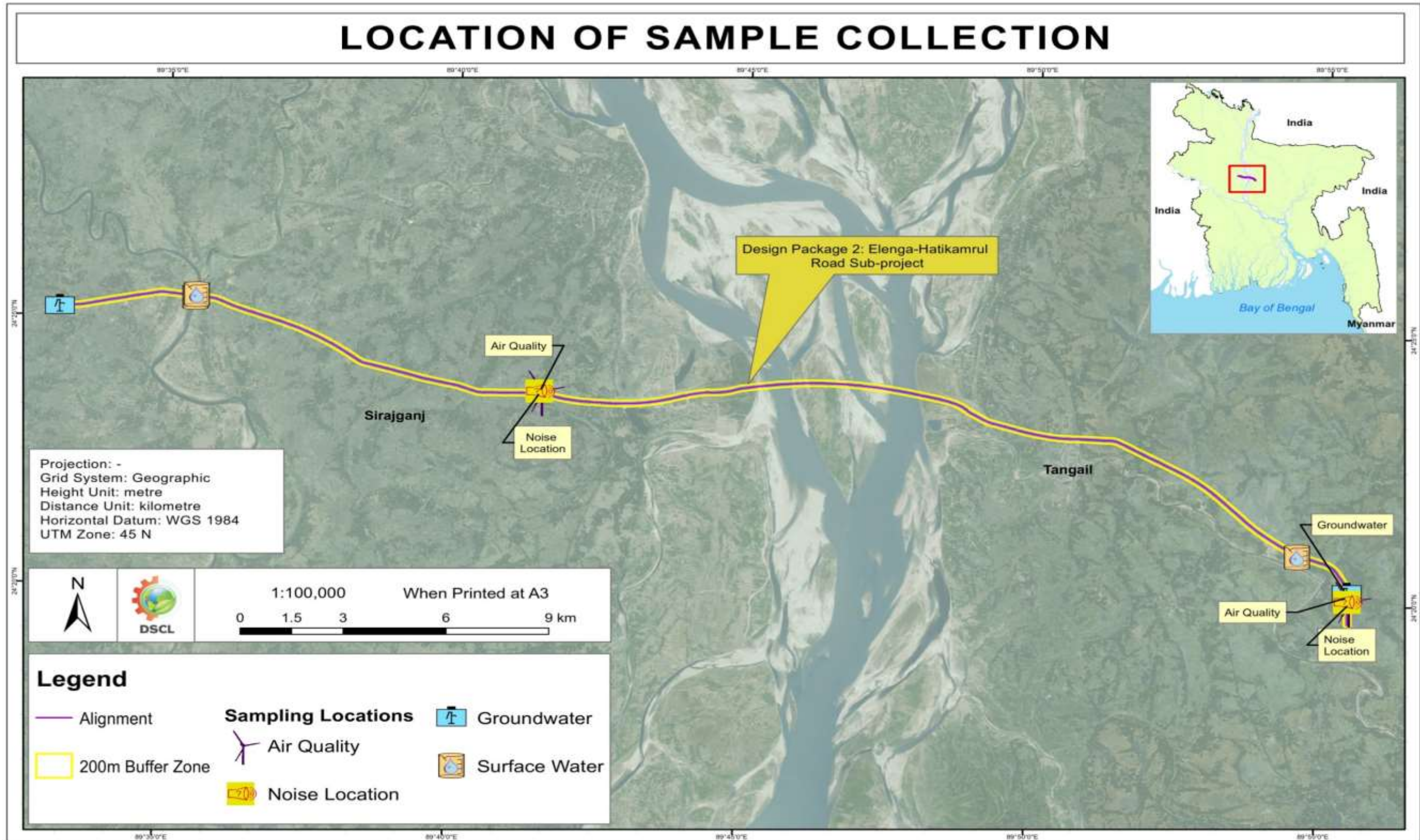


Figure 1: Location of Sample Collection along the Project Road

20. **Noise.** The noise monitoring was performed by a trained specialist, using a calibrated Digital Sound Level Meter (Model No SL-4033SD) set to A-weighting, fast response and statistical analysis settings. The Sound Level Meter (SLM) was mounted on a tripod at a height of approximately 1.5m, facing in the direction of the apparent predominant noise source. The SLM was programmed to record statistical noise levels for 24 hours at each location and was calibrated before and after the survey; no significant drift was detected.

21. **Ground/Drinking Water Quality.** Sampling and analysis of ground/drinking water has been carried for the following parameters: pH, Manganese (Mn), Arsenic (As), Iron (Fe), Chloride (Cl), Total Hardness, Total Coliform (TC) and Faecal Coliform (FC).

22. **Surface Water Quality.** Sampling and analysis of surface water quality has been carried out for the following parameters: pH, Total Organic Carbon (TOC), Total Phosphate (PO₄), Total Suspended Solids (TSS), Oil and Grease, and Dissolved Oxygen (DO).

23. **Soil Quality.** Soil quality has been carried out to identify presence of heavy metals for the parameters: Mercury (Hg), Zinc (Zn); Arsenic (As), Cadmium, Copper and Lead (Pb).

3. Biological Environment

24. The status of the flora and fauna of the project area were determined by an ecological survey, review of literature relevant to the area, and an assessment of terrestrial environment.

25. **Flora.** The vegetative communities were identified and classified into community types. Identification was carried out of dominant tree species, assessment of stage of growth (mature or sapling) and assessment of canopy cover.

26. **Fauna.** Information on fauna was gathered from existing literature on reported species as well as observations in the field.

4. Socio-Cultural Environment

27. In order to assess the socio-cultural environment the Consultants utilized a combination of desk research, field investigations, census data, structured interviews, maps, reports to generate the data required for description of the existing social environment and assessment of the potential impacts due to the construction of the project. The important data collected and analysed to assess the parameter are given below:

- Land use
- Traffic, transportation and access Roads
- Demographics
- Livelihoods
- Poverty
- Education
- Health
- Social setup
- Community facilities
- Recreational activities
- Archaeological and cultural heritage, etc.

28. **Public Consultation.** Public consultation is one of the important components of the EIA preparation activities. Local knowledge about the ecosystem and problems associated with the existing roads were carefully recorded and used in impact assessment and developing mitigation plan. Formal institutional level public consultation, in tandem with opportunistic informal ones involving local dwellers, road users and people whose livelihood depends on these roads, were executed. Detailed description of public consultation has been presented at Chapter 8.

D. The Environmental Impact Assessment (EIA) Team

29. SMEC International Pty Ltd is a specialist consultancy firm which has been contracted by RHD to prepare and deliver the EIA for the project. The SMEC team members have many years of professional experience working in environmental impact assessments both within Bangladesh and internationally. The composition of the EIA team is provided below in Table 2.

Table 2: The EIA Team

Name	Position
Md. Shafiqur Rahman	Environmental Specialist
Raisin Akhter Feroz	Environmental Specialist

II. ENVIRONMENTAL POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. Regulatory Requirements for the Project

30. Regulatory requirements toward protection and conservation of environment and various environmental resources and also toward protection of social environment from adverse impact of projects and activities associated with them have been enunciated by the GOB as well as the ADB pertinent among these requirements are summarized below.

B. GOB Environmental Policy, Regulations, and Guidelines

1. National Environmental Policy, 1992

31. Bangladesh has adopted a National Environmental Policy (NEP) in 1992 aimed at sustainable development. The NEP sets out the basic framework for environmental action together with a set of broad sectoral guidelines for action. Major elements of the policy are as follows:

- Maintaining the ecological balance and ensuring sustainable development through protection and conservation of the environment;
- Protection of the country against natural disasters;
- Identification and control of activities that pollute and destroy the environment;
- Ensuring environment-friendly development in all sectors;
- Promoting sustainable and sound management of natural resources; and
- Active collaboration with international initiatives related to the environment.

32. The environmental policy in the transport sector aims at prevention of pollution and degradation of resources caused by roads and inland waterways transport. The policy mentions that Environmental Impact Assessments (EIA) should be conducted before projects are undertaken.

2. National Environmental Management Action Plan, 1995

33. The National Environmental Management Action Plan (NEMAP) builds on the National Environment Policy (NEP) and was developed to address specific issues and management requirements during the period 1995-2005. The plan includes a framework within which the recommendations of a National Conservation Strategy (NCS) are to be implemented. The NEMAP was developed with the following objectives:

- Identify key environmental issues affecting Bangladesh;
- Identify actions to halt or reduce the rate of environmental degradation;
- Improve management of the natural environment;
- Conserve and protect habitats and bio-diversity;
- Promote sustainable development; and
- Improve the quality of life of the people.

3. Environmental Conservation Act (ECA), 1995

34. 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.

35. The main objectives of ECA are:

- Conservation and improvement of the environment; and
- Control and mitigation of pollution of the environment.

36. The focus 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.

37. Before any new project can go ahead, as stipulated under the ECA, the project proponent must obtain Environmental Clearance from the Director General (DG), DOE. An appeal procedure does exist for these proponents 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.

4. Environmental Conservation Act (Amendment 2000)

38. 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.

5. Environmental Conservation Act (Amendment 2002)

39. 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.

6. Environmental Conservation Act (Amendment 2010)

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

- No individual or institution (Gov. or Semi Gov, / Non Gov. / Self-Governing) cannot cut any Hill and Hillock. In case of national interest; it can be done after getting clearance from respective department

- No remarked water body cannot 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.

7. Environmental Conservation Rules (ECR), 1997 and Amendments

41. These are 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 based on categories of industrial and other development interventions.

42. The Environment Conservation Rules, 1997 were issued by the GOB in exercise of 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.

43. 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 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 ECA. Under this mandate, the Ministry of Environment and Forest (MOEF) has declared Sundarbans, 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.

44. 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.

45. The categorization of a project determines the procedure for issuance of an Environmental Clearance Certificate (ECC). All proposed industrial units and projects that are 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, a site clearance certificate and thereafter an environmental clearance certificate will be required. A

detailed description of these 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.

- Clause 63 - Construction, reconstruction and extension of road (feeder road, local road);
- Clause 64 - Construction, reconstruction and extension of bridge (length below 100 meters).

46. According to Schedule 1, the Red Category includes the following projects:

- Clause 67 – Construction / reconstruction / expansion of road (regional, national and international)
- Clause 68 – Construction / reconstruction / expansion of bridge (length 100 meters and above).

47. Thus, for the proposed Elenga – Hatikamrul Road, an EIA will be required to secure ECC from DoE. Apart from general requirements, for every Red Category proposed industrial unit or project, the application for ECC must be accompanied with feasibility report and Initial Environmental Examination/Environmental Impact Assessment with Environmental Management Plan (EMP), which are based on the ToR approved by DoE.

8. Bangladesh Climate Change Strategy and Action Plan

48. The GOB also prepared the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) in 2008 and revised in 2009. This is a comprehensive strategy to address climate change challenges in Bangladesh. Bangladesh Climate Change Strategy and Action Plan built on and expanded the NAPA. It is built around the following six themes:

- **Food security, social protection and health** to ensure that the poorest and most vulnerable in society, including women and children, are protected from climate change and that all programs focus on the needs of this group for food security, safe housing, employment and access to basic services, including health.
- **Comprehensive disaster management** to further strengthen the country's already proven disaster management systems to deal with increasingly frequent and severe natural calamities.
- **Infrastructure** to ensure that existing assets (e.g., coastal and river embankments) are well maintained and fit for purpose and that urgently needed infrastructure (cyclone shelters and urban drainage) is put in place to deal with the likely impacts of climate change.
- **Research and Knowledge management** to predict that the likely scale and timing of climate change impacts on different sectors of economy and socioeconomic groups; to underpin future investment strategies; and to ensure that Bangladesh is networked into the latest global thinking on climate change.
- **Mitigation and low carbon development** to evolve low carbon development options and implement these as the country's economy grows over the coming decades.
- **Capacity building and Institutional strengthening** to enhance the capacity government ministries, civil society and private sector to meet the challenge of climate change.

49. There are 44 specific programs proposed in the BCCSAP under the above six themes.

9. Relevant other regulatory requirements for the project

50. The Government of Bangladesh has framed various laws and regulations for protection and conservation of natural environment. These legislations with applicability to this project are summarized below in Table 3.

Table 3: Applicability of Key Environmental Legislation

No.	Act/Rule/Law/Ordinance	Responsible Agency-Ministry/Authority	Key Features-Potential Applicability
1	Water Pollution Control Ordinance 1970	Ministry of Water Resources	The Ordinance adopt measures for the prevention, control and abatement of existing or potential pollution of any waters, including construction, modification, extension or alteration of disposal systems; provide information to the Board regarding wastes, sewerage or treatment works; and permit any officer to inspect and search land and buildings.
2	Bangladesh Labour Law, 2006	Ministry of Labor	This Act pertains to the occupational rights and safety of factory workers and the provision of a comfortable working environment and reasonable working conditions.
3	National Land use Policy, 2001	Ministry of Land	The plan deals with land uses for several purposes including agriculture (crop production, fishery and livestock), housing, forestry, industrialization, railways and roads, tea and rubber. The plan basically identifies land use constraints in all these sectors.
4	National Forest Policy and Forest Sector Review (1994, 2005)	Forest Department, MOEF	<ul style="list-style-type: none"> ▪ Afforestation of 20% land. ▪ Bio-diversity of the existing degraded forests ▪ Strengthening of agricultural sector ▪ Control of global warming, desertification, control of trade in wild birds and animals ▪ Prevention illegal occupation of the forestlands, tree felling and hunting of wild animals.
5	National Biodiversity Strategy and Action Plan (2004)	Ministry of Environment and Forest	<ul style="list-style-type: none"> ▪ Conserve, and restore the biodiversity of the country; ▪ Maintain and improve environmental stability of ecosystems; ▪ Ensure preservation of the unique biological heritage of the nation for the

No.	Act/Rule/Law/Ordinance	Responsible Agency-Ministry/Authority	Key Features-Potential Applicability
			benefit of the present and future generations; <ul style="list-style-type: none"> ▪ Guarantee safe passage and conservation of globally endangered migratory species, especially birds and mammals in the country; ▪ Stop introduction of invasive alien species, genetically modified organisms and living modified organisms.
6	Bangladesh Climate Change Strategy and Action Plan (2008)	Ministry of Environment and Forest	Establishment of six strategic pillars for action, including: <ol style="list-style-type: none"> 1. food security, social protection and health 2. disaster management 3. protective infrastructure 4. research and knowledge management, 5. decreased carbon development, and 6. capacity building and institutional strengthening.
7	National Fisheries Policy, 1998	Ministry of Fisheries and Livestock (MOFL)	Preservation & management of inland open water fisheries.
8	The Protection and Conservation of Fish Act, 1950 and The Protection and Conservation of Fish Rules, 1985	Ministry of Fisheries and Livestock	Prohibits and regulates the construction of temporary or permanent of weirs, dams, bunds, embankment and other structures
9	Wetland Protection Act 2000	Ministry of Water Resources (MOWR)	Advocates protection against degradation and resuscitation of natural water-bodies such as lakes, ponds, beels, khals, tanks, etc. affected by man-made interventions or other causes. Prevents the filling of publicly-owned water bodies and depressions in urban areas for preservation of the natural aquifers and environment. Prevents unplanned construction on riverbanks and indiscriminate clearance of vegetation on newly accreted land.
10	Embankment & Drainage Act,	Ministry of Water Resources	An Act to consolidate the law relating to embankment & drainage.

No.	Act/Rule/Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features-Potential Applicability
11	The ground Water Management Ordinance 1985	Ministry of Water Resources	Focuses on management of Ground Water Resources. Disallows digging of tube wells without permission from the Upazilla Parishad
12	Vehicle Act 1927 & Motor vehicle ordinance 1983	Bangladesh Road Transport Authority (BRTA)	Road/traffic safety Vehicular air & noise pollutions Fitness of vehicles & registration
13	National Land Use Policy, 2001	Ministry of Land	The National Land Use Policy was adopted by Bangladesh government in 2001, setting out guidelines for improved land-use and zoning regulations. The main objectives of this policy is to ensure criteria based uses of land and to provide guidelines for usage of land for the purpose of agriculture, housing, afforestation, commercial and industrial establishments, rail and highway and for tea and rubber gardens. Overall, this policy promotes a sustainable and planned utilization of land.

C. Transport Related Policies and Regulations

1. National Land Transport Policy

51. The Land Transport Policy has been formulated in light of the Government pledge to establish a transport system that is safe, cheap, modern, technologically dependable, and environmentally friendly. The objectives are:

- To introduce long-term network planning
- To maintain the road network at a level which protects the value of the investment
- To secure a sustainable means of funding road maintenance
- To improve the management of traffic
- Management of road-side activities
- To develop an integrated planning approach in road construction
- To involve the private sector more in infrastructure, services and maintenance
- To well protect the environment from road construction program.

52. According to the policy, all new roads and major improvements, tolled or otherwise, are subjected to an Environmental Impact Assessment (EIA).

2. Geometric Design Standards for Roads & Highways Department

53. This manual aims to promote good, consistent practice in the geometric design of the Roads and Highways Department's roads. All RHD road projects should be designed in

accordance with the design approach, standards, assumptions, etc., which are set out in this manual.

54. The Roads and Highways Department (RHD) is committed to following good practice with regard to the safety and environmental impact of its roads. RHD ensures that all the Government's environmental regulations are complied with, and for major projects this will usually involve the preparation of environmental impact assessments and environmental management plans.

D. Applicable Road Safety Policies in Bangladesh

55. Bangladesh lags in ensuring that its road safety laws meet international standards and best practices. The existing 'The Motor Vehicle Ordinance 1983' has not been able to meet the standards and good practices as well as current demands to ensure road safety. Against this backdrop, the Government has initiated two new laws: The drafting of the Bangladesh Road Transport Authority (BRTA) Act 2015 has already been completed, including the incorporation of feedback from stakeholders; another law – the Bangladesh Road Transport Act (RTA) 2015 is currently in the drafting phase under the leadership of BRTA.

E. International Treaties

56. Bangladesh has signed several international treaties, conventions and protocols on environment, pollution control, bio-diversity conservation and climate change, including the Ramsar Convention, the Bonn Convention on migratory birds, the Rio de Janeiro Convention on biodiversity conservation and the Kyoto Protocol on climate change. An overview of the relevant international treaties and conventions signed by GOB is shown in Table 2.2.

Table 4: Relevant International Treaties, Conventions and Protocols signed by Bangladesh

Treaty or Convention	Year	Brief description	Responsible Agency
On protection of birds (Paris)	1950	Protection of birds in wild state	DOE/DOF
Occupational hazards due to air pollution, noise & vibration (Geneva)	1977	Protect workers against occupational hazards in the working environment	MOHFW
Occupational safety and health in working environment (Geneva)	1981	Prevent accidents and injury to health by minimizing hazards in the working environment	MOHFW
Occupational health services (Geneva)	1985	To promote a safe and healthy working environment	MOHFW
International convention on climate changes (Kyoto Protocol)	1997	International treaty on climate change and emission of greenhouse gases	DOE/MOEF

F. GoB Environmental Clearance and Public Consultation Procedure

57. Steps to be followed for obtaining the Environmental Clearance Certificate for this road construction project are shown in Figure 2. For any Orange B or Red category project, an IEE must be submitted to DoE in order to obtain clearance to proceed to construction or to undertake the full EIA if Orange B is bumped up to Red by DoE. Once the Orange B IEE is approved by DoE, the environmental requirements have been met. All Red Category projects require a DoE approved IEE before proceeding to EIA preparation.

58. For all SRTP-road subprojects DoE agreed to allow RHD to conduct full EIA without preparing the IEE, and to no require separate EIAs for large bridges so long as EIAs provided additional details for each large bridge over natural waters (as opposed to canals).

59. Public participation/consultation during the EIA process is not a condition in the Act, the ECR 1997, or EIA Guidelines; however is mandatory under the ADB's SPS 2007. Therefore, a full public consultation programme was included in this EIA.

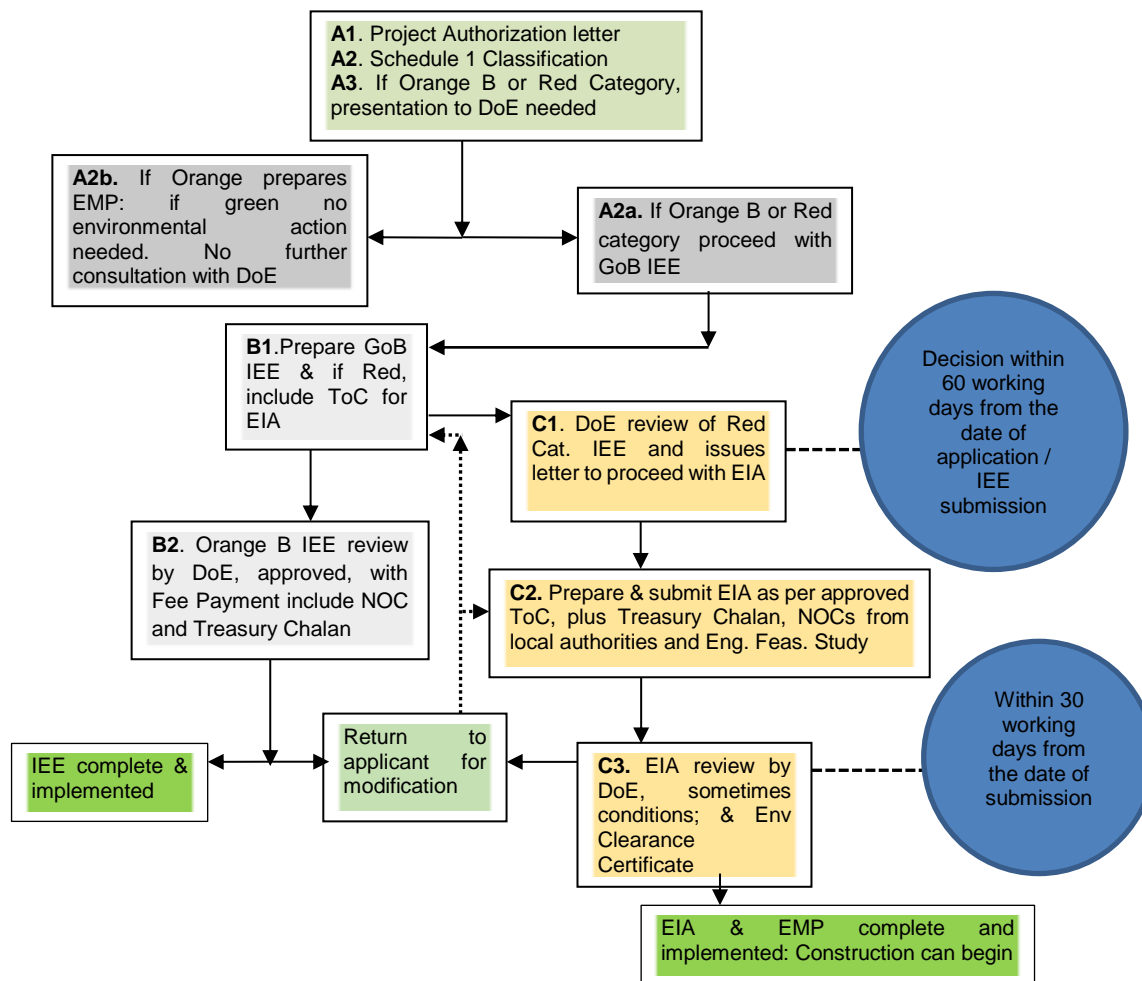


Figure 2: Government of Bangladesh Environmental Assessment Process

G. Asian Development Bank Safeguard Policies, 2009

60. Asian Development Bank (ADB) has three safeguard policies that seek to avoid, minimize or mitigate adverse environmental impacts and social costs to third parties, or vulnerable groups as a result of development projects⁴. The current generation of safeguard policies was designed when direct project lending was the dominant modality for development assistance. New lending modalities and financing instruments, such as the multitranches financing facility (MFF), have increased the complexity of applying safeguard policies and ensuring compliance. The new modalities and the likelihood of continued innovation, as well as changing client circumstances, suggest a need to enhance the relevance and effectiveness of ADB's safeguards, which has been

⁴ ADB.2009. Safeguard Policy Statement, Manila

reflected in an update of the Safeguard Policy by 2009, announced through the Safeguard Policy Statement 2009.

61. According to the newly revised and published Safeguard Policies in 2009 (SPS 2009) of ADB, ADB's overarching statement on its commitment and policy principles are:

62. ADB affirms that environmental and social sustainability is a cornerstone of economic growth and poverty reduction in Asia and the Pacific. ADB's Strategy 2020 therefore emphasizes assisting Developing Member Countries (DMCs) to pursue environmentally sustainable and inclusive economic growth. In addition, ADB is committed to ensuring the social and environmental sustainability of the projects it supports. In this context, the goal of the SPS is to promote the sustainability of project outcomes by protecting the environment and people from projects' potential adverse impacts.

63. The objectives of ADB's safeguards are to:

- avoid adverse impacts of projects on the environment and affected people, where possible;
- minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible; and
- help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks.

64. Since the ADB Safeguard Policy Statement had been approved it supersedes the Involuntary Resettlement Policy (1995), the Policy on Indigenous Peoples (1998), the Environment Policy (2002), and the second sentence of para. 73, and paras. 77–85, and 92 of the Public Communications Policy (2005).

1. Safeguard Requirements 1: Environment

65. The objectives are to ensure the environmental soundness and sustainability of projects, and to support the integration of environmental considerations into the project decision-making process.

66. The requirements apply to all ADB-financed and/or ADB-administered sovereign and non-sovereign projects, and their components regardless of the source of financing, including investment projects funded by a loan; and/or a grant; and/or other means, such as equity and/or guarantees. Mechanisms such as Public Consultation, Identification of potential impacts, elaboration of adequate mitigation measures and impact monitoring as well as implementation of an appropriate environmental management plan remained mainly unchanged referring to the former Environmental Safeguard Policy.

67. Special attention has been put on the Grievance Redress Mechanism, securing that the borrower/client will establish a mechanism to receive and facilitate resolution of affected peoples' concerns, complaints, and grievances about the project's environmental performance. The grievance mechanism should be scaled to the risks and adverse impacts of the project. It should address affected people's concerns and complaints promptly, using an understandable and transparent process that is gender responsive, culturally appropriate, and readily accessible to all segments of the affected people at no costs and without retribution. The mechanism should not impede access to the country's judicial or administrative remedies. The affected people will be appropriately informed about the mechanism.

68. Guidelines provide a rational approach for determining environmental category of the Project, the need for public consultation and disclosure, environmental management planning, and resolving involuntary resettlement, indigenous people and gender issues.

2. Safeguard Requirements 2: Involuntary Resettlement

69. The objectives are to avoid involuntary resettlement wherever possible; to minimize involuntary resettlement by exploring project and design alternatives; to enhance, or at least restore, the livelihoods of all displaced persons in real terms relative to pre-project levels; and to improve the standards of living of the displaced poor and other vulnerable groups. The safeguard requirements underscore the requirements for undertaking the social impact assessment and resettlement planning process, preparing social impact assessment reports and resettlement planning documents, exploring negotiated land acquisition, disclosing information and engaging in consultations, establishing a grievance mechanism, and resettlement monitoring and reporting.

70. The involuntary resettlement requirements apply to full or partial, permanent or temporary physical displacement (relocation, loss of residential land, or loss of shelter) and economic displacement (loss of land, assets, access to assets, income sources, or means of livelihoods) resulting from (i) involuntary acquisition of land, or (ii) involuntary restrictions on land use or on access to legally designated parks and protected areas. Resettlement is considered involuntary when displaced individuals or communities do not have the right to refuse land acquisition that result in displacement.

3. Safeguard Requirements 3: Indigenous Peoples

71. The objective is to design and implement projects in a way that fosters full respect for Indigenous Peoples' identity, dignity, human rights, livelihood systems, and cultural uniqueness as defined by the Indigenous Peoples themselves so that they (i) receive culturally appropriate social and economic benefits, (ii) do not suffer adverse impacts as a result of projects, and (iii) can participate actively in projects that affect them.

72. For operational purposes, the term Indigenous Peoples is used in a generic sense to refer to a distinct, vulnerable, social and cultural group possessing the following characteristics in varying degrees:

- (i) self-identification as members of a distinct indigenous cultural group and recognition of this identity by others;
- (ii) collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories;
- (iii) customary cultural, economic, social, or political institutions that are separate from those of the dominant society and culture; and
- (iv) a distinct language, often different from the official language of the country or region.

73. In considering these characteristics, national legislation, customary law, and any international conventions to which the country is a party will be taken into account.

74. Guidelines provide a rational approach for determining environmental category of the Project, the need for public consultation and disclosure, environmental management planning, and resolving involuntary resettlement, indigenous people and gender issues.

75. Activities carried out under the project needs to conform to current laws in Bangladesh and sound social and environmental principles. In general, the project activities will not trigger serious impacts on physical and human environment.

H. Project Category

76. The ADB SPS addresses environmental concerns, if any, of a proposed activity in the initial stages of project preparation. For this, the ADB SPS categorizes the proposed components into A, B, or C to determine the level of environmental assessment required to address the potential impacts. The project has been categorized as B based on SPS 2009. Stakeholder consultation was an integral part of the EIA, and an environmental management plan (EMP) specifying mitigation measures to be adhered to during implementation of the project has been prepared.

77. According to ECR Schedule 1, the project is red category because it involves construction, reconstruction, and extension of roads and bridges⁵. In due course an environmental assessment must be prepared in the prescribed format and be submitted to the Department of Environment (DOE) for approval. Table 5 shows the summary of environmental regulatory compliance required for the project.

Table 5: Environmental Regulatory Compliance

Component Description	Government of Bangladesh		ADB	
	Category in Accordance with ECR	Environmental Assessment	Category in Accordance with SPS	Environmental Assessment
Elenga-Hatikamrul Road Project	Red Category: Construction / reconstruction / expansion of roads and bridge (regional, national & international)	IEE, EIA, and EMP	Category B	IEE

1. Occupational Health and Safety

78. During construction, the project will conform to the labour laws and occupational and health related rules as outlined in Table 6.

Table 6: Relevant Occupational Health and Safety Laws and Rules

Title	Overview
Bangladesh Labor Act, 2006	Provides for safety of work force during construction period. The act provides guidance of employer's extent of responsibility and the workman's right to compensation in case of injury caused by accident while working.
Labor Relations under Labor Laws, 1996	General concerns during the project implementation state that the project manager must recognize labor unions.
Public Health (Emergency Provisions) Ordinance, 1994	Calls for special provisions about public health. In case of emergency, it is necessary to make special provisions for

⁵ Consultation with the DoE during the course of this environmental assessment confirmed that the project is category red and requires EIA under the ECA and ECR.

Title	Overview
	preventing the spread of disease, safeguarding the public health, and providing adequate medical service, and other services essential to the health of respective communities and workers during construction-related work.
The Employees State Insurance Act, 1948	Health, injury and sickness benefit should be paid.
The Employer's Liability Act, 1938	Covers accidents, risks, and damages with respect to employment injuries
Maternity Benefit Act, 1950	Framed rules for female employees, who are entitled to various benefits for maternity
Bangladesh Factory Act, 1979	Workplaces provisions: these Act and Labor Laws require medical facilities, first aid, accident and emergency arrangements, and childcare services to be provided to the workers at workplace.

III. DESCRIPTION OF THE PROJECT

A. Background

79. Geographically, Bangladesh is an important location which can serve as vital link between neighbouring countries Nepal, Bhutan, Myanmar, and India. The Transport Working Group (TWG) of the South Asia Sub-regional Economic Cooperation (SASEC) has also identified four of the six corridors passing through Bangladesh. With the opening of Bangabandhu Bridge and the proposed development of Padma Bridge, the Dhaka –Chittagong transport corridor and other transport corridors can serve to facilitate trade between Bangladesh and the north-eastern states of India, the Indian state of West Bengal, and neighbouring country Bhutan and Nepal. This central location of Bangladesh generates immense potential to benefit from better trade facilitation efforts. However, this potential has not been fully realized because of deficiencies in key infrastructure and the trade-related constraints.

80. The Elenga-Hatikamrul road is vital links in the national highway network. The Elenga-Hatikamrul road is part of Asian Highway Network route AH2.

81. The Road Master Plan 2008 of Bangladesh already considered the improvement of this road. The existing road is two lanes road with shoulders. There is no separate provision for slow moving vehicular traffic (SMVT) or non-motorised traffic (NMT). Moreover, this road does not have capacity to carry required number of vehicles in some places like congested junctions.

82. The execution of the proposed upgrading will substantially improve transport efficiency on the road linking North and North-west of Bangladesh to Dhaka (the capital) and the Southeast Road Corridor (to Chittagong). This will also contribute in integrating the southwest region into the national economy, a key issue identified in the Asian Development Bank country strategy and programme for Bangladesh (2006-2010) as a requirement to support the country's National Poverty Reduction Strategy.

B. Project Location

83. The Elenga-Hatikamrul road located north of Tangail city will start at Elenga Junction (N 24°20'22" and E 89°55'28") (chainage 69+300) near the intersection of N4 and N405. The beginning of this road will touch the N4 and then follows the N405. The project road will halt at chainage 82+900 because of the Bangabandhu Bridge and will start again at chainage 90+700 at the West side of this bridge. The road will end at Hatikamrul (24°25'8.97"N and 89°33'6.97"E) (chainage 110+700) of Sirajganj district. The total length is 41.2 km. Figure 3 shows the project location.

84. The road is a standard two-lanes highway (two 3.65m lanes, paved shoulders each 1.5m and verges each 1.0m). The road condition is varying in different section. Pavement crack is one the main problem for this road. There are several sub-standard horizontal curves. Road passes through some commercial areas at Elenga, Koddar Moor and Hatikamrul but there is no heavily congested area.

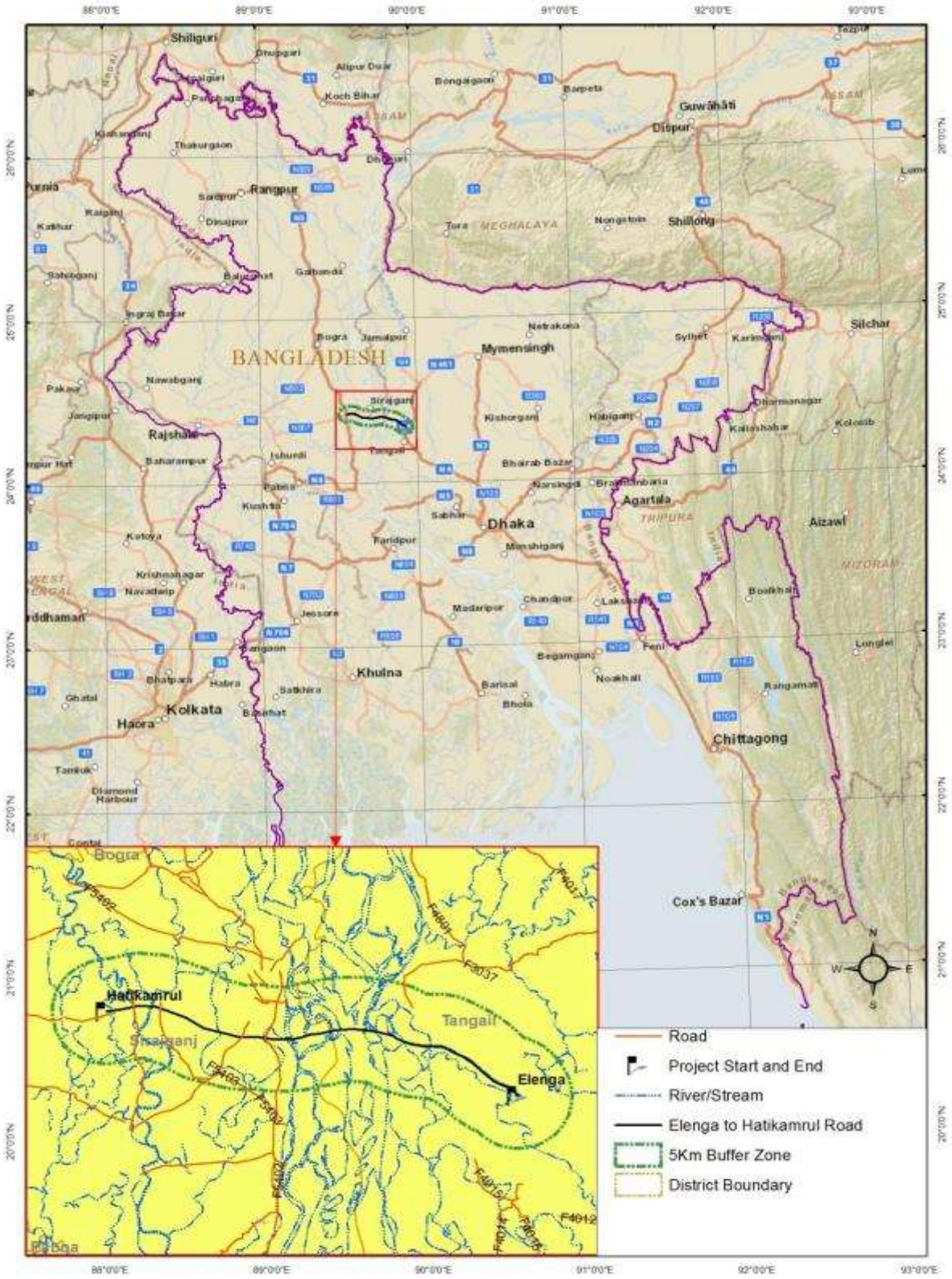


Figure 3: Locality Plan

C. Project Components

85. The project components and design standards are defined in the following sections:

Table 7: Road Components and Design Standards for Elenga-Hatikamrul Road

Road Components	
Length	41.7 km (including 7.6 km Bangabandhu Bridge on Jamuna River and approach roads)
Alignment	Follow existing road alignment for road widening and improvement. No new road construction or bypass is proposed.
Flyovers	2 flyovers (at Elenga and Koddar Moor Intersection)
Major Bridges	42 bridges /culverts of which 15 bridges (1 Major Bridge (>100m in length over Fuljor River) and 27 culverts
Embankment Design	Embankment height established for 1m free board on 20 years frequency HFL Dredged river sand based, side slope 3 hor: 1 ver, 600mm compacted cladding layer and turf for slope stabilization.
Design Standard	
Speed	Design: 80 km/h Posted : 70 km/h
Horizontal Controls	Controlling Curve: Maximum Super Elevation: 0.06 m/m Minimum Curve Radius: 252 m Design Speed: 50 km/h
Cross-Section Elements	Travelled each lane: 3.65 m Cross Fall : 3 %
Structural standards	Roads and Highways Department (RHD) Bridge Design Standard 2004 American Association of State Highway and Transportation Officials (AASHTO) Standards Specification

1. Alignment and ROW

86. The project road is two lanes at most of the places, and will be upgraded to a four-lane highway. The carriage way at each side typically will have of 7.3 m width with median of 1.2 m and either side shoulder of 1.0 m wide. The side slope of road embankment will be of 1:2. Widening will be either right aligned or left aligned, but will be mostly left aligned. The RoW required is 50m on the average, and is available throughout the road. The ROW may not be available in areas where new parallel bridges and its approach roads are to be constructed. The road is also passing through rural, semi-urban, and sparsely populated areas. In many areas, ROW is encroached by the people. At some places, either ROW may not be available for the desired embankment height or cannot be utilized due to encroachment. At such places, RC retaining wall option will be exercised to reduce the ROW requirement.

87. Typical cross sections of road alignment for normal road, constricted road and highly constricted road are given in Figure 4. The pavement works comprise construction of sub-grade, sub-base, base binder course and wearing course. All roads have been designed following road safety requirements as per RHD published guidelines and standards. This includes separation of motorised and non-motorised traffic, planning of cross section, bus stop, and service road to ensure accident flow of traffic. The cross section bus stand layout and embankment drain on curve is shown at Figure 5 and Figure 6.

88. No new bypass is proposed. The river protection works will be decided based on the depth and flow pattern of the river, the scouring regime and the type of structure. Geotextiles, brick blocks, concrete blocks, sand cement blocks and sand geo- bags may be used for construction of protective works.

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE STATED.
2. FOR DETAIL A, B & C REFER TO DRG. S060191-10-010-1016.

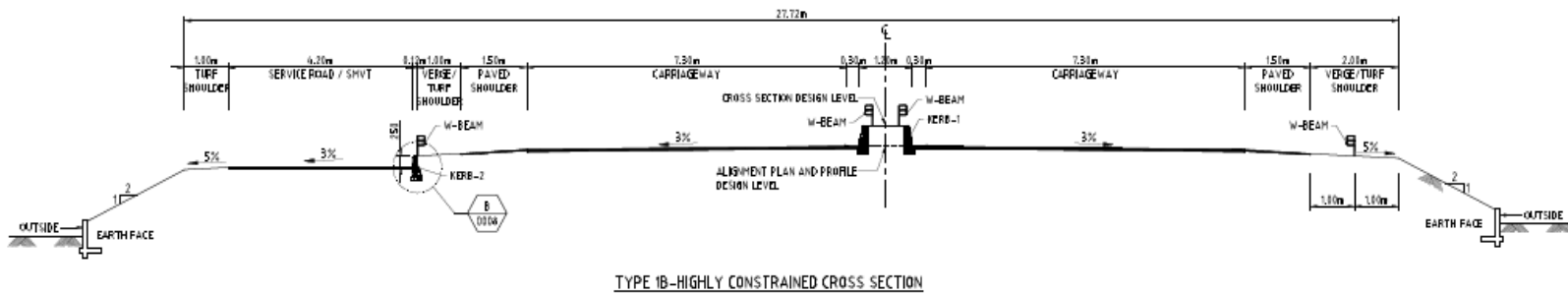
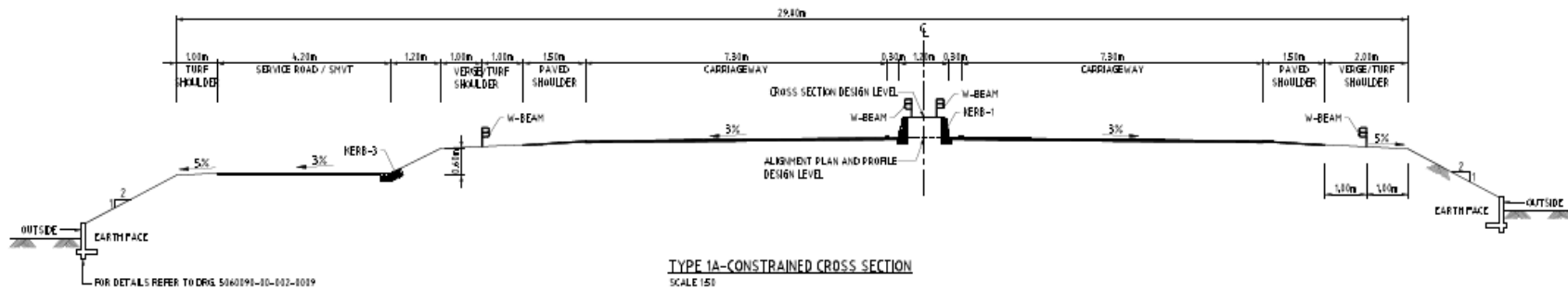
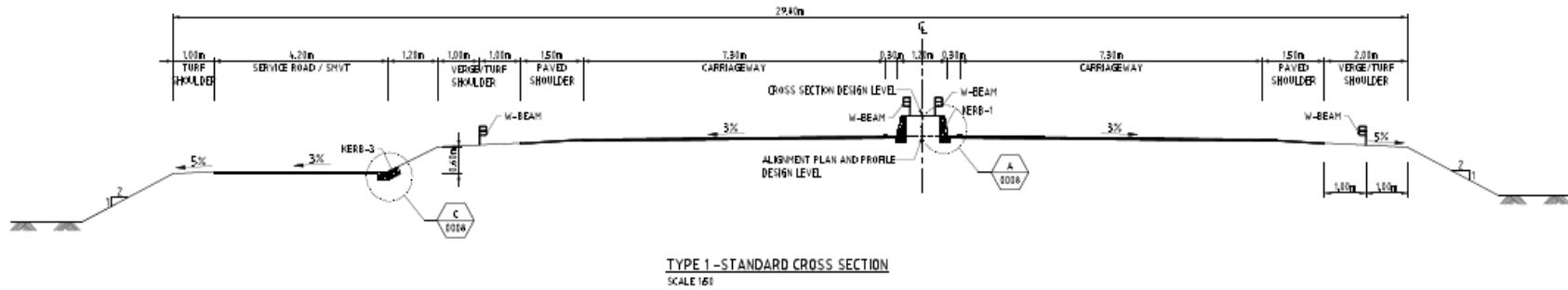


Figure 4: Typical Cross Section

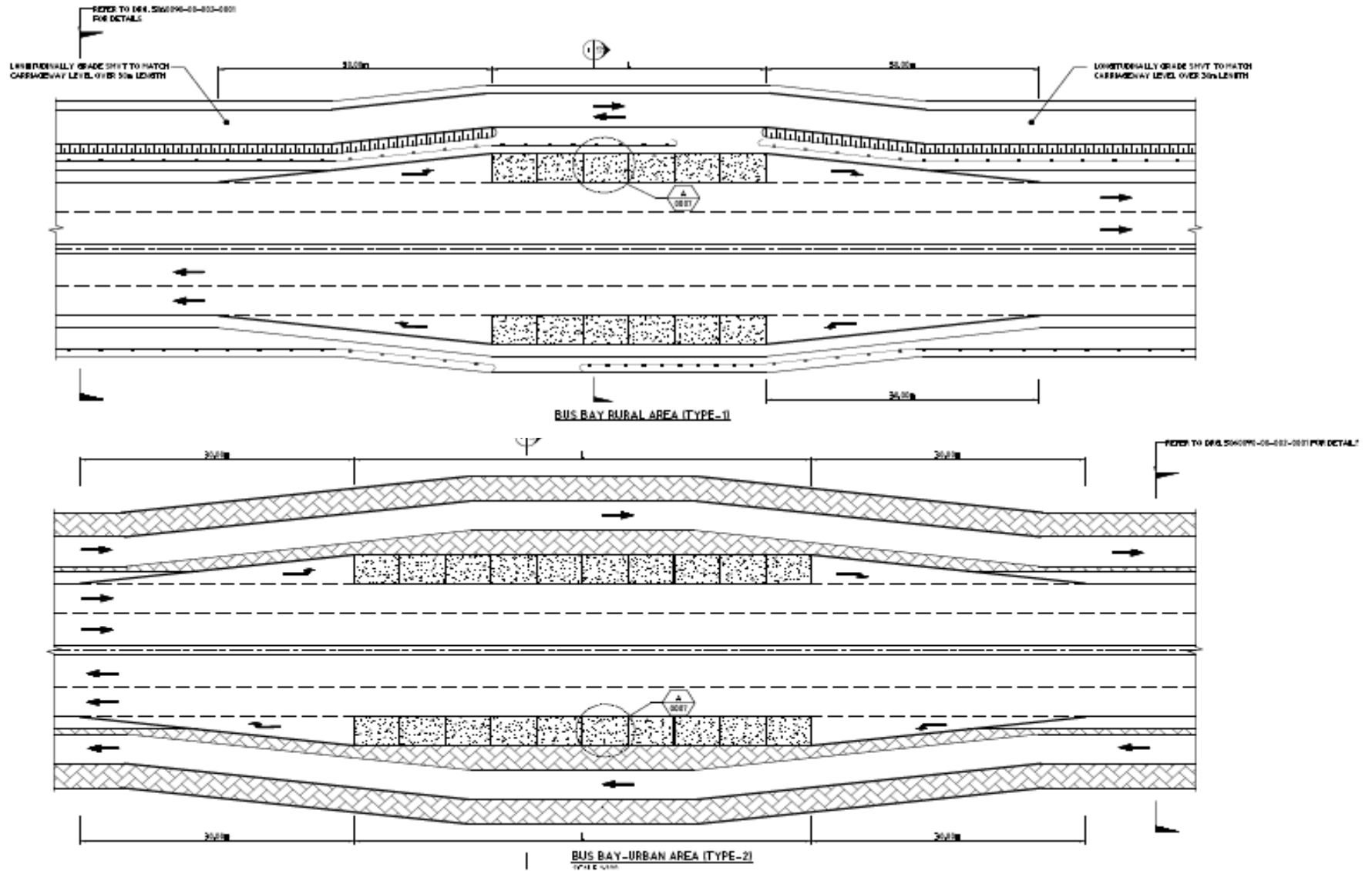


Figure 5: Layout Plan of Bus Bay at Rural and Urban Area

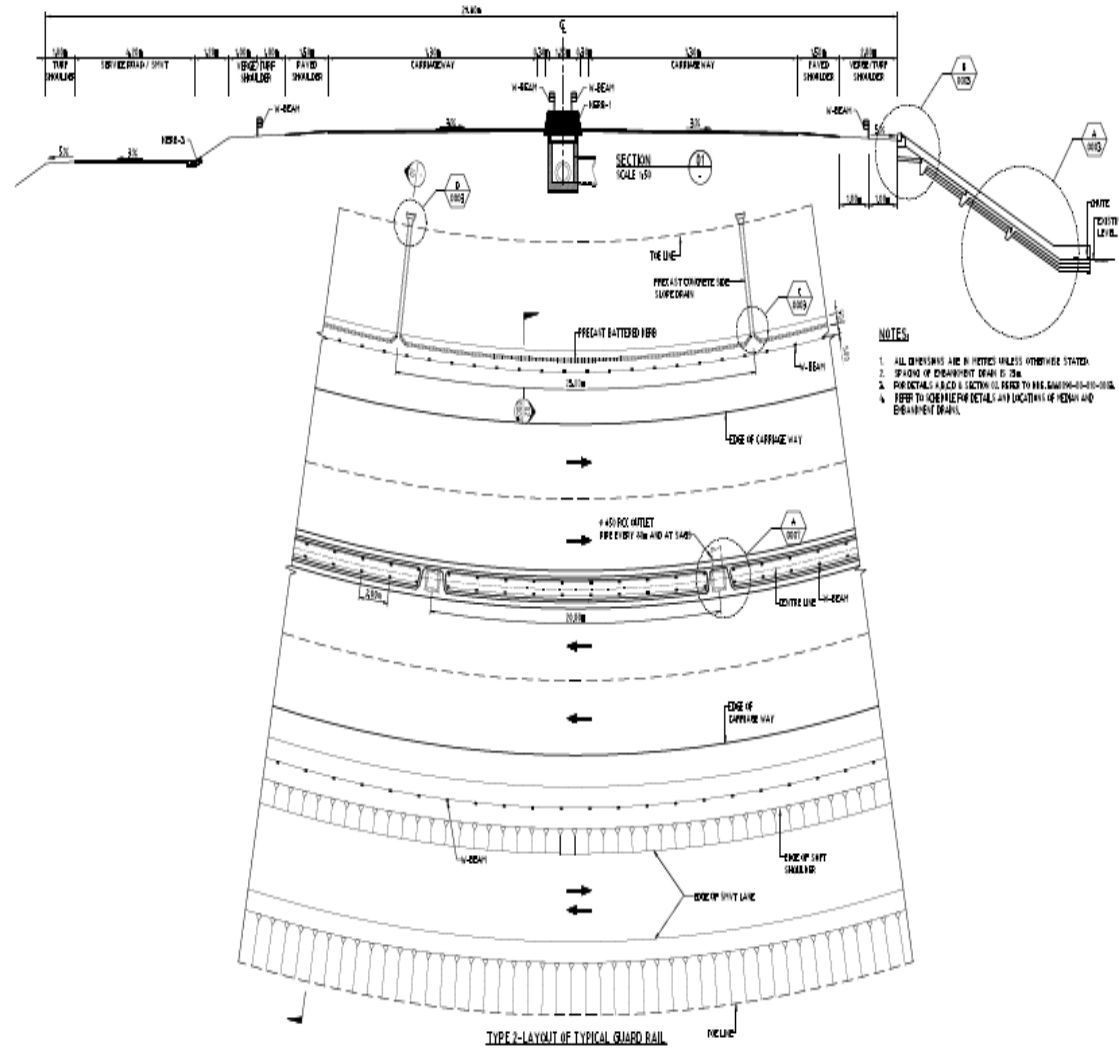


Figure 6: Embankment Drain on Curve

2. Existing and Proposed Cross Drainage Structures

89. One major bridge of more than 100m length is proposed to be constructed over Fuljor River. The location of this bridge at chainage 106+310km as starting Vogra Bazar Junction and its length is 236.4m. There will be no need for any river training work as this river is not morphologically active. However, riverbank protection work will be conducted at the time of bridge construction.

90. The Elenga-Hatikamrul project EIA TOR has been approved from the concerned authorities and that will cover the possible impact and mitigation measures for the entire project. This major bridge is within the Elenga-Hatikamrul project and work activities are within the same project. Therefore, this EIA has been fulfilled details environmental impacts and mitigation measure for this bridge also. In addition to the major bridge, there are many other lesser bridges and culverts on the project roads. These structures mostly cross-undefined channels and carry only seasonal flow. Some of these bridges are located over depressions and low-lying ditches. Culverts are located in depressions and at low lying agricultural land and are used merely as balancing structures and equalizing water levels either side of the road embankment. The list of all the structures with length and structural condition is given in Table 8.

Table 8: List of All Drainage Structures on the Elenga-Hatikamrul Road

Sl. No.	Chainage (km)	GPS Reading (Decimal Degrees)	Name of the Structure	Type of Structure	Size of Bridge (Span arrangement) / Size of culvert (vent no x opening x height) (m)	Length (Along the Road) (m)	Width (Across the Road) (m)	Recommendations
		Latitude/ Longitude						
1	70+094	24.34068/89.92354	Elenga Box Culvert	Box Culvert	1 Vent x 5.0m x 4.0m		30.04	Extend to 4-lane
2	70+836	24.3459/89.91914	Elenga Box Culvert	Box Culvert	2 Vents x 5.0m x 4.5m		32.84	
3	71+462	24.34754/89.91468	Babla Bridge	PC Girder Bridge		34.71	14.71	New Bridge (2Lane + SMVT)
4	72+293	24.3475/89.91477	Char Babza Bridge-1	PC Girder Bridge		34.71	14.71	New Bridge (2Lane + SMVT)
5	72+632	24.3507/89.90725	Char Babza Bridge-2	PC Girder Bridge		34.71	14.71	New Bridge (2Lane + SMVT)
6	73+129	24.35228/89.90465	Dhalatankor Box Culvert	Box Culvert	2 Vents x 5.0m x 5.0m		31.42	
7	73+472	24.35481/89.90049	Doladongor Bridge	PC Girder Bridge		34.71	14.71	New Bridge (2Lane + SMVT)
8	73+842	24.35902/89.89504	Hangula-1 Box Culvert	Box Culvert	2 Vents x 5.0m x 5.0m		30.61	
9	74+424	24.35908/89.89510	Hangula-2 Box Culvert	Box Culvert	2 Vents x 5.0m x 5.0m		30.43	
10	74+979	24.36274/89.8911	Hananla Box Culvert	Box Culvert	2 Vents x 5.0m x 4.5m		30.52	
11	75+361	24.36624/89.88725	Hananla Bridge	PC Girder Bridge		34.71	14.71	New Bridge (2Lane + SMVT)
12	76+053	24.36861/89.88444	Challa Bridge-1	PC Girder Bridge		34.71	14.71	New Bridge

Sl. No.	Chainage (km)	GPS Reading (Decimal Degrees)	Name of the Structure	Type of Structure	Size of Bridge (Span arrangement) / Size of culvert (vent no x opening x height) (m)	Length (Along the Road) (m)	Width (Across the Road) (m)	Recommendations
		Latitude/ Longitude						
								(2Lane + SMVT)
13	76+657	24.37234/89.87903	Hananla-2 Box Culvert	Box Culvert	2 Vents x 5.0m x 3.5m		30.69	
14	77+245	24.37514/89.87388	Shalla-1 Box Culvert	Box Culvert	2 Vents x 5.0m x 4.5m		30.49	
15	77+900	24.37774/89.86878	Challa Bridge-2	PC Girder Bridge		34.71	14.71	New Bridge (2Lane + SMVT)
16	78+369	24.38268/89.85913	Jogarchar-1	Box Culvert	2 Vents x 5.0m x 3.5m		31.06	
17	78+682	24.38263/89.85913	Jogarchor-2 Box Culvert	Box Culvert	2 Vents x 5.0m x 4.0m		30.12	
18	79+851	24.38353/89.8563	Jogarchar Bridge	PC Girder Bridge		34.71	14.71	New Bridge (2Lane + SMVT)
19	94+473	24.39485/89.69331		Box Culvert	2 Vents x 5.0m x 4.0m		29.89	Extend to 4-lane
20	95+392	24.3952/89.6868		PC Girder Bridge		70.48	9.91	New Bridge (2Lane)
21	96+067	24.39514/89.6868		Box Culvert	1 Vent x 5.0 m x 4.0 m		35.91	Extend to 4-lane
22	96+365	24.39509/89.68069		Box Culvert	1 Vent x 5.0 m x 4.0 m		31.10	Extend to 4-lane
23	96+685	24.39512/89.68064		Box Culvert	1 Vent x 5.0 m x 4.0 m		30.90	Extend to 4-lane
24	97+632	24.39754/89.6655	Rail Over Bridge	PC Girder Bridge		34.71	14.71	New Bridge (2Lane + SMVT)
25	97+701			Box Culvert	1 Vent x 5.0 m x 4.0 m		35.53	Extend to 4-lane
26	97+747			Box Culvert	1 Vent x 5.0 m x 5.0 m		43.67	Extend to 4-lane
27	98+268	24.40012/89.65423		Box Culvert	2 Vents x 5.0 m x 3.5 m		30.67	Extend to 4-lane
28	99+448	24.40272/89.64432		PC Girder Bridge		67.43	14.71	New Bridge (2Lane + SMVT)
29	100+490	24.40856/89.63262		Box Culvert	1 Vent x 5.0 m x 3.5 m		29.80	Extend to 4-lane
30	101+864	24.41323/89.6235		Box Culvert	2 Vents x 5.0 m x 3.5 m		29.85	Extend to 4-lane
31	102+929	24.41654/89.61475		PC Girder Bridge		34.71	14.71	New Bridge (2Lane + SMVT)
32	103+883	24.41655/89.61473		Box Culvert	1 Vent x 5.0 m x 4.5 m		30.77	Extend to 4-lane
33	104+283	24.41768/89.61118		RCC Girder Bridge		49.13	14.71	New Bridge (2Lane + SMVT)
34	104+538	24.41858/89.60895		Box Culvert	2 Vents x 5.0 m x 4.5 m		29.80	Extend to 4-lane
35	105+108	24.42275/89.5972		PC Girder Bridge		34.71	14.71	New Bridge (2Lane + SMVT)
36	105+792	24.42324/89.59242		Box Culvert	1 Vent x 5.0 m x 4.0 m		30.93	Extend to 4-lane
37	106+381	24.42325/89.59239	Nalka Bridge	PC Girder Bridge		239.59	14.71	New Bridge

Sl. No.	Chainage (km)	GPS Reading (Decimal Degrees)	Name of the Structure	Type of Structure	Size of Bridge (Span arrangement) / Size of culvert (vent no x opening x height) (m)	Length (Along the Road) (m)	Width (Across the Road) (m)	Recommendations
		Latitude/ Longitude						
								(2Lane + SMVT)
38	106+928	24.42431/89.58059		Box Culvert	2 Vents x 3.0 m x 2.5 m		33.41	Extend to 4-lane
39	107+481	24.42454/89.58044		Box Culvert	4 Vents x 3.0 m x 2.5 m		33.16	Replace with New 4-vent BC
40	107+822	24.42359/89.57746		Box Culvert	3 Vents x 3.0 m x 2.5 m		32.61	Extend to 4-lane
41	108+024	24.42169/89.56705		Box Culvert	3 Vents x 3.0 m x 2.5 m		33.82	Extend to 4-lane
42	108+885	24.41964/89.55634		Box Culvert	3 Vents x 3.0 m x 2.5 m		32.51	Replace with New 3-vent BC

3. Major Bridge with Design Features in Elega-Hatikamrul Road

91. The Nalka Bridge over Fuljor River at Km 106+381 is not in good condition and needs to be replaced with new four lane bridge. This is 239.59 m long bridge. The river carries seasonal flow and appears to be gradually drying up due to encroachment and the lack of adequate rainwater discharge from the upstream area. A new bridge is proposed to be built at this location catering for the two traffic lanes plus a SMVT lane required for the upgrading to four-lane standard.

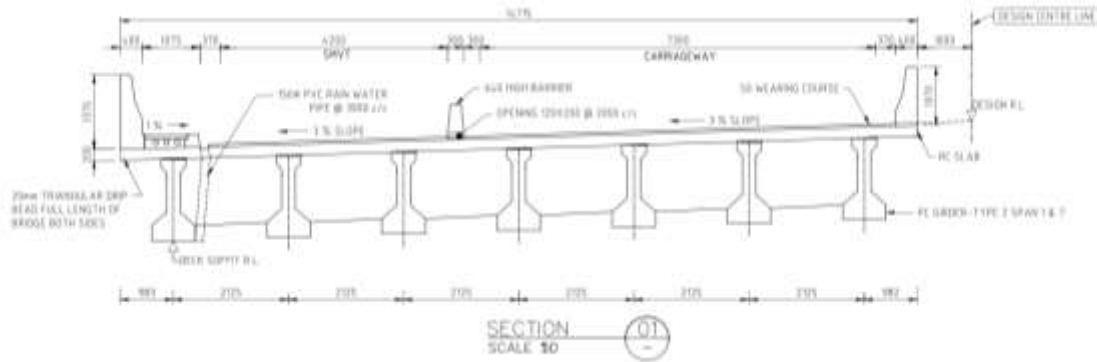


Figure 7: Cross Section of the Proposed Bridge

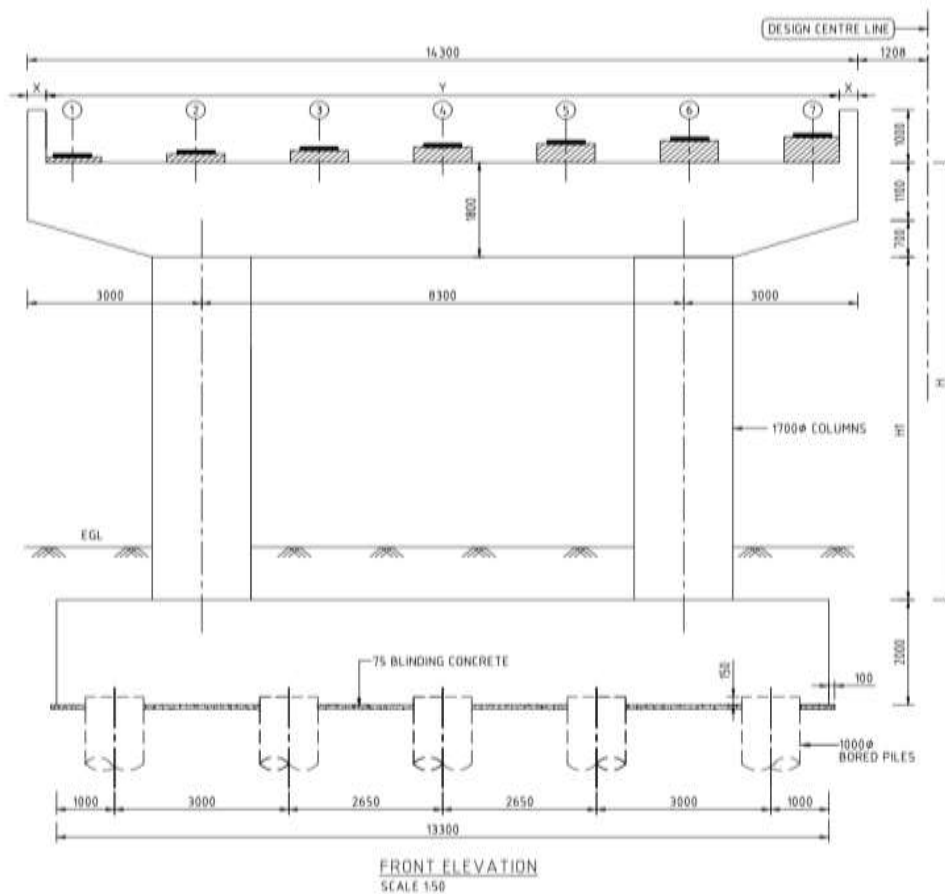


Figure 8: Cross Section of the Proposed Bridge

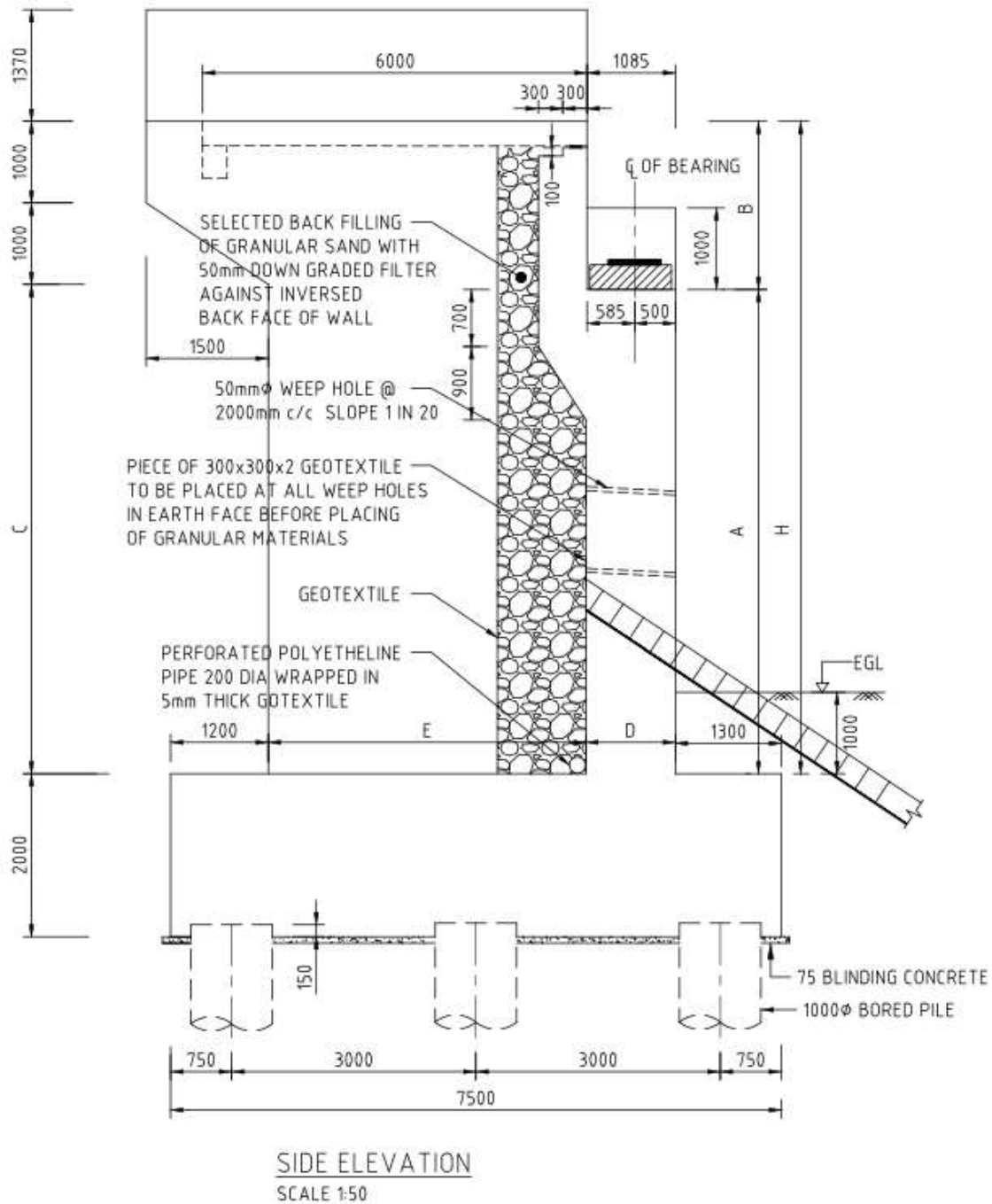


Figure 9: Abutment Design of the Nalka Bridge

4. Flyovers and Overpasses

92. To improve road efficiency and safety two flyovers and foot overpasses are proposed in Elenga-Hatikamrul road. The list of these structures is given at Table 9.

Table 9: Details of Proposed Flyovers and Overpasses in Elenga-Hatikamrul Road

Sl. No.	Location	Chainage	Length (Along the Road) (m)	Width (Across the Road) (m)	Type
1	Elenga	70+056	1538.61	19.120	New Flyover (4 lane)
2	Koddar Moor	95+553	395.64	19.120	New Flyover (4 lane)
3	Elenga	69+373	35.2	3.0	Pedestrian Overpass
4	Panchlia Bazar	108+278	35.2	3.0	Pedestrian Overpass

5. Construction Material and Sources

93. **Embankment Fills.** The GOB has adopted a policy to encourage construction of roadway embankments with river sand rather than clayey agricultural soil. Accordingly, the embankments for new carriageways on this project have been designed based on the use of river sand with a CBR value estimated as 10% or greater. River sand is a good fill material with higher CBR value. It is quite abundant in the various riverbeds in the project area. Sand is easily compactable to a high degree of compaction but will require protection against erosion by cladding with a layer of cohesive soil.

94. **Concrete Aggregate.** Stone aggregates from Sylhet quarries are commonly used for the manufacture of normal and high strength concrete and it is proposed to be used for these roads as well. The major concreting operation for Jamuna Bridge was undertaken using stone aggregate from Sylhet sources.

95. **Cement and Steel Reinforcement.** Bangladesh produces different classes of EN and ASTM standard cement and high strength deformed bar of 40, 60 and 75 grades. These materials are readily available in the project area.

71. **Bitumen.** Bitumen will be imported. Commonly used bitumen in the road construction industry in Bangladesh is 60-70 and 80-100 penetration grade bitumen. For Bangladesh temperatures 60-70 grade is better suited but the supply of this grade is limited.

96. **Recycled Pavement Materials.** The preliminary design envisages recycling pavement materials by milling the existing asphalt concrete and re-using the product. This recycled asphalt concrete mixed with unbound base and sub-base materials shall be used in the sub-base or lower base of the new carriageways.

6. Establishment of Road Research and Training Centre (RRTC)

97. The Technical Assistance for Subregional Road Transport Project Preparatory Facility recommended to combine Bangladesh Road Research Laboratory (BRRL) and Roads and Highways Department Training Centre (RHDTTC) and establish a new Centre of Excellence for quality Control, research and training for human resource development. This new institution, to be named Road Research and Training Centre (RRTC) will support RHD's road sector development strategy and road operation, and aims to an enhanced holistic approach to quality management, applied sector-specific research and development of skills needed to manage and achieve improvements in road network service quality levels.

98. The Road Research and Training Centre will establish a) RHD Training Centre and ICT; and b) Road Research and Laboratory. The Training Centre and ICT will comprise training / class rooms, conference room, network and computer training room, office, and living accommodation. The Road Research and Laboratory will include research centre, laboratory, equipment hall, office, computer laboratory, auditorium, and internal mosque.

99. The proposed 10-storey RRTC building will cover gross area of about 185,000 sq. ft. and will include parking facility with 100 slots. The building will be established inside the RHD Headquarter in Mirpur, Dhaka.

7. Establishment of Road Operations Unit (ROU)

100. The Road Operations Unit (ROU) will be established and implemented initially along the Dhaka-Elenga-Hatikamrul-Rangpur (Dhaka-Northwest international trade corridor). The ROU will focus on pilot good practices on overloading control, road asset management and road safety. The ROU will establish axle load control stations, required facilities and equipment, business models (operation plan and staffing plan), enforcement mechanism engaging other agencies, and safety provisions to reduce the safety vulnerability.

101. There will be 3 ROU located 01 at Chandra (Chainage 17+000 km from Joydevpur on SASEC-I Project area), 01 at Hatikamrul (Chainage 107+00 km from Joydevpur on SASEC-II Project area and 01 at Polashbari (Chainage 207+00 km from Joydevpur on SASEC-II Project area).

8. Existing Traffic and Forecast

102. The type of traffic considered for traffic assessment and forecast includes (i) normal traffic which is using the existing corridor, and (ii) generated traffic likely to arise from reduced transport costs. The existing weighted average Annual Average Daily Traffic (AADT) as per the traffic studies carried out for 2013 including two- and three-wheelers and forecast traffic are given at Table 10.

Table 10: Existing and Traffic Forecast for Elenga-Hatikamrul Road

Traffic Assessment Year	Traffic in AADT (Maximum of any section of the road)
2013	15,035
2015	17,366
2016	18,848
2020	28,231
2025	38,419
2030	51,352
2035	68,650
2040	91,786

Source: Traffic Survey by Project Personnel, 2013

103. The nature of traffic is mixed in nature except in case of Elenga-Hatikamrul road where a high proportion goods vehicles and Heavy Goods Vehicle (HGVs) is high. It is probably the common route for traffic between Dhaka and the districts in North and North-western Bangladesh.

9. Project Schedule

104. Project construction schedule were not finalised at the time of preparation of this report. For the purpose of EIA, the consulting services will be for a period of 36 months, the construction with additional 12 months defect liability period, and operation period is assumed as 20 years after construction. The actual commencement date will be confirmed during negotiations and will depend on progress in awarding the contract to contractors for construction in the project.

10. ADB's Environmental categorisation

105. Based on REA Checklist (Appendix C) and the field assessment, the project is categorised as Category B as per ADB Safeguard Policy Statement 2009. The project is unlikely to cause any significant adverse environmental impact. It does not pass through any protected areas or ecologically sensitive areas. Most of the habitat areas are provided with flyover or pedestrian overpasses.

IV. DESCRIPTION OF THE ENVIRONMENT

A. General

106. The environmental baseline reflects the environmental conditions of the project area. The baseline condition of environmental quality in the locality of project site serves as the basis for identification, prediction and evaluation of impacts. The baseline environmental quality is assessed through field studies within the impact zone for various components of the environment, viz. air, noise, water, land and socio-economic, etc.

107. To take significant actions against environmental impacts or consequences in environmental assessment process information of baseline environmental status of the project area is mandatory. Based on the existing environmental scenario potential impacts of road expansion will be identified and accordingly management plan will be proposed in forthcoming sections. The baseline environmental conditions will help in comparing and to monitor the predicted negative and positive impacts resulting from the project during pre-construction, construction and operation phases. Significant action depicts direct adverse changes caused by the action and its effect on the health of the biota including flora, fauna and human being, socio-economic conditions, current use of land and resources, climate change aspects, physical and cultural heritage properties and biophysical surroundings. Baseline data generation of the following environmental attributes is essential in EIA studies.

108. The data of several macro-environmental setting like climate (temperature, rainfall, humidity, and wind speed), physiography, geology etc. was collected from secondary sources. First hand information have been collected to record the micro-environmental features within and adjacent to the project corridor. Collection of primary information includes extrapolating environmental features on proposed road design, tree inventories, location and measurement of socio-cultural features adjoining proposed road. Ambient air, noise, soil and water quality samples were collected at important locations in terms of environment quality to prepare a baseline database. Consultation was another source of information to explain local environmental conditions, impacts, and suggestions, etc.

109. The following section describes the baseline environment into three broad categories:

- Physical Environment- factors such geology, climate and hydrology;
- Biological Environment- factors related to life such as flora, fauna and ecosystem; and
- Socio-economic Environment- anthropological factors like demography, income, land use and infrastructure.

B. Physical Environment

110. Physical environment denotes the physical features that occur naturally (air, water, soil, atmosphere etc.). In order to depict the existing physical environment in the project area, a few of the major parameters are considered like geology & soil, ambient air, noise, surface & ground water, etc.

1. Climate

111. Although less than half of Bangladesh lies within the tropics, the presence of the Himalayan mountain range has created a tropical macroclimate across most of the east Bengal

land mass. Bangladesh can be divided into seven climatic zones (Rashid 1991). According to the classification, the project area is located in three different climatic regions (Figure 4.1). These areas are South-central region, South-western region and North-western climatic zone.

- i. **South-central Zone:** In this zone, rainfall is abundant, being above 1,900 mm. The range of temperature is, as can be expected, much less than to the west, but somewhat more than in South-eastern zone. This is a transitory zone between the South-eastern, North-western and South-western zones and most of the severe hail storms, nor'westers and tornadoes are recorded in this area.
- ii. **South-western Zone:** Here the extremes of the zones to the north are somewhat tempered. Rainfall is between 1,500 mm and 1,800 mm. Mean summer maximum temperature is below 35°C. Dew-fall is heavier than in Western zone.
- iii. **North-western Zone:** Except that the extremes are less and the rainfall is lower, this zone is similar to northern part of the northern region. The lower rainfall makes this area both atmospherically and pedagogically drier (Banglapedia, 2010).

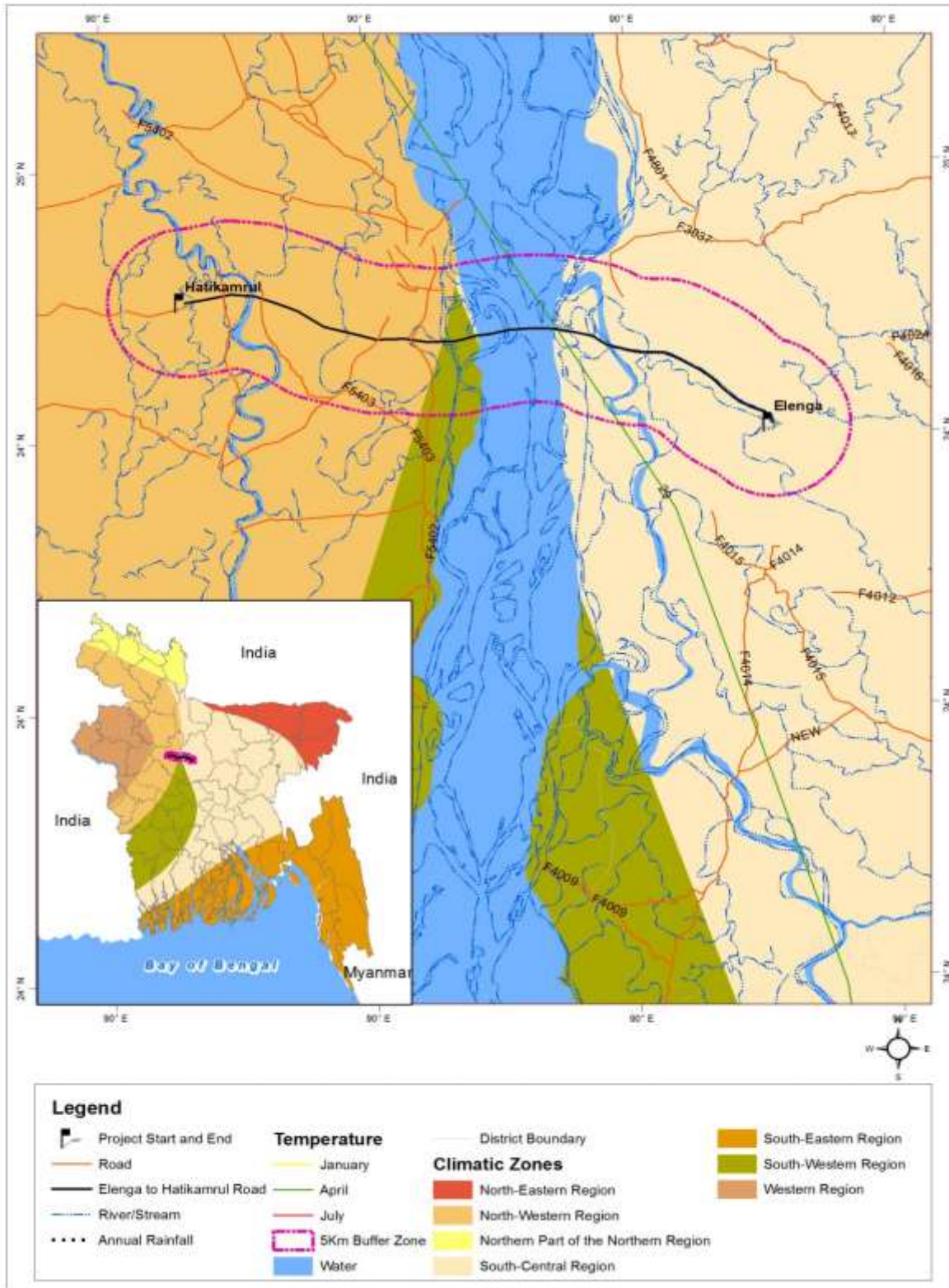
112. Like other parts of the country, the project area is heavily influenced by the Asiatic monsoon, and it has these three distinct seasons:

- Pre-monsoon hot season (from March to May),
- Rainy monsoon season (from June to October), and
- Cool dry winter season (from November to February).

113. The pre-monsoon hot season is characterized by high temperatures and thunderstorms. April is the hottest month in the country with mean temperatures ranging from 27°C in the east and south, to 31°C in the west-central part of the country. After April, increasing cloud-cover reduces the temperature. Wind direction is variable during this season, especially during the early part. Rainfall, mostly caused by thunderstorms, can account for 10 to 25 percent of the annual total.

114. The rainy monsoon season is characterized by southerly or south-westerly winds, very high humidity, heavy rainfall and long periods of consecutive days of rainfall. The monsoon rain is caused by a tropical depression that enters the country from the Bay of Bengal. About 80% of the annual precipitation occurs during the five-month monsoon season from May to September.

115. The cool dry season is characterized by low temperatures, cool air blowing from the west or northwest, clear skies and meagre rainfall. The average temperature in January varies from 17°C in the northwest and north-eastern parts of the country to 20°C to 21°C in the coastal areas. Minimum temperatures in the extreme northwest in late December and early January reach between 3°C to 4°C.



(Source: Rashid, 1991)

Figure 10: Climatic Zones

116. **Temperature.** Long-term average monthly temperature data (1991-2012) were collected at Tangail weather station from Bangladesh Meteorological Department (BMD). The highest temperature recorded in this station was 37.5 °C in April and the lowest temperature was found in the month of January which was 7.7 °C. The average monthly temperature graphs (Figure 12) show that the area face high temperature from March to May and lowest temperature during winter remains from December to February in the year.

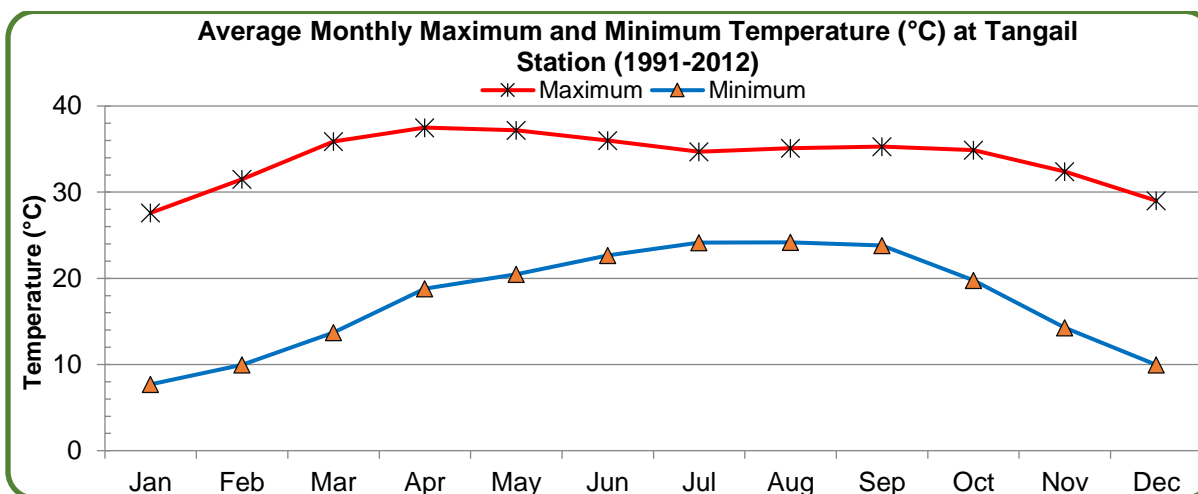


Figure 11: Average Monthly Maximum and Minimum Temperature at Tangail Station (1991-2012)

117. **Rainfall.** The rainfall data collected for the same station represents that maximum rainfall occurs during May to September and the lowest rainfall occurs in November to February during winter season (Figure 13). Statistical data of 1991 to 2012 shows that the station experiences more than 300 mm rainfall in June and July months during monsoon. In the months of December and January of winter season around 10 mm rainfall occurred in the region of Tangail stations.

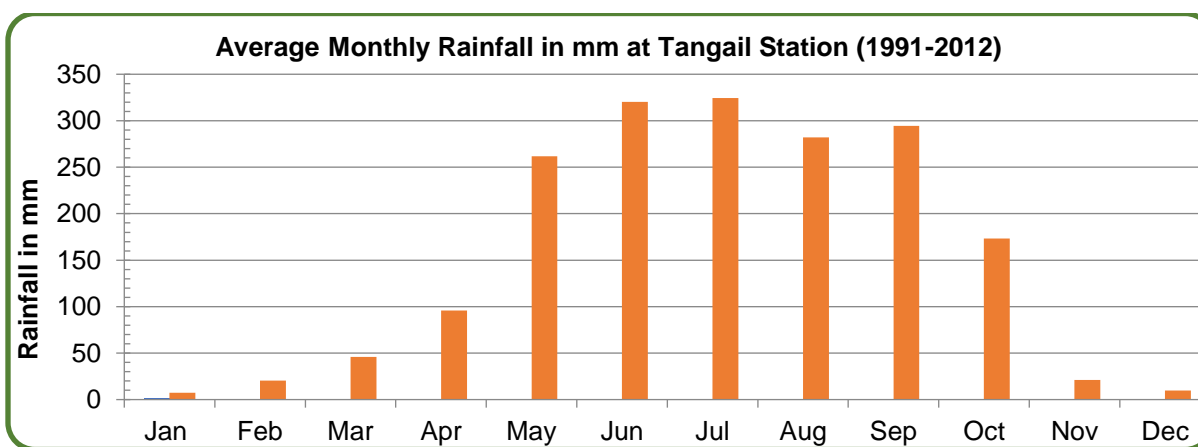


Figure 12: Average Monthly Total Rainfall at Tangail Station, 1991-2012

118. **Humidity.** Humidity is the amount of water vapour in the air. There are three main measurements of humidity: absolute, relative and specific. Relative humidity is an important metric used in weather forecasts and reports, as it is an indicator of the likelihood of precipitation, dew, or fog. While humidity itself is a climate variable, it also interacts strongly with other climate variables.

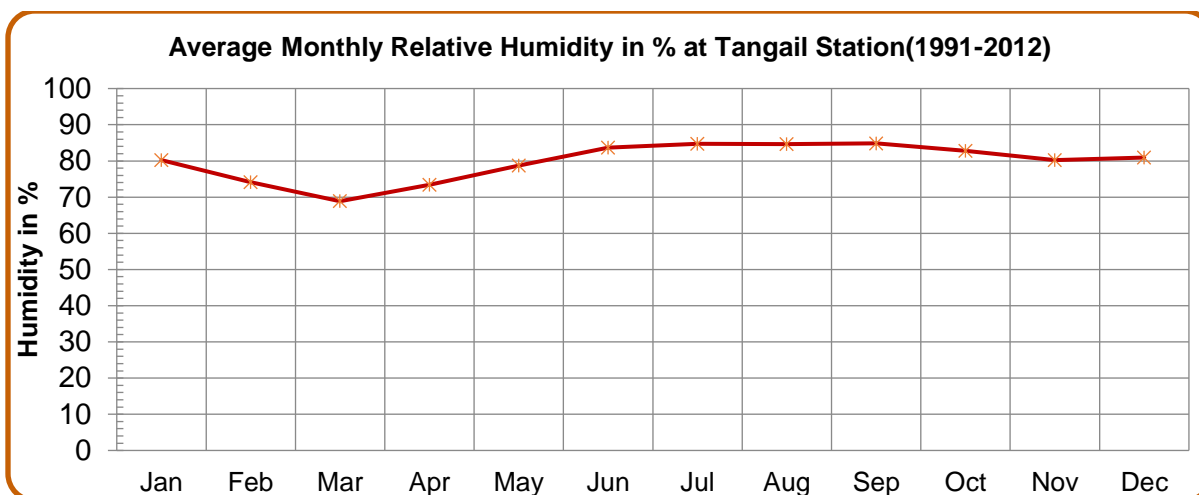


Figure 13: Average Monthly Humidity at Tangail Station, 1991-2012

119. Humidity remains high in summer and comparatively low in winter season. The statistical data of humidity from 1991 to 2012 indicates that humidity in the area maximized in July to September in the year which is ranges from 80% to 85%. On the other hand, humidity falls 60% to 75% in February, March and April during the winter season in the considered area (Figure 14).

120. **Wind Speed.** Prior to the onset of the monsoon in March and April, hot conditions and thunderstorms prevail while winds gradually start blowing from the south or southwest - a pattern that continues throughout the monsoon period. Winds are generally stronger in the summer than they are in winter. The direction of prevailing winds is generally consistent during the winter and monsoon seasons and more variable during the transition periods. The Himalayan mountains are influence wind patterns. Recirculation of winds during the monsoon season under the influence of the Himalayas can result in winds circling to the east–southeast in the northern parts of the country.

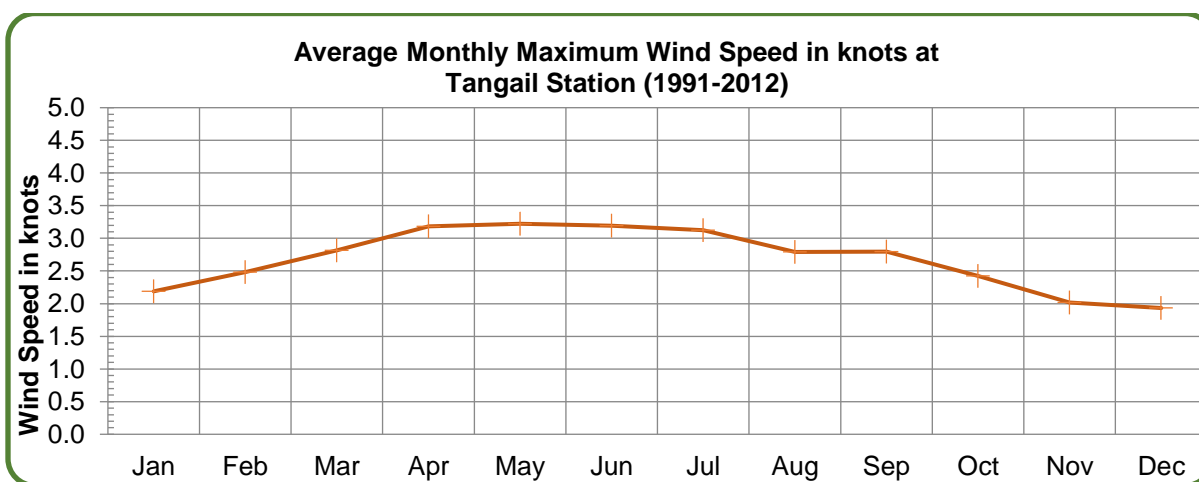


Figure 14: Average Monthly Maximum Wind Speed at Tangail Station, 1991-2012

121. The statistical wind speed data (Figure 15) shows that wind speed remained maximum with 3.3 knots in May and the minimum was 1.9 knots in the month of December for Tangail station.

2. Physiographic Features

122. Physiography is the subfield of geography that studies physical patterns and processes of the Earth. It aims to understand the forces that produce and change rocks, oceans, weather, and global flora and fauna patterns. Physiographic region/unit refers to a region of which all parts are similar in terms of physical characteristics and which have consequently had a uniform geomorphic history, and whose pattern of topographical features or landforms differs significantly from that of adjacent regions.

123. In the context of physiography, Bangladesh can be divided into three broad categories based on topography, physical features, and geological history (Brammer, 1996):

- Floodplains
- Terraces
- Hills

124. The Elenga-Hatikamrul road alignment area lies mostly in the central part of the country and depends on the Jamuna River for freshwater supply. The Elenga-Hatikamrul road area is characterized by the floodplains of Jamuna in Tangail District and Tista floodplain in the Sirajganj District. The entire road alignment runs through the following two physiographic units 2 and 4 (Figure 4.6).

- ***Tista floodplain (2)***: A big sub-region stretches between the Old Himalayan Piedmont Plain in the west and the right bank of the N-S flowing Brahmaputra in the east. An elongated outlier representing the floodplain of the ancient Tista extends up to Sherpur (Bogra district) in the south. Most of the land is shallowly flooded during monsoons. There is a shallow depression along the Ghaghat river, where flooding is of medium depth. The big river courses of Tista, Dharla and Dudhkumar cut through the plain. The active floodplain of these rivers, with their sandbanks and diyaras, is usually less than six kilometres wide.
- ***Old Brahmaputra floodplain (4)***: In 1787, a remarkable change in the course of the Brahmaputra took place. In that year, the river shifted from a course around the eastern edge to the western side of the Madhupur Tract. The Old Brahmaputra floodplain stretching from the south-western corner of the Garo Hills along the eastern rim of the Madhupur Tract down to the Meghna exhibits a gentle morphology composed of broad ridges and depressions.

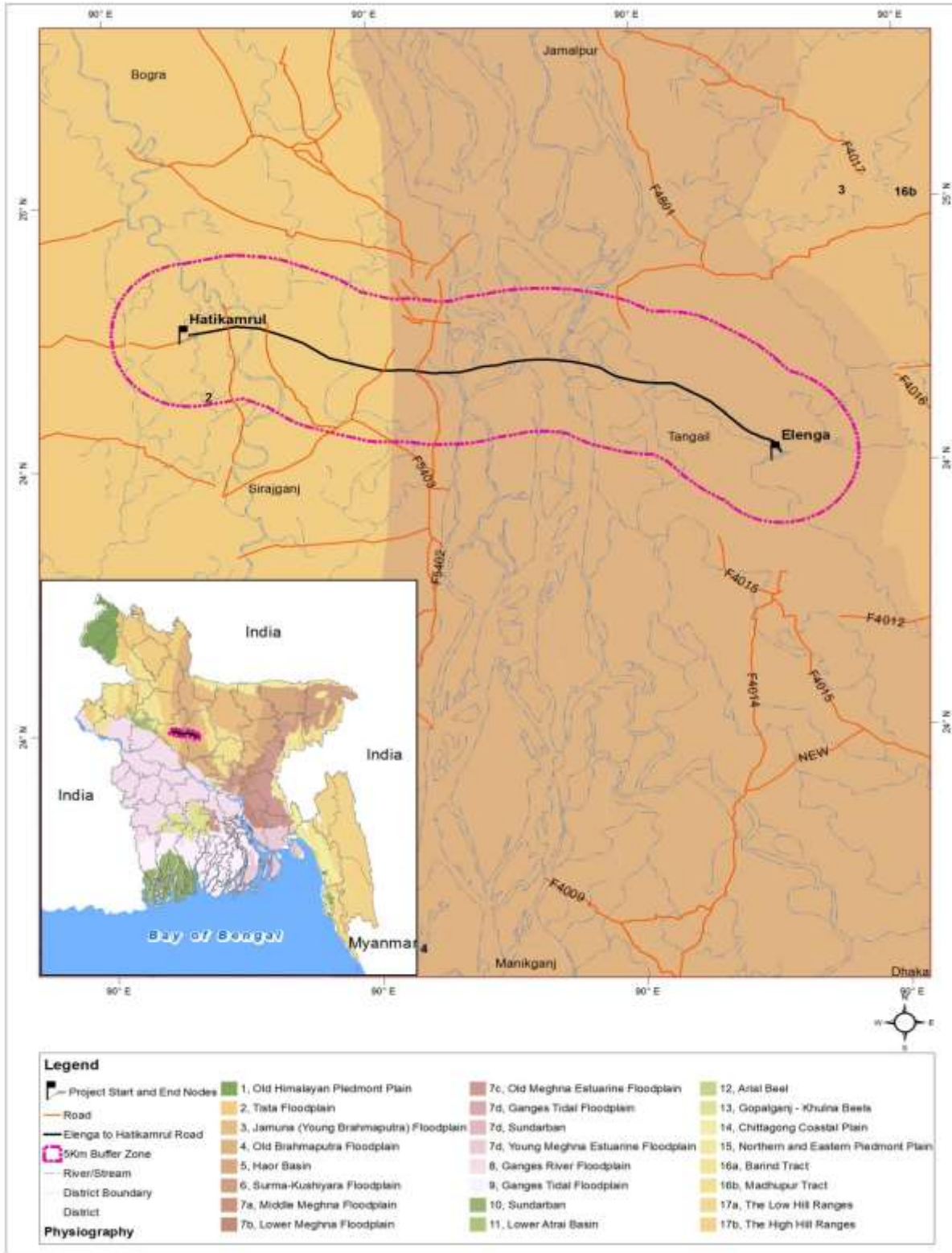


Figure 15: Physiographic Sub-regions of Bangladesh

(Source: SRDI, 1997)



Photograph 1: Physiography of the Project Area.

3. Topography

125. Topography is the configuration of a land surface including its relief and contours, the distribution of mountains and valleys, the patterns of rivers, and all other features, natural and artificial, that produce the landscape. Although Bangladesh is a small country, it has considerable topographic diversity. It has three distinctive features: (i) a broad alluvial plain subject to frequent flooding, (ii) a slightly elevated relatively older plain, and (iii) a small hill region drained by flashy rivers.

126. The general topography of the project area comprises floodplains in the majority of the road and terraces. The general topography of the project area slopes from north to south with elevation ranged from 16m a.m.s.l to 15m a.m.s.l (Figure 17).

127. The project is located on the flood plain of the Jamuna and Fuljor River. The ground elevation of the project area is about 13mPWD. Topographically the cluster of the project location is almost flat, with many depressions, natural khals, bounded by the rivers. There are many vacant low lands on the bank of the Rivers, where mainly agricultural practices are dominant.

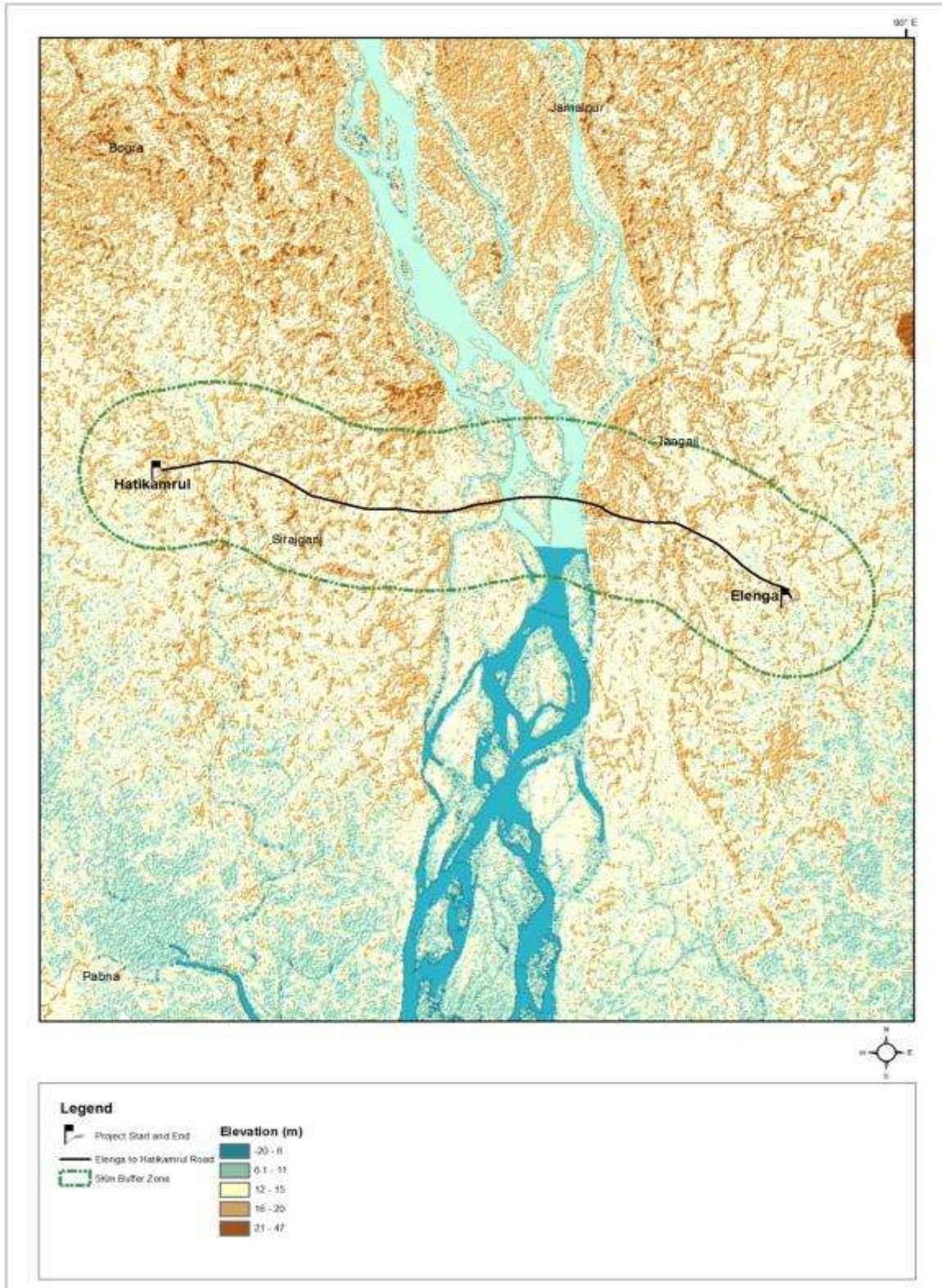


Figure 16: Topographical Map of Elenga – Hatikamrul Road

4. Geology

128. Bangladesh is situated to the east of the Indian sub-continental plate. Nearly 85% of Bangladesh is underlain by deltaic and alluvial deposits of the Ganges, Brahmaputra, and Meghna river systems. The project area consists of Holocene alluvial deposits flood plain and predominantly consisting of fine sand, silts and clay. The site is on deep Cenozoic deposits that overlie Precambrian basement rock. The Precambrian rocks form the basement of all geological formations of Bengal Basin and shield areas. The materials deposited are a mixture of sediments transported by the old Brahmaputra and by the Jamuna (Brahmaputra) River. The generalized geological features of the project area are shown in the geological map of Bangladesh (Figure 18).

- **Faridpur Trough:** Situated adjacent to Hinge Zone is characterised by a general gravity low with development of Neogene sequence. Sylhet Limestone is 6500 m deep in area south of the confluence of the Padma and the Jamuna. Chalna and Bagerhat are the notable structural highs of very low amplitude (Banglapedia, 2006).
- **Bogra Shelf:** Represents the southern slope of Rangpur Saddle which is a regional monocline plunging towards southeast gently to Hinge Zone. This zone marks the transition between the Rangpur Saddle and the Bengal Foredeep from depositional as well as structural point of view. The width of Bogra Shelf varies from 60-125 km up to the Hinge Zone and the thickness of the sedimentary sequence increases towards the southeast. Stanvac Oil Company (SVOC) carried out aeromagnetic and seismic surveys in the mid-fifties followed by two wells at Kuchma and Bogra. Seismic contours on top of Eocene Limestone (Bogra limestone) show regional dip of 2-3° besides revealing a number of NE-SW trending faults of which Bogra fault is the most prominent. The attitude of Sylhet Limestone most possibly reflects the surface of the Archean Basement. There is no closed anticlinal fold in this tectonic zone. The Bogra fault did not provide the seal to the structural trends at Kuchma and Bogra for accumulation of commercial hydrocarbons (Banglapedia, 2006).

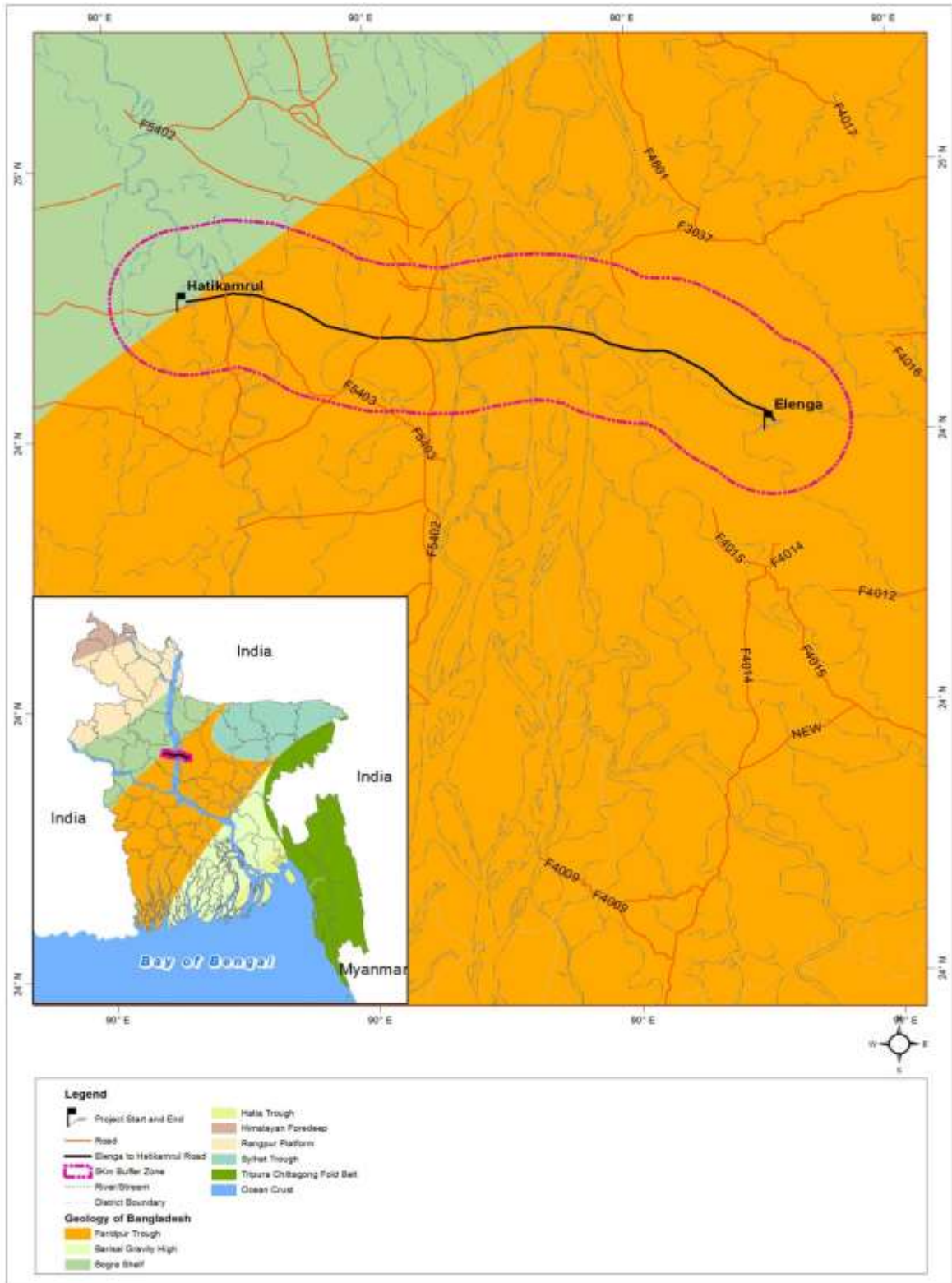


Figure 17: Geology of the Project Area

5. Seismicity

129. Seismic Zone expression of the proneness of a region to earthquake occurrence in the historical past including the expectations in future. A region experiencing more frequent and large earthquakes has a higher seismicity compared to one with less frequent and small earthquakes. Both the temporal and spatial distributions of all earthquakes, small and big, have to be systematically accounted for by determining their past behaviour to determine the future trend.

130. Bangladesh is situated in one of the most tectonically active regions in the world. Here is where three major plates meet (the Indian Plate, the Tibet Sub-Plate, and the Burmese Sub-Plate). The project area is located over the Indian Plate, which is moving north. However due to the location of relevant plates, fault lines and hinge zones, Bangladesh itself is divided into three seismic zones (Table 11), based on the ranges of the seismic coefficient (*note: the seismic coefficient is a measure of how strong an earthquake has the potential to be based on a combination of the mass of the plate and the seismic forces acting on it, as well as how frequently these quakes are likely to occur*). Zone 3 is in the most seismically active area with a seismic coefficient on 0.25, and Zone 1 is the least active with a significantly lower seismic coefficient of 0.075 (Zahiruddin, 1993). As per the seismic zone map (Figure 19), project road falls in Zone II, which means medium seismic intensity. There is no evidence of major earthquakes in the project areas in the past.

Table 11: Seismic Zones of Bangladesh

Zoning	Area Mercalli Scale	Bask Seismic Coefficient
I	North and eastern regions of Bangladesh (Seismically most active)	0.08
II	Lalmai, Barind, Madhupur Tracts, Dhaka, Comilla, Noakhali and western part of Chittagong Folded belt	0.05
III	Khulna division S-E Bangladesh (Seismically relatively quiet)	0.04

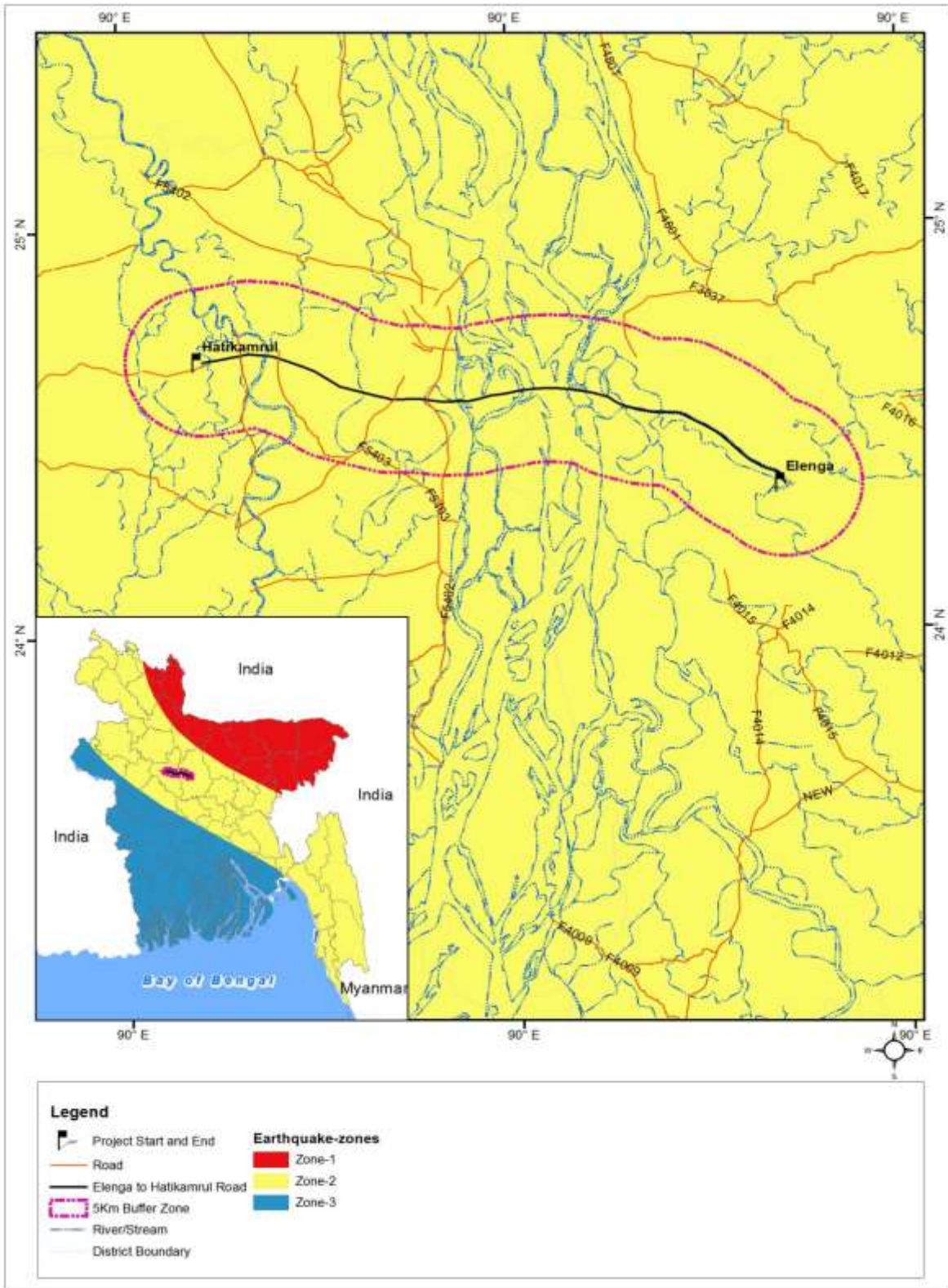


Figure 18: Seismic Zones within Bangladesh
 (Source: Hossain, 1988 & Zahiruddin, 1993)

6. Soil

131. The major part of Bangladesh is on the delta formed by the three major rivers Brahmaputra, Ganges and Meghna. These rivers and many of the country's other minor rivers originate outside the national boundary of the country and make up the Ganges-Brahmaputra-Meghna river system.

132. The project road passes through two different soil formation zones (Figure 20). The general soil types of the project road area predominantly include the following:

- **Non-calcareous Alluvium (1):** Similar to calcareous alluvium, except they are non-calcareous in soil profiles. These soils occupy extensive areas on the active Tista and Brahmaputra-Jamuna floodplains. They are sandy or silty, grey or olive, neutral to slightly alkaline. Most of these soils have been included as Eutric Fluvisols.
- **Grey floodplain soil (5):** Generally comprise grey topsoil and a cambic B-horizon in the subsoil with a grey matrix or grey gleans. They extensively occupy Tista, Karatoya-Bangali, Jamuna, middle Meghna and eastern Surma-Kushiyara floodplains. However, there are considerable regional differences in the proportions occupied by individual soil textures. Silt loam texture is dominant in the Tista meander floodplain whereas silty clays are predominant in the Ganges tidal floodplain and in the Surma-Kushiyara floodplain. But the Jamuna floodplain has a more even distribution of silt loam, silty clay loam and silty clays. Most of these soils have been included in Eutric Gleysols (Banglapedia, 2006).

7. Agroecological Zones within the Project Area

133. Agroecological Zone is the land areas recognised on the basis of hydrology, physiography, soil types, tidal activity, cropping patterns, and seasons. In fact an agroecological zone indicates an area characterised by homogeneous agricultural and ecological characteristics. This homogeneity is more prominent in the sub region and unit levels.

134. The purpose of assessing the AEZs within the project area is to establish a broad overview of expected soil conditions which can be compared against more detailed, Upazila-level data sources.

135. The agroecological zones of Bangladesh have been identified on the basis of four elements such as physiography, soils, land levels in relation to flooding and agroclimatology. The most recent assessment was completed by the Soil Resource Development Institute (SRDI, 1998) which classified Bangladesh into 30 AEZs. These 30 zones have been subdivided into 88 agroecological sub-regions, which have been further subdivided into 535 agroecological units. The project area contains 3 AEZs (refer Figure 20), namely:

- i. **Karatoya - Bangali Floodplain (4):** This region is very similar to the Tista Meander Floodplain in physiography and soil, and comprises a mixture of Tista and Brahmaputra sediments. Most areas have smooth, broad, floodplain ridges and almost level basins. The soils are grey silt loams and silty clay loams on ridges and grey or dark grey clays in basins. Five general soil types occur in the region, of which non-calcareous grey floodplain and non-calcareous dark grey floodplain soils predominate. The soil is moderately acidic throughout. Organic matter contents are generally low in the cultivated layer of ridge soils and moderate in

basins. General fertility is medium. The eastern half of Bogra and most of Sirajganj districts are included in this zone (Banglapedia, 2006).

- ii. **Active Brahmaputra - Jamuna Floodplain (7):** This region comprises the belt of unstable alluvial land along the Brahmaputra-Jamuna Rivers where land is constantly being formed and eroded by shifting river channels. It has an irregular relief of broad and narrow ridges and depressions. The area is occupied by sandy and silty alluvium, rich in weatherable K minerals that are slightly alkaline in reaction. Six general soil types occupy the area. Organic matter status is low and fertility status is low to medium (Banglapedia, 2006).
- iii. **Young Brahmaputra - Jamuna Floodplain (8):** The zone comprises the area of Brahmaputra sediments. It has a complex relief of broad and narrow ridges, inter-ridge depressions, partially in filled cut-off channels and basin. This area is occupied by permeable silt loam to silty clay loam soils on the ridges and impermeable clays in the basins, neutral to slightly acid in reaction. General soil types include predominantly grey floodplain soils. Organic matter content is low in ridges and moderate in basins. Soils are deficient in N, P, and S but the status of K and Zn are reasonable (Banglapedia, 2006).

136. The nature and soil characteristics of these zones influence the crops and cropping patterns within the region. Human interventions and modifications in the drainage patterns have already affected the cropping calendar, crop diversity and introduction of new varieties and agricultural products.

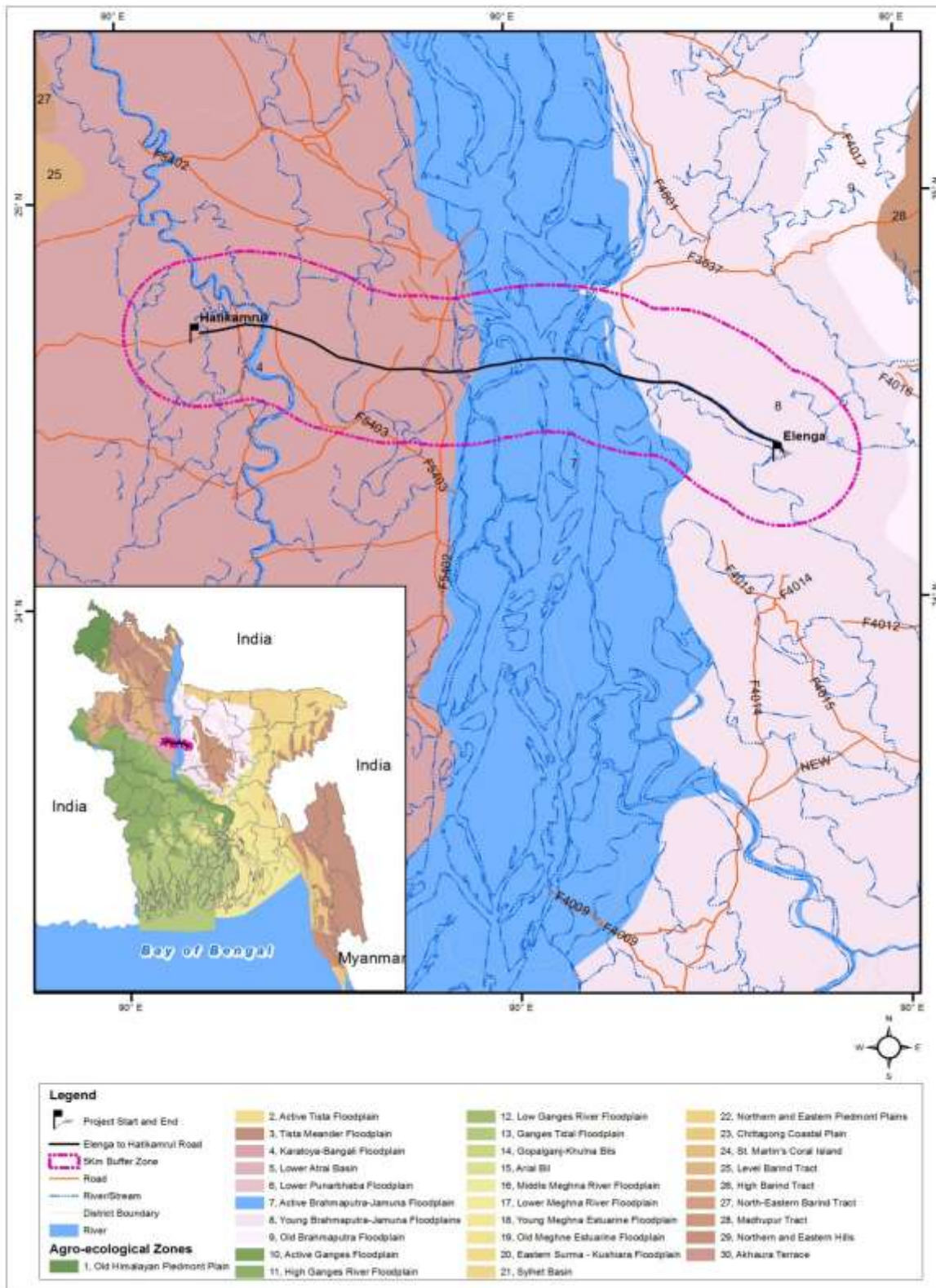


Figure 19: Agroecological Zones

8. Soil Quality

137. According to the United States Department of Agriculture (USDA) Natural Resources Conservation Service, soil quality is the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation. Soil in the project area is highly productive and suitable to support different ecosystems in balance. The land in this area is mostly used for agricultural cultivation. During the construction phase of the project, road embankment will be built by carried earth. Hence, there is the chance of the native soil to be disturbed by the external carried earth. There has the priority of using the dredged earth from the rivers along the road alignment instead of using the local soil from the land.

138. Soil sample in 1 m depth from the bed of the Jamuna River and Fuljor River was analysed in the environmental laboratory of BUET to assess the current soil quality as the dredged material. Table 4.2 reflects the test results of the collected soil sample. Test report of soil analysis proves that river bed material (sand) of the Jamuna and Fuljor Rivers contains acceptable amount of Arsenic (As), Lead (Pb), Zinc (Zn) and Mercury (Hg) comparing with the standard of EU Directive 86/278/EEC for land application. Thus, sand from the rivers can be used for developing project Road Embankment.



Photograph 2: Riverbed Materials Collection at Jamuna River, Tangail and Fuljor River, Sirajganj

Table 12: Test Results of Soil Quality

Parameter	Unit	Concentration Present		EU Directive 86/278/EEC for Land Application	Method of Analysis
		Jamuna River Location: 24° 18' 57.716" N 89° 55' 15.340" E	Fuljor River Location: 24° 25' 20.088" N 89° 35' 26.547" E		
Arsenic (As)	mg/kg	1.761	1.911	-	USEPA 206.2; SM 3113 B
Lead (Pb)	mg/kg	23.2	25.2	1200	USEPA 200.9 Rev 2.2; SM 3111 B
Zinc (Zn)	mg/kg	49	64	4000	USEPA 200.9; SM 3111 B
Mercury (Hg)	mg/kg	0.109	0.095	25	-----
Cadmium (Cd)	mg/kg	0	0	-	EPA 213.2 ; 3113 B

Parameter	Unit	Concentration Present		EU Directive 86/278/EEC for Land Application	Method of Analysis
		Jamuna River Location: 24° 18' 57.716" N 89° 55' 15.340" E	Fuljor River Location: 24° 25' 20.088" N 89° 35' 26.547" E		
Copper (Cu)	mg/kg	29	41	-	-----

Source: Lab Analysis, November 2012, BUET

9. Water Resources and Hydrology

139. Bangladesh is located over a subsiding basin of tectonic origin overlain with a great thickness of sedimentary strata. This sedimentary stratum is an unconsolidated alluvial deposit of recent age overlaying marine sediments. The recent delta and alluvial plains of the Ganges, Brahmaputra and the Meghna Rivers constitute the upper formation. The near surface Quaternary alluvium contains good aquifer characteristics (transmission and storage coefficients). The groundwater (GW) storage reservoir has three divisions: upper clay and silt layer, a middle composite aquifer (fine to very fine sand) and a main aquifer consisting of medium to coarse sand. Drinking water is generally taken from deep tube wells with strainers set between depths of 200 meters to around 400 meters (DPHE, 2011). The Ground water level is at or very close to the surface during the monsoon; whereas, it is at maximum depth during the months of April and May (Banglapedia, 2010).

140. **Surface Water.** Two major surface water bodies surrounding the project area which are Jamuna River and Fuljor River. The project road alignment crosses all the water bodies are presented in Figure 21. There are also significant numbers of beel and khal in and around the project locations. Besides, there are remarkable numbers of ponds and ditches available in the project area. Most of the water bodies become waterless or contain minimum amount of water during the dry season and gets water in rainy season. People use the water from the river, khal, canal and ponds for washing, bathing and irrigation purposes. In the wet season, substantial amount of the land in the area is inundated due to flood. In the dry season local canals and channels provide water for irrigation for boro cultivation and for growing winter crops. Table 13 represents the affected water bodies & fish resources in the RoW of the project road alignment.



Photograph 3: Water Bodies along the Elenga-Hatikamrul Road.

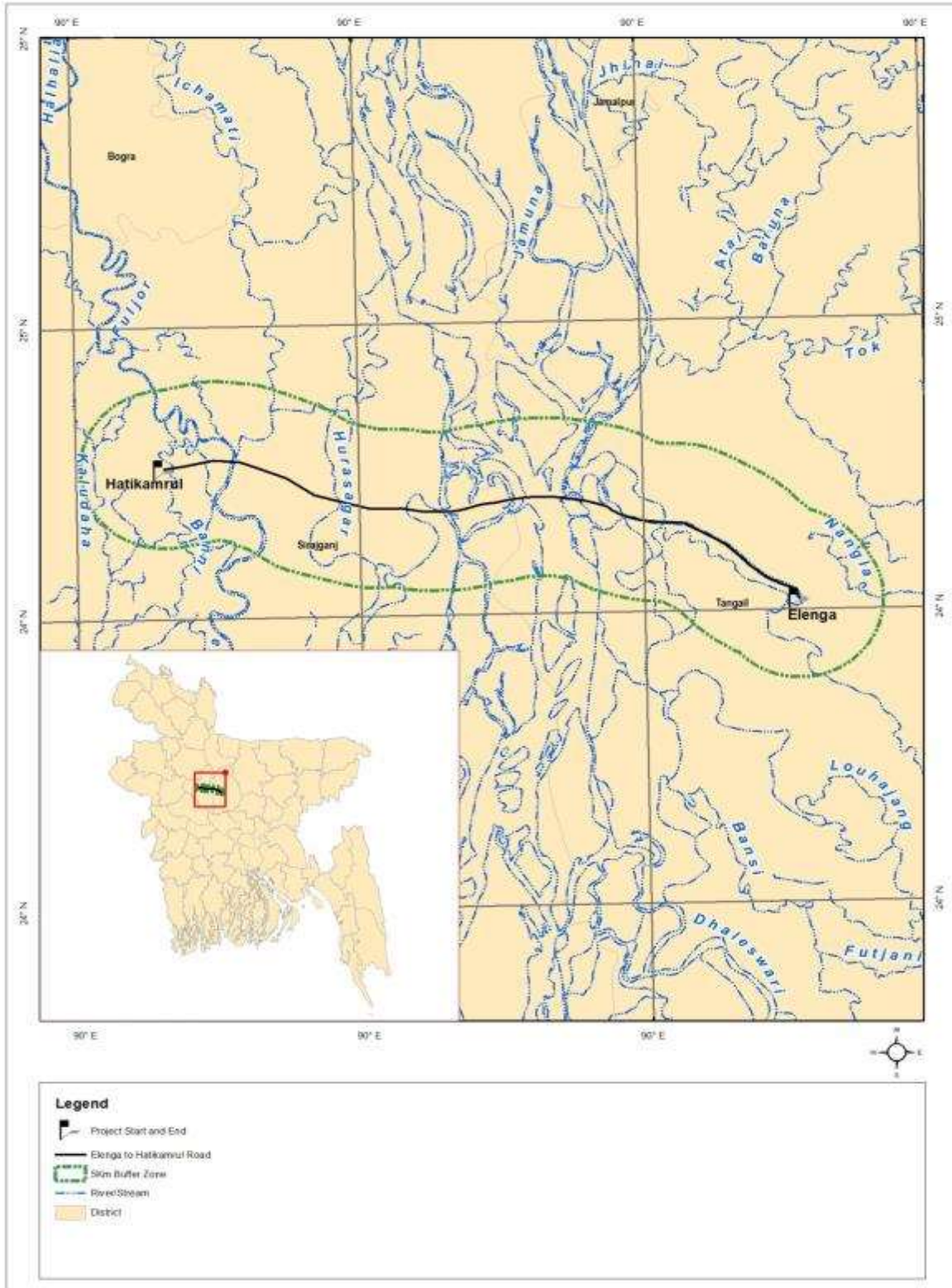


Figure 20: River Network

Table 13: Affected Water Bodies & Fish Resources within 25m of the Rows of the Alignment

Type of Water Bodies	Chainage (Km)		Total No. of Water Bodies	Area (ha)		Affected Total Fish Production	
	Right	Left		Total Area	Affected Area	MT/ha/Year ⁶	Total Production (MT)
River	95+425, 106+320		2	-	-	-	-
Canal	72+100, 77+700, 79+070, 99+500,		4	-	-	-	-
Pond	69+500, 70+560,		2	0.133	0.032	1.92	0.061
Beel		92+800,	1	-	-	-	-
Khal		98+300, 105+850-106+000,	2	-	-	-	-
Ditch	69+550, 69+700,		2	0.101	0.036	0.82	0.029

10. Surface Water Quality

- Water quality refers to the chemical, physical and biological characteristics of water. It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose. It is most frequently used by reference to a set of standards against which compliance can be assessed. The most common standards used to assess water quality relate to health of ecosystems, safety of human contact and drinking water. To assess the current quality of ground and surface water, water samples were collected from two locations along the whole alignment.
- The overall quality of surface water around the project site and its surroundings varies throughout the year. Typically water quality improves during the monsoon due to the influx of fresh rainwater, and worsens during the dry season as water evaporates and the concentration of contaminants increases. The surface water quality at various locations was measured in the project area during the Environmental Impact Assessment. In March 2017, surface water samples were collected by environmental team from two surface water bodies (at major bridge site two samples were collected from 50 m upstream and 50 m downstream of bridge location) along the project corridor. The Bangladesh Council of Scientific and Industrial Research (BCSIR) analysed the samples. The result of the surface water samples and are shown in Table 14.

⁶ Production in MT/ha/Y has been given based on the information collected from the owners of the water bodies



Photograph 4: Surface Water Sample Collection from River along the Project Road

Table 14: Results for Surface Water Field Samples

SL No.	Sample ID	Sampling Location	Results					
			pH	Total Organic Carbon (TOC)	Total phosphate (PO ₄)	Total Suspended Solids (TSS)	Dissolved Oxygen (DO)	Oil and Grease
Method of Analysis			pH Meter	Wet Oxidation Method Followed by Potentiometric Titration	Vanadomolybdophosphoric Yellow Color Method	Gravimetric Method	DO Meter	APHA 5520.B
Unit			-	ppm	ppm	mg/L	mg/L	mg/L
1	SW 14.1 (50m US)	Hatikamrul (Fuljor River)	6.88	4.01	0.26	<5	3.66	8.80
2	SW 14.2 (50m DS)	Hatikumrul (Fuljor River)	7.27	3.65	0.71	< 5	4.04	<5
3	SW 16	Elenga	7.49	12.69	6.12	192.70	4.63	2.40
Standards for Inland Surface Water (water usable for recreational activity)			6.5-8.5	No standard	No standard	No standard	5 or more	No standard

Source: Lab Analysis, April, 2017, BCSIR

11. Groundwater

141. The groundwater resources in the project area are found in three separate aquifers. An upper aquifer: a surface layer consisting mainly of clay and silt, characterized by high porosity but low permeability; composite aquifer: an intermediate layer of mainly fine sand and clay characterized by high porosity and moderate permeability (possibility of providing water with hand pumps); and main aquifer: a deeper layer, containing mainly fine to coarse sand. The main aquifer is characterized by high porosity and moderate to high permeability and is separated from the composite aquifer by a clay layer. Fresh groundwater is relatively carbonate-rich with low total dissolved solid contents of less than 500 milligrams/liter (mg/l). Arsenic is a problem in large part of Bangladesh ground water. The project area also has Arsenic levels in ground water varying

from <1 microgram to 50 microgram per liter of water. The acceptable quantity of arsenic in potable water is 0.05 mg per liter under the Department of Environment standard and 0.01 mg per liter under the WHO standards (Figure 22).

142. Based on field observations and interviews with local residents it was found that groundwater in the area is used as a drinking water source in many instances, as well as for irrigation purposes. Water is generally extracted via hand pump (tube wells) from the shallow regions of the composite aquifer, and via machine-driven pumps (deep tube wells) which draw from the deeper main aquifers (Table 15). The ground water reservoir usually recharges from rainfall, floods and river. In summer season, the water table slightly goes down and goes up in rainy season.

Table 15: Source of Drinking Water in the Project Area

District	Upazila (sub-district)	No. of Households	Source of Drinking Water (%)		
			Tap	Tube-well	Others
Tangail	Kalihati	97,988	0.4	97.8	1.8
Sirajganj	Sirajganj Sadar	124,852	4.0	93.9	2.1
	Kamarkhand	31,920	0.8	97.7	1.5
	Royganj	77,104	0.7	95.4	3.9
	Ullapara	123,630	0.9	94.7	4.4

Source: Population Census, 2011

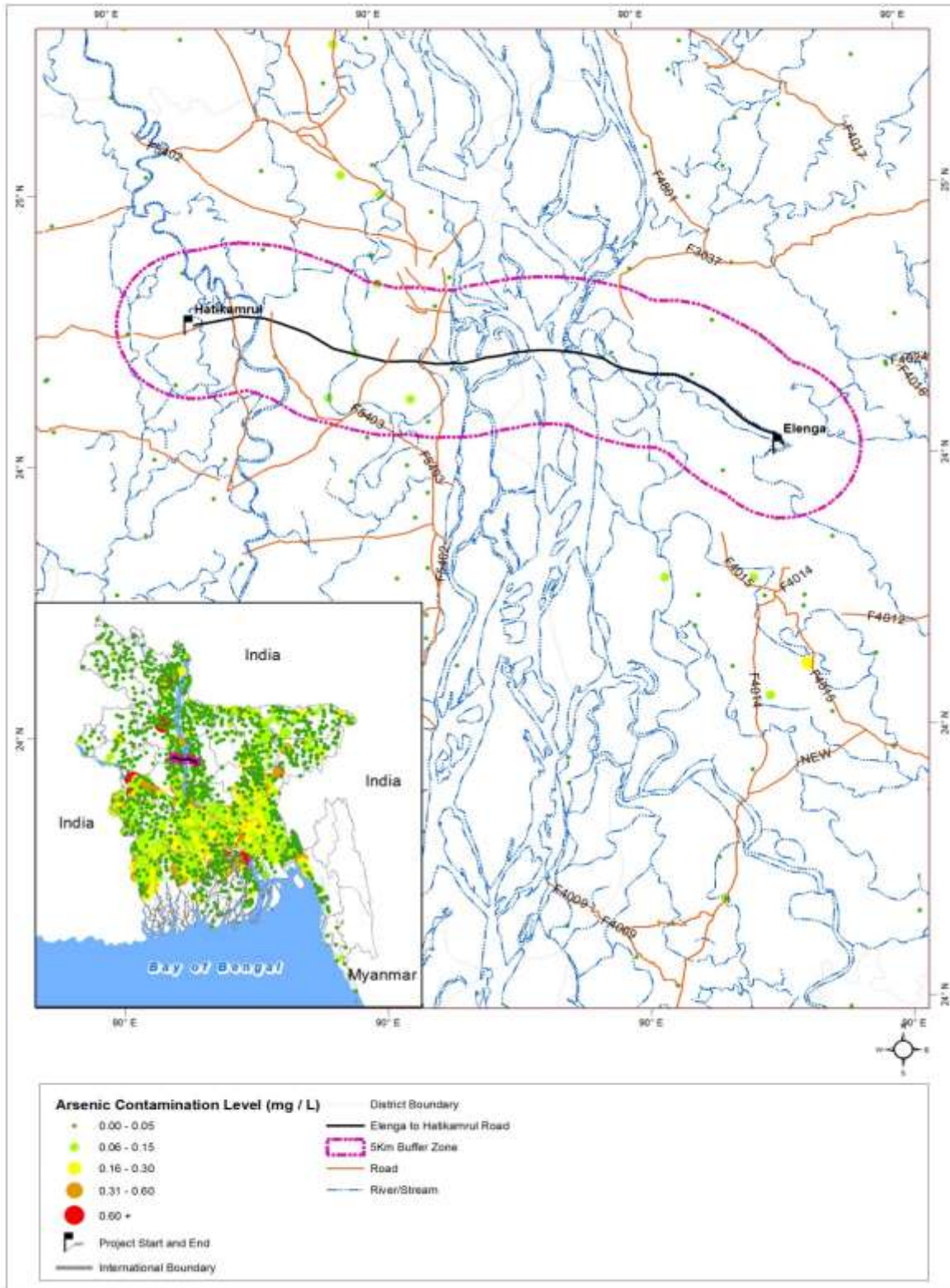


Figure 21: Arsenic Concentrations in Groundwater

12. Groundwater Quality

143. In March 2017, groundwater samples were collected from two locations of shallow tube wells by environmental team along the project road. The Bangladesh Council of Scientific and Industrial Research (BCSIR) analysed the samples and coliforms were tested at International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) laboratory. The result of the groundwater samples and the GoB standards for potable water (ECR, 1997) are shown in Table 16. The water quality test results are given in Appendix E. The concentration of Mn and Fe is higher than the standard value at Hatikamrul water source.



Photograph 5: Groundwater Sampling along the Project Road

Table 16: Results for Groundwater Field Samples

Parameters	Unit	Elenga	Hatikamrul	Drinking Water Quality Standard, DOE (ECR,97)	Method of Analysis
pH	-	7.32	7.20	6.5-8.5	pH meter
Manganese (Mn)	ppm	0.056	0.67	0.1	AAS
Arsenic (As)	ppm	0.0051	0.022	0.05	AAS with HVG Unit
Iron (Fe)	ppm	0.027	12.7	0.3-1.0	AAS
Chloride (Cl)	ppm	20.83	2.66	150-600	Ion Chromatography
Total Hardness	ppm	83.9	172	200-500	Potentiometric Titration
Total Coliform (TC)	CFU/100mL	0	0	0	Membrane Filtration
Faecal Coliform (FC)	CFU/100mL	0	0	0	Membrane Filtration

Source: Lab Analysis, April 2017, BCSIR & icddr,b

13. Ambient Air Quality

144. Ambient air quality refers to the background air quality levels in a region, characterised by concentrations of various pollutants in the atmosphere. The presence of air pollutants and their

concentrations depends on the type of polluting sources, and other factors that influence their flow and dispersion. In most cases vehicular emissions are the predominant source of air pollution. Existing ambient air quality data on various sections of the project corridors was collected to establish a baseline database. The aim was to identify areas that already have high pollution levels or are expected to experience so, on account of the road project, and to design adequate mitigation measures, as applicable.

145. The activities, which generate modify atmospheric air quality, are transportation (i.e., motor vehicle emissions, which are addressed in this report); domestic and construction. The principal sources of air pollution due to road projects are hot mix plants and machineries used during construction phase and the vehicles that ply over it during the operation phase. The major pollutants of significance to roadside air quality, on account of vehicular emissions, are suspended particulate matter (SPM), sulphur dioxide (SO₂), nitrogen oxides (NO_x), hydrocarbons (HC), carbon-monoxide (CO), total volatile organic carbon (TVOC), etc.

146. Dispersal of pollutants depends upon factors like prevailing wind direction and other weather conditions, height of the source, and characteristics of roadside plantation and presence of other sinks along the project corridor.

147. The main sources of air pollution in the project area are from road dust, black smoke from diesel engines, construction dust, windblown dust from agricultural lands, domestic heating and cooking, and transportations.

148. In order to monitor air quality, the field investigation was undertaken in March, 2017. The concentrations of SPM and PM₁₀ were obtained by collecting the sample over 24 hours in the location. Measured ambient air quality data are recorded in Table 17. Photograph 6 shows snapshots of air quality monitoring processes.



Photograph 6: Air quality measurement along the Project Road

Table 17: Ambient Air Quality in Different Locations

Air Quality Parameters	Unit	Concentration Present			Bangladesh Standard (ECR, 2005)
		Hatikamrul	Koddar Moor	Elenga	
GPS Location		24°27'12.21"N 89°42'9.94"E	24°23'45.73"N 89°41'29.92"E	24°20'19.78"N 89°55'28.53"E	
Temperature	°C	26.15	25	27.96	

Air Quality Parameters	Unit	Concentration Present			Bangladesh Standard (ECR, 2005)
		Hatikamrul	Koddar Moor	Elenga	
Relative Humidity	%	79.84	79.97	83.91	
Wind Speed	Km/h	0.14	0.43	0.0	
Wind Direction	Degree	194.57° South-West	238.37° South-West	153.5° South - East	
O ₃	ppm	3.09	3.71	5.35	157 (8-hr Average) 235 (1-hr Average)
NO _x	ppm	92.42	83.79	102.33	100 (annual)
SO ₂	ppm	9.85	19.50	20.81	80 (Annual) 365 (24-hr Average)
CO	ppm	0.0	.04	0.0	10 (8-hr Average) 40 (1-hr Average)
VOC	ppb	0.0	0.0	0.0	NYS
PM ₁₀	µg/m ³	65.78	148.80	98.95	50 (annual average) 150 (24-hr average)
PM _{2.5}	µg/m ³	27.77	99.85	67.20	15 (annual average) 65 (24-hr average)

Source: Baseline Survey, March 2017

149. The particulate matters, and oxides of nitrogen concentrations exceeded the DoE allowable limit at several measured locations along the project road. Human activities, such as the burning of fossil fuels in vehicles, construction activities and various industrial processes also generate significant amounts of particulates. In the project area human activities are mainly responsible for the high concentration of particulate matters.

150. To assess the likely impacts on the ambient air quality due to the proposed road project, CALINE-4, a line source model developed by the California Transport Department, was used to predict carbon monoxide (CO) and particulate matter (PM) concentrations on the road. The model was run to predict hourly average CO, PM_{2.5} and PM₁₀ concentrations generated from traffic movement on proposed highway.

151. Kerb side locations were selected to compare the model prediction with monitored locations. Compared with the actual measurements of PM_{2.5}, PM₁₀ and CO concentrations in Koddar More, the predicted concentrations of each pollutant is lower (99.85 vs. 70 µg/m for PM_{2.5}; 148.8 vs 85 µg/m for PM₁₀; and 0.4 vs. 0.3 ppm for CO). This might be due to the contributions of other sources of pollutants such as natural dust and emission of fossil fuels. The contribution of vehicles movement is almost 60-70% of total concentration at receptor location. The high movement of heavy duty diesel trucks (45%) along the road generates high amount of CO and particulates in the downwind side of the road. Details of the air quality modelling is in Appendix F.

14. Noise Level

152. Excessive noise is a potential issue for both human and biological receivers and can potentially cause a range of negative issues, from mild annoyance and moderately elevated levels of aggression to significant disturbance of behavioural patterns and in severe cases temporary or permanent hearing loss. According to World Health Organization's Guidelines for Community Noise (1999), daily sound pressure levels of 50 decibels (dB) or above can create discomfort amongst humans, while ongoing exposure to sound pressure levels over 85 dB is usually considered the critical level for temporary hearing damage.

153. Two primary sources of noise have been identified in the project area:

- **Commercial Areas:** There are some commercial or refreshment areas where always significant number of people gather and makes chaos continuously. This is another source of noise pollution along the road.
- **Road Traffic:** Road traffic is one of the major noise sources in the project area. The project road is common route of transportation for several districts. This highway carries a relatively high volume of both motorized and non-motorized vehicles, resulting in road traffic noise impacts along the road corridors.

154. Monitoring of ambient noise levels was undertaken by the environment team at three locations for twenty four hours in March 2017 within the project area. The outcomes of this monitoring are presented in Table 18. Photograph 7 shows some of the snapshots during the monitoring phases.

Table 18: Noise Level at Different Locations of the Project Alignment

Location	Noise Level Description, L_{Aeq} (dBA)
Sirajganj Road Chowrasta/Hatikamrul	64.93
Elenga Bazar, Elenga	71.45
Koddar Moor	65.17

Source: On Site Monitoring, SMEC Environmental Team

155. Analysis of the noise data shows that the baseline noise around the project area varies from location to location. However, the noise levels at measured locations are higher than the standard set by the Bangladesh Noise Pollution Control rules. Noise pollution propagation generated from traffic was predicted using Canarina CUSTIC 3.2 software, where noise emission from vehicles along the proposed Elenga – Hatikamrul Road is modelled as steady state line source. Sensitive noise receptors along the corridor were identified such as educational institutions, health complexes and religious centres. Based on the model prediction, the predicted noise for the following sensitive receptors will be exceeded by 2040, compared to the current scenario: Bytunnur Jame Mosque, An-Noor Mosque, unnamed mosque, Sayadabad Mosque, Bangabandhu Setu Purbo Station, Bangabandhu Setu Poschim Station, Analiabari High School, Talimul Islam Madrasha, Jamuna Polytechnic Institute, Shohidul Bulbul Karigori College, and Simanto Bazar. Predicted noise levels ranged from 65.6-74.8 Leq. Based on the model prediction, the predicted noise for the sensitive receptors is indicated in Table 19.

Table 19: Predicted noise for the year 2040 where there is exceedance vs. baseline data

Segment name	Name of sensitive receptor	Type of establishment	Latitude	Longitude	Baseline noise (Leq) under current traffic conditions	Predicted noise (Leq) for the year 2040	Comments (No change/ net increase in noise)
Tangail (Elenga)-Hatikamrul Road	Bytunnur Jame Mosque	Religious	24.34407	89.91985	62.0	67.4	Increase
	An-Noor Mosque	Religious	24.38649	89.8258	62.0	68.5	Increase
	Mosque	Religious	24.39461	89.73837	48.9	65.6	Increase
	Sayadabad Mosque	Religious	24.39177	89.71413	61.0	69.9	Increase
	Dhopakanti Mosque	Religious	24.42	89.5575	72.3	74.8	Increase
	Fuljor Degree College Mosque	Religious	24.42454	89.58956	65.7	68.0	Increase
	Bangabandhu Setu Purbo Station	Others	24.38945	89.81992	66.3	72.4	Increase
	Bangabandhu Setu Poschim Station	Others	24.39579	89.73359	59.7	71.8	Increase
	Hatikomrul Highway Thana	Others	24.41885	89.55367	76.0	70.7	No change
	Gas Transmission Company Ltd	Industry	24.3384	89.92561	73.5	68.9	No change
	Poschimanchol Gas Company Limited	Industry	24.42158	89.59808	74.6	68.6	No change
	Shakhawat Memorial Hospital	Health	24.41961	89.55268	80.0	72.3	No change
	Analiabari High School	Educational	24.37013	89.88501	60.3	66.1	Increase
	Talimul Islam Madrasha	Educational	24.39169	89.7142	66.0	69.3	Increase
	Jamuna Polytechnic Institute	Educational	24.39612	89.69189	64.6	67.6	Increase
	Shohidul Bulbul Karigori College	Educational	24.39864	89.65486	63.4	66.9	Increase
	Simanto Bazar	Bazar	24.41015	89.63028	67.0	73.6	Increase
	Rahbol Girls High School	Educational	25.05966	89.36947	63.4	68.3	Increase
	TMSS Health Complex	Health	25.08785	89.3807	61.8	73.3	Increase

156. The noise analysis result using noise modelling software is given in Appendix G.



Photograph 7: Monitoring of Ambient Noise Level at Project Area

157. Permitted noise level in different area according to Bangladesh Noise Pollution (Control) Rules, 2006 is listed below in Table 20. The corresponding World Bank EHS guidelines is shown in Table 21. Except for the industrial area where World Bank's EHS guideline standard is 70 dBA during day time, most of the national standards are more stringent compared to World Bank's EHS guidelines.

Table 20: Bangladesh Standard for Noise Level at Different Types of Areas

Area Type	Noise Level (dBA)	
	Day	Night
Silent Zone	50	40
Residential Area	55	45
Mixed Area	60	50
Commercial Area	70	60
Industrial Area	75	70

Table 21: Bangladesh Standard for Noise Level at Different Types of Areas

Area Type	Bangladesh Standard Noise Level (dBA)		World Bank EHS Guidelines 1-hour L_{eq} (dBA)	
	Day (06:00-21:00)	Night (21:00-6:00)	Day (07:00-22:00)	Night (22:00-7:00)
Silent Zone	50	40	55	45
Residential Area	55	45	55	45
Mixed Area	60	50		
Commercial Area	70	60	70	70
Industrial Area	75	70	70	70

C. Biological Environment

158. Bangladesh was once well forested, but most of the native forests have disappeared in recent decades due to mounting pressure from human populations. Only scattered patches of native trees, wetlands and associated fauna habitat remain in isolated locations within the terrestrial environment (IUCN, 2002). In many parts of the country, the abundance of plantations and groves of trees around villages creates an aspect of discontinuous forest (Wahab, 2008).

159. The floodplains of Bangladesh have long been subject to cultivation, the most dominant land use within the project area, with only scattered patches of native trees, wetlands and associated fauna habitat remaining in isolated locations within the terrestrial environment (IUCN, 2002).

1. Bio-ecological Zones

160. Within a relatively small geographic boundary, Bangladesh enjoys a diverse array of ecosystems. Being a low-lying deltaic country, seasonal variation in water availability is the major factor, which generates different ecological scenarios of Bangladesh. Temperature, rainfall, physiographic variations in soil and different hydrological conditions play vital roles in the country's diverse ecosystems. The ecosystems of Bangladesh could be categorised into two major groups, i.e. (i) land based and (ii) aquatic. The land-based ecosystems include forest and hill ecosystems, agro-ecosystems and homestead ecosystems; while seasonal and perennial wetlands, rivers, lakes, coastal mangroves, coastal mudflats and chars, and marine ecosystems fall into the aquatic category.

161. Each of the ecosystems has many sub-units with distinct characteristics as well. IUCN Bangladesh in 2002 classified the country into twenty-five bio-ecological zones (Figure 23). The project road alignment falls below the three bio-ecological zones.

- **Teesta floodplain (4a):** Teesta floodplain spreads over several different landscapes in greater Rangpur and the adjoining regions. The diversity results from the fact that the Teesta river had occupied and later abandoned several different channels during the last few thousand years including the valleys now are occupied by the Mahananda, Punarnava, Atrai, Choto Jamuna, Karatoya and Ghaghat rivers. There were large patches of forests in this zone, but they have in most cases been ruthlessly cut down. However, this zone is still fairly wooded with many valuable indigenous timber species. Although most of the large mammals have disappeared from this area but most of common bird species are still found in this location.
- **The Brahmaputra-Jamuna floodplain (4c):** The Brahmaputra floodplain situated in greater Mymensingh and Dhaka districts comprises the active channel of the Brahmaputra River and the adjoining areas of the young floodplain lands formed since about 1780, when the river shifted to its present course (i.e. the Jamuna River) to the south of Dewanganj in Jamalpur district. The main river course is strongly braided and consists of several interconnecting channels. This floodplain possesses a unique variety of plants, medicinal herbs, fruit yielding trees, many jungle shrubs, creepers and climbers, flowering trees etc., many of which yield valuable products. Bushes of reeds and canes are also found here. The faunal diversity in this zone is also rich. Leopard was frequently sighted in this zone. The most common poisonous snake is the Banded krait in this area, which could easily be identified by its broad black and yellow bands (IUCN, 2002f).
- **Major Rivers (11):** Bangladesh consists mainly of riverine and deltaic deposits of three large and extremely dynamic rivers entering the country: the Brahmaputra, Ganges and Meghna rivers. Newly accreted land, if it does not erode quickly, is initially colonized by grass, particularly catkin grass (*Saccharum spontaneum* for example). Dense growth of catkin grass can accelerate silt deposition on chars. Jamuna river provide highest amount of char lands. Many of the species' natural distribution, migration and storage are primarily functioned via these rivers into other wetland ecosystems (GoB-IUCN, 1992). A diverse range of waterfowls are

directly or ecologically dependent on these rivers and its associated ecosystems. However, it is quite alarming that, with the exception of few species of turtles, all other river biodiversity is threatened with extinction.

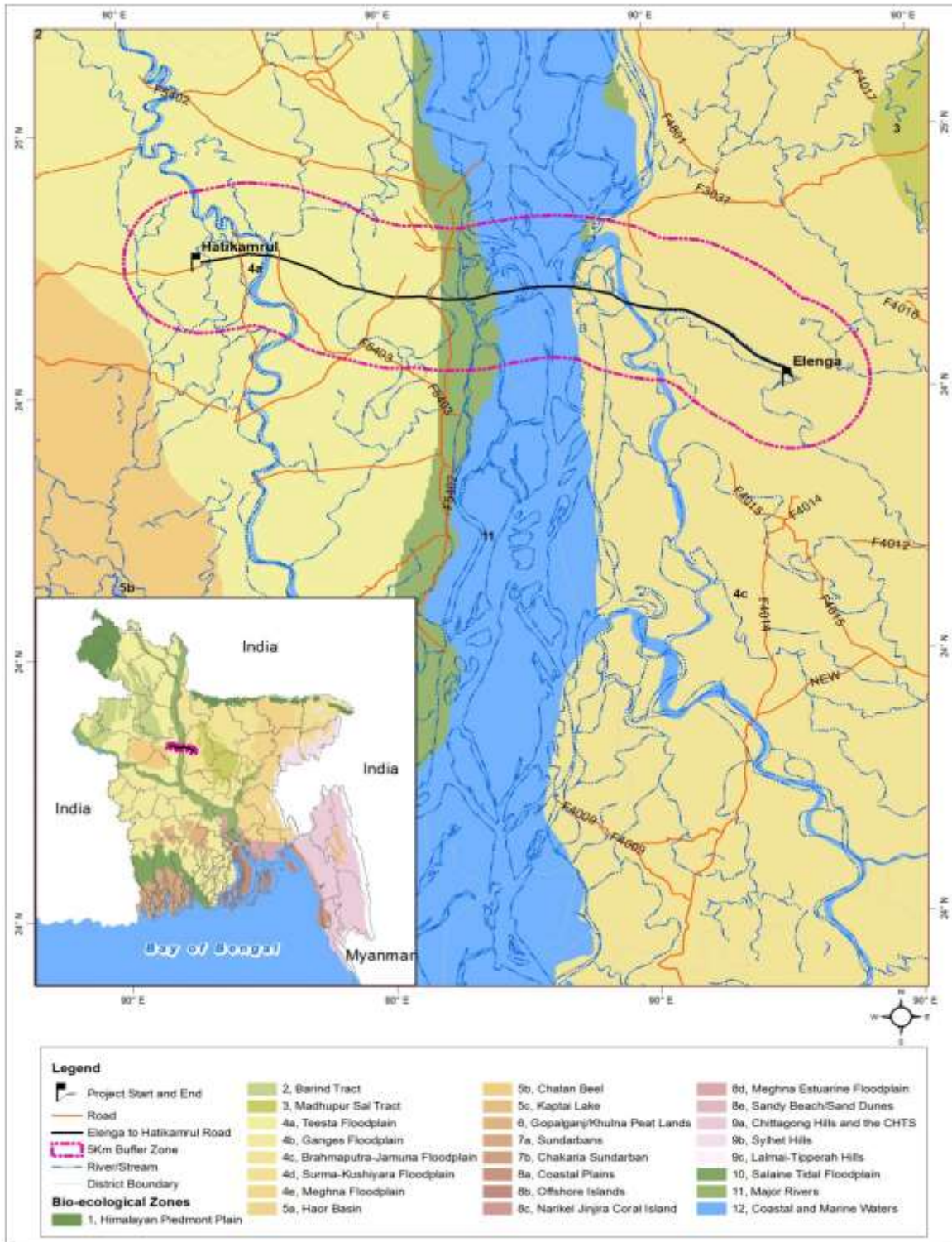


Figure 22: Bio-ecological Zones

2. Diversity of Terrestrial Floral and Faunal Species

162. The prominence of terrestrial floras and faunas at the project area were assessed from visual observations, review of literature, and information documented by other agencies. The project area consists of several ecological subsystems e.g. open agricultural land, homesteads, and roadside vegetation. The open agriculture land ecosystem dominates the area providing widespread habitat types for various species of flora and fauna under flooded and non-flooded conditions. The vegetation covers of agricultural lands are different crop species, weeds and other herbaceous plants species. The faunal species in the agriculture land and roadside bush ecosystems include birds, amphibians, fishes, snakes rodents and few mammals. The homestead ecosystem provides the main tree covered areas within the project site. The homesteads are covered by fruit, timber, fuel wood, medicinal plants and various multipurpose tree species. The wildlife species in homestead ecosystem include the birds, amphibians, reptiles, rodents and mammals like mongoose, jackal, cats, monkey, etc. Many of the species including mammals are vulnerable or/and endangered in Bangladesh due to habitat loss, over exploitation, natural calamities and lacking of management. The project area, including rivers where proposed bridges will be constructed, is not the specific habitat for any particular species of flora and fauna hence none such species will be specifically affected due to project implementation.

3. Terrestrial Flora

163. The project influence area (PIA) is highland with mixed vegetation. Crops, vegetables are cultivated at the surrounding mainly include rice, wheat, rabi crops and variety of homestead vegetables. A sizeable number of fruit trees with economic value have been observed in the PIA. The fruit trees include jackfruit, mangoes, litchi, banana, coconut, blackberry etc. and timber trees include mehegoni, neem, epil-epil, koroi etc. Considerable number of trees and bushes in the PIA site provide habitat for birds and other animals. The composition of plant community includes low growing grasses, trees, herbs and shrubs. The data collected from the field survey and suggests that the predominant species are those of cultivated vegetables and trees. A detailed list of terrestrial floral species found in the project area is shown in Table 22.

164. According to the census and IOL survey done in February-March 2014, a total of 31,450 trees of different sizes⁷ (large=3,432, medium= 7,318, small= 17,383 and saplings= 3,317) were found standing within ROW (details in Appendix D) of the subproject's road alignment. Among the list of affected trees 876, 1288 and 29,286 trees were found on private land, Government land (other than RHD) and on the slopes of the road (RHD land) respectively. Among the affected

⁷ **Large Tree:** A commonly found tree (except some particular species such as palm, dates, coconut, betel nut, guava, lemon, sharifa/sofeda, etc) with more than 4 feet of girth at the chest position has been classified as big tree. In case of fruit bearing trees (Mango, Jackfruit, Litchi, Black Berry, etc.) the girth size 3.5 feet and above are also considered as big category. In case of Palm, dates, coconut, betel nut, etc. 20 feet or above height is considered big. In case of guava, lemon, sharifa/sofeda, etc the age of the trees and judgment of the surveyor and trees owners has been imposed to classify the size. More than 10 years of age of such species of trees has been categorized as large.

Medium Tree: Trees having 2-4 feet girth is classified as medium. In case of palm, dates, coconut, betel nut species, the height between 10-20 feet is medium and for guava, lemon, sharifa/sofeda, etc the age of the trees between 5-10 years are classified as medium.

Small Tree: Three having less than 2 feet girth is classified as small, In case of palm, dates, coconut, betel nut species, the height between 5-10 feet is small and for guava, lemon, sharifa/sofeda, etc the age of the trees between 2-5 years are classified as small

Sapling/plant: Tree planted for gardening or growing up is classified as sapling. The plant still in nursery or eligible for shifting is classified as seedling.

trees, 25,647 trees are timber, 2,921 trees are fruit, 1,012 trees are medicinal, 658 trees are banana and 1,212 trees are bamboo.



Photograph 8: View of Terrestrial Flora along the Elenga-Hatikamrul Road.

Table 22: Common plants available in the subproject area

Common Name	Scientific Name	English Name	Family
Akashmoni	<i>Acacia auriculiformis</i>	Graps	Vaticaeae
Akanda	<i>Calotropis procera</i>	Swallow wort	Asclepiadaceae
Ashok	<i>Saraca indica</i>	Ashoka	Caesalpinioideae
Am	<i>Mangifera indica</i>	Mango	Anacardiaceae
Babla	<i>Acacia nilotica</i>	-	-
Bash	<i>Bambusa spp.</i>	Bamboo	Gramine
Kola	<i>Musa sapientum</i>	Banana	Musaceae
Boroi	<i>Zizyphus mauritiana</i>	Jujube	Rhamanaceae
Kamranga	<i>Averrhoa carambola</i>	Chinese Gooseberry	Averrhoaceae
Jambura	<i>Citrus grandis</i>	Shaddock	Citraceae
Olive	<i>Elaeocarpus robustus</i>	Olive plant	Elaeocarpaceae
Bot	<i>Ficus benghala nsis</i>	Banyan tree	Moraceae
Durba Ghas	<i>Cynodon dactylon</i>	Barmuda grass	Gramineae
Debdaru	<i>Polyalthia longifolia</i>	-	Annonaceae
Epil Epil	<i>Leucaena leucocephala</i>	Ipil ipil	Leguminosae
Gheta Kumari	<i>Aloe indica</i>	Indian aloe	Liliaceae
Peyara	<i>Psidium guajava</i>	Guava	Myrtaceae
Helencha	<i>Alternanthera philoxeroides</i>	Jalabrahmi -	Amaranthaceae
Kathal	<i>Artocarpus heterophyllus</i>	Jackfruit	Moraceae
Koroi	<i>Samanea saman</i>	Rain tree	Leguminosae
Lajjabati	<i>Mimosa pudica</i>	Sensitive plant	Mimosoideae
Mehogoni	<i>Swietenia mahagoni</i>	Mahogany	Meliaceae
Papaya	<i>Carica papaya</i>	Papaw tree	Caricaceae
Tal	<i>Borassus flabellifer</i>	Palmyra palm	Palmae
Shimul	<i>Bombax ceiba</i>	Red Silk Cotton Tree	<i>Bombacaceae</i>
Kadom	<i>Anthocephalus chinensis</i>	Kadamba	<i>Rubiaceae</i>
Krishnochura	<i>Delonix regia</i>	Gulmohur	<i>Leguminosae</i>
Shishu	<i>Dalbergia sisoo</i>	-	-
Telakucha	<i>Coccinea cordifolia</i>	-	Cucurbitaceae
U-caliptas	<i>Eucalyptus citriodora</i>	River Red Gum Dehn	Myrtaceae
Ziga	<i>Lannea coromandelica</i>	Jiga	Anacardiaceae

Source: Census and IOL Survey, February-March 2014

4. Terrestrial Fauna

165. The diversified habitat and ecosystem in the project area support various types of animals as given in Table 23. Primary and secondary mode was adopted for identification of fauna. Most of the birds are identified through direct observation rather than from people. Most of the Amphibians, Reptiles and Mammals were identified by using books and description of the local people during the field survey. A total of 38 species are identified during field survey among them 3 are Amphibian, 6 Reptilian, 24 Avian faunas and 5 Mammalian faunas. The list of these species with their vulnerability status is given at Table 23. Out of the species identified 2 are vulnerable. No endemic species are found in the project area.

Table 23: List of Fauna Identified in and around the Project Area

Scientific Name	English Name	Local Name	Local Status	IUCN Status
Class: Amphibian				
<i>Bufo melanostictus</i>	Common Toad	Kuno bang	NO	Least concern
<i>Rana temporalis</i>	Bull Frog	Kola bang	NO	Near threatened
<i>Rana pipiens</i>	Grass Frog (Leopard frog)	Sona bang	NO	Least concern
Class: Reptilian				
<i>Hemidactylus flaviviridis</i>	Common House Lizard	Tiktiki	NO	Least concern
<i>Calotes versicolor</i>	Common Garden Lizard	Rokto-chosha	NO	Not yet classified
<i>Varanus bengalensis</i>	Bengal monitor	Gui shap	VU	Least concern
<i>Xenochrophis piscator</i>	Checkered keelback	Dhora shap	NO	Not yet classified
<i>Enhydris enhydris</i>	Common smooth water snake	Paina shap	NO	Least concern
<i>Atretium schistosum</i>	Olive keelback	Maitta shap	NO	Least concern
Class: Aves				
<i>Phalacrocorax niger</i>	Little cormorant	Paan-kowri	NO	Least concern
<i>Ardeola grayii</i>	Indian pond heron	Kani bok	NO	Least concern
<i>Casmerodius albus</i>	Great egret	Sada bok	NO	Least concern
<i>Actitis hypoleucos</i>	Common sandpiper	Kada Khocha	--	Least concern
<i>Columba livia</i>	Rock pigeon	Jalali Kobutar	NO	Least concern
<i>Streptopelia chinensis</i>	Spotted dove	Tila Ghughu	NO	Least concern
<i>Psittacula krameri</i>	Rose-ringed parakeet	Tia	NO	Least concern
<i>Amaurornis phoenicurus</i>	White-breasted waterhen	Dahuk	NO	Least concern
<i>Eudynamis scolopacea</i>	Asian cuckoo	Kokil	NO	Least concern
<i>Tyto alba</i>	Barn owl	Laxmi Pencha	NO	Least concern
<i>Alcedo atthis</i>	Common kingfisher	Choto Maachranga	NO	Least concern
<i>Dinopium benghalense</i>	Black-rumped flameback	Kaththokra	NO	Least concern
<i>Oriolus xanthonus</i>	Black-headed oriole	Holdey Pakhi	NO	Least concern
<i>Corvus splendens</i>	House crow	Pati Kak	NO	Least concern
<i>Corvus marorrhynchos</i>	Jungle crow	Darn Kak	NO	Least concern

Scientific Name	English Name	Local Name	Local Status	IUCN Status
<i>Dicrurus macrocercus</i>	Black drongo	Fingey	NO	Least concern
<i>Copsychus saularis</i>	Oriental magpie robin	Doel	NO	Least concern
<i>Acridotheres ginginianus</i>	Bank myna	Gang Shalik	NO	Least concern
<i>Sturnus contra</i>	Asian pied starling	Gobrey Shalik	NO	Least concern
<i>Pycnonotus cafer</i>	Red-vented bulbul	Bulbuli	NO	Least concern
<i>Orthotomus sutorius</i>	Common tailorbird	Tuntuni	NO	Least concern
<i>Dicaeum. agile</i>	Thick-billed Flowerpecker	Fuljuri	NO	Least concern
<i>Passer domesticus</i>	House sparrow	Charui	NO	Least concern
<i>Ploceus philippinus</i>	Baya weaver	Babui	NO	Least concern
Class: Mammalia				
<i>Pteropus giganteus</i>	Flying Fox	Badur	NO	Least concern
<i>Herpestes auropunctatus</i>	Small Indian Mongoose	Benji	NO	Least concern
<i>Vulpes bengalensis</i>	Bengal Fox	Khek shial	VU	Least concern
<i>Rattus rattus</i>	Common House Rat	Indur	NO	Least concern
<i>Suncus murinus</i>	House Shrew	Chicka	NO	Least concern

EN – Endangered, VU – Vulnerable, NO – Not Threatened

5. Diversity of Aquatic Flora and Fauna

166. Aquatic Flora. Different types of aquatic flora species were recorded in the project areas. The most abundant hydrophytes in the project area are Kochuripana (*Eichhornia crassipes*), Topapana (*Pistia stratiotes*), Khudipana (*Lemna minor*) Pata Jhajji (*Vallisneria spiralis*), Shapla (*Nymphaea sp.*), Kolmi (*Ipomoea aquatica*), Helenchaa (*Enhydra fluctuant*), and Duckweed (*Spiredella sp.*). Numerous algae (e.g. *Spirogyra* and *Scytonema*) and amphibian plant, Dhol kolmi (*Ipomoea fistulosa*) are also found in the road side water bodies.

167. Aquatic Fauna. Fish is the most important aquatic fauna of the project areas, along with other groups. The aquatic fauna includes Prawns (*Macrobrachium spp.*), crabs, snails (*Pila*, *Vivipara*, *Lymna* etc.), freshwater mussels (*Lamellidens sp.*) etc. invertebrates and several species of fish. Kolabang (*Rana tigrina*); Guishap (*Varanus bengalensis*) and Matia sap (*Enhydrisenhydris*) are common. The aquatic birds are – Pancowri (*Phalacrocoraxcarto*), Kanibok (*Ardeolagravii*), Sadabok (*Egretta garzetta*), Borobok (*Egretta alba*), Machranga (*Halcyon pileata*), Dahuk (*Gallinulex cinerea*), and winter migratory birds – Balihash (*Dendrocygna javanica*) and Chakha (*Tadorna ferruginea*).

168. Fishes. The fisheries in the project area comprises of ponds, canals, rivers, flood lands, Burrow pits, and Khals. The major fresh water fish species are the rui (*Labeo rohita*, LC⁸), katla (*Catla catla*, LC), mrigal (*Cirrhinus cirrhosis*), kalbashu (*Labeo calbasu*, LC); shoal (*Channa striata*), gajar (*Channa marulius*, EN⁹), taki (*Channa punctata*), pangash (*Pangasius pangasius*, EN), boal (*Wallago attu*, VU¹⁰), tengra (*Mystus tengara*, LC), aier (*Sperata aor*, VU), shing (*Heteropneustes fossilis*, LC), magur (*Clarias gariepinus*), baillya (*Awaous guamensis*, LC), chela (*Salmostoma acinaces*, LC), batashi (*Neotropicalis atherinoides*, LC), kahalisha (*Colisa fasciata*,

⁸ LC= Least Concern

⁹ EN= Endangered

¹⁰ VU= Vulnerable

puthi (*Puntius puntio*, DD¹¹), kai (*Anabas testudineus*, LC), falli (*Notopterus notopterus*, VU), chital (*Chitala chitala*, EN), baim (*Mastacembelus armatus*), chanda (*Parambassis ranga*), etc.

169. Fresh water Crab is a common aquatic arthropod observed in most of wetlands. Fresh water Crab is a common aquatic arthropod observed in most of wetlands. No aquatic mammal like Dolphin was observed in the Rivers (Jamuna and Fuljor) along the project road.

6. Biodiversity/Environmentally Sensitive Areas

170. Protected areas for biodiversity conservation in Bangladesh are based on three legislations: (i) Bangladesh Wildlife Preservation (amended) Act in 1973 (ii) Bangladesh Environment Conservation Act, 1995 (amended in 2002 and 2010) and (iii) Fish Act 1850 (amended in 1985).

171. Many wildlife species are in stress in Bangladesh, many more are endangered/ threatened and a large number already faced extinction. The status of faunal species in Bangladesh has been published by IUCN (2000). According to the IUCN findings, this country has lost 10% of its mammalian fauna, 3% avifauna and 4% reptiles over the last 100 years. More than 50 species are presently critically endangered in Bangladesh of which 23 species are already declared as endangered in the Red Data Book of IUCN. In addition, 83 species are commercially threatened and are included in the appendices of Convention on International Trade in Endangered Species (CITES). Among the most endangered species are: elephant, tiger, wild Cat, Leopard or wild goat, serao, dolphin; birds: white-winged duck, comb duck, stork, carne, pheasant, partridge, and crocodile, python, monitor, lizard, tiger terrapin, roofed turtle, soft turtle, and marine turtles.

172. In and around the project area some wildlife species were identified as locally vulnerable. The name of these vulnerable species is Bengal monitor and Bengal fox. Any construction must consider impacts on the rate of deforestation, loss of habitat, habitat fragmentation, and interruption of wildlife migration patterns. The Chalan Beel is one of the biggest wildlife sanctuaries are quite far from the project location and not within the 5 km buffer zone (Figure 24).

¹¹ DD= Data Deficient

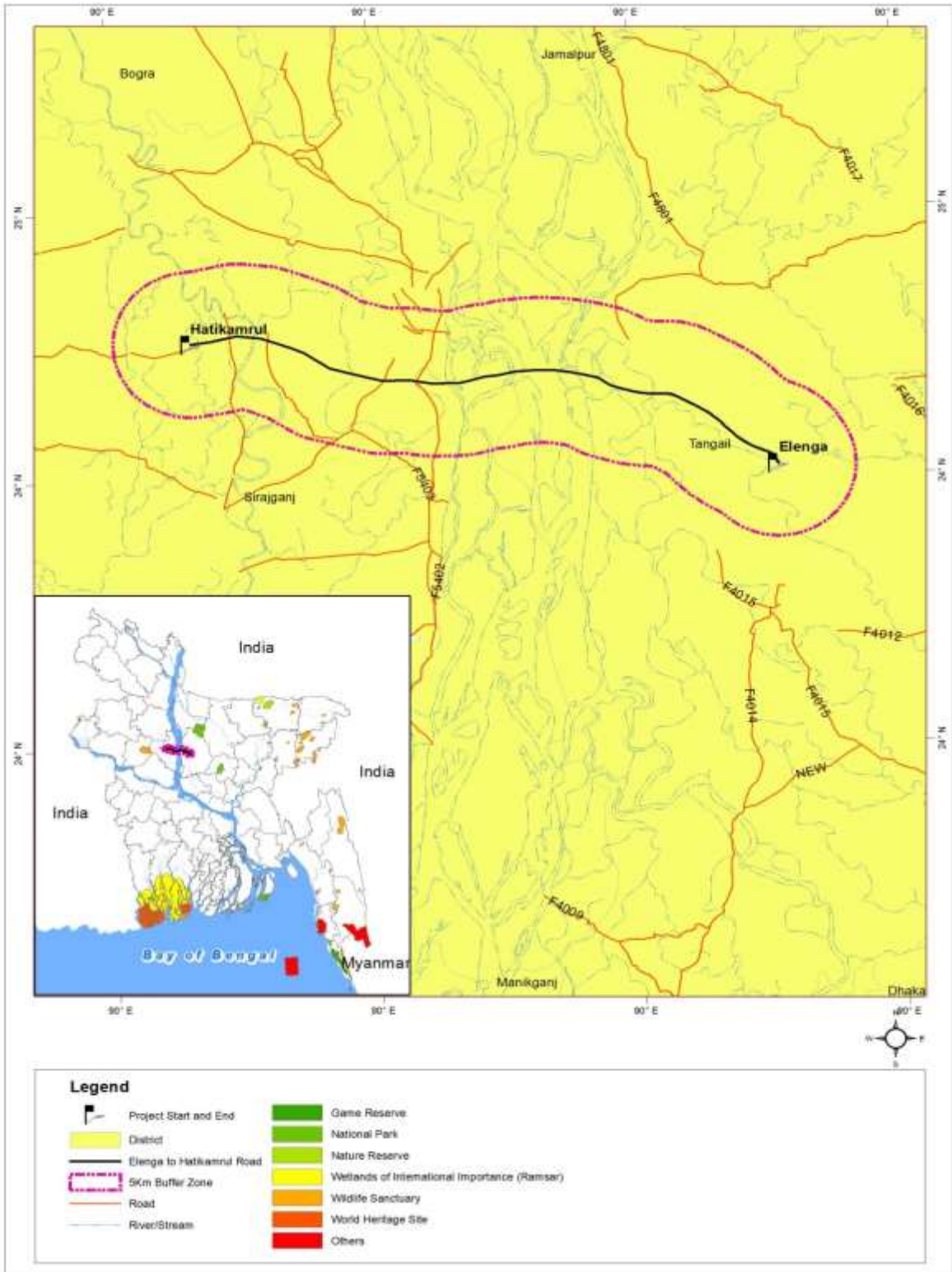


Figure 23: Environmental Protected Areas

D. Socio-Economic Environment

173. Socioeconomics (also known as socio-economics or social economics) is the social science that studies how economic activity affects social processes. In general it analyzes how societies progress, stagnate, or regress because of their local or regional economy, or the global economy. It is essential for every development project, whether small or large, to understand the social, human and economic aspects of the primary stakeholders, i.e., people living in and around the project site. The following tools and techniques were used to collect the relevant data/information on the social and economic aspects of affected people:

- Literature review;
- Focus Group Discussion (FGD); and
- Informal meeting with various professionals.

174. In addition, data obtained from secondary sources were compared with the primary data/information gathered during the study.

175. Data on population, age/sex composition, household patterns, and sources of drinking water, sanitation facility, and ownership of agricultural land were enumerated from the latest community series census published by the Bangladesh Bureau of Statistics (BBS).

1. Demography

176. An overview of socio-economic environment profile of Elenga-Hatikamrul area is presented below at the upazilas (sub divisional) basis in the region. The demographic information is collated from Population Census, 2011. However, there are diverse religious group in this area with several types of ethnic people but the community is Muslim dominated. The demographic details are given at Table 24.

177. The road project alignment runs through 2 districts that cover 5 administrative Upazilas (Kalihati, Sirajganj Sadar, Kamarkhand, Royganj and Ullapara).

Table 24: Demographic Status in the Project Area

Upazilas Through	District	Total	Male	Female	Sex Ratio	Population density [sq. km]
Kalihati	Tangail	410,293	202,688	207,605	98	1,388
Sirajganj Sadar	Sirajganj	555,155	279,113	276,042	101	1,734
Kamarkhand	Sirajganj	138,645	68,411	70,234	97	1,527
Royganj	Sirajganj	317,666	158,604	159,062	100	1,223
Ullapara	Sirajganj	540,156	269,481	270,675	100	1,320

Source: Population Census, 2011

2. Settlement and Housing Pattern

178. The entire alignment runs through an open place. Agricultural lands are found in both sides of the road. However, there are some households and bazar take places. There are some large and small restaurants/refreshment centres situated in the both sides of the RoW housing condition of the five upazilas (Kalihati, Sirajganj Sadar, Kamarkhand, Royganj and Ullapara) of the project is predominantly kutcha, semi pucca and pucca houses found in the semi-urban area. The average data about the main house of the dwelling households by type of structure shows

that pucca and semi-pucca household structures remain higher in urban area comparing to the rural area and upazila. According to the resettlement survey done in February-March 2014, a total of 181,083 square feet primary structures¹² will be affected. Details of the housing structures by types in the project area have been given in Table 25.

Table 25: Type of Household Structure in the Project Area

Upazilas Through	District	Number of Households	Type of Structure (%)			
			Pucca	Semi-pucca	Kutcha	Jhupri
Kalihati	Tangail	97988	1.4	4.4	93.4	0.9
Sirajganj Sadar	Sirajganj	124852	4.1	14.0	80.9	1.0
Kamarkhand	Sirajganj	31920	1.2	11.3	86.4	1.1
Royganj	Sirajganj	77104	1.3	7.7	90.2	0.8
Ullapara	Sirajganj	123630	3.2	12.1	84.3	0.4

Source: Population Census, 2011

3. Land Use Patterns

179. Lands at the project area are used for agriculture, fisheries, agro-forestry, homestead, homestead forestry and vegetation, animal husbandry, etc. The areas through which the existing alignment passes is characterized by an agricultural ecosystem with very little of the natural ecosystem remaining. The most heavily vegetated areas along the alignment are the homestead areas where several species of trees of economic value are present.

180. The land use pattern along the alignment like other areas has traditionally been devised based on soil condition, relief, climate, hydrology and flood conditions, availability of resources, etc. The road alignment would impact the local land uses positively due to establishment of fast, safe and convenient road linkages between the project command areas and small markets of rural areas.

181. Land use analysis is carried out along five-kilometre buffer zone from centreline of the Elenga-Hatikamrul road using optical satellite imageries. Four land use classes i.e. agriculture; river, settlement and water body were found along Elenga-Hatikamrul section (Figure 4.16).

182. The below Table 26 shows the land use category and their area in 5km buffer zone from the centreline of Elenga-Hatikamrul road. Agriculture area is in the dominant position along the project road which is 63.72%. A significant portion covers the river area which is 12.59%. The settlement area covers 20.66% and water bodies covers 3.03% respectively.

Table 26: Land Use Category of Elenga-Hatikamrul Road Project Area

Category	Area (ha)	Area in %
Agricultural	248.570	29.590
Residential	131.102	15.606
Commercial	25.509	3.037
Industry	8.187	0.975
Brick Field	2.506	0.298
Playground	0.312	0.037
Road	61.195	7.285

¹² Structure used for residential (bed room, kitchen, store room, etc.) and commercial purposes or community interest those are measured in square feet/square meters.

Category	Area (ha)	Area in %
Road Island	0.401	0.048
Railway Line	9.180	1.093
Railway Station	0.438	0.052
River	73.173	8.711
Char	16.196	1.928
Vacant Land	68.848	8.196
Vegetation	101.499	12.082
Water body	92.939	11.063

4. Water Supply and Sanitation

183. Tube wells are the most common source of drinking water in both the semi-urban and rural areas. Tap water is not accessible in rural areas. Most households do not treat water prior to drinking. Sewage facilities are not available in most of the rural areas. The below Table 27 shows the sanitary facilities in the project area.

Table 27: Sanitary Facilities in the Project Area

Upazilas Through	District	Number of Households	Toilet Facility (%)			
			Sanitary (water-sealed)	Sanitary (non-water-sealed)	Non-sanitary	None
Kalihati	Tangail	97988	19.5	49.2	26.0	5.3
Sirajganj Sadar	Sirajganj	124852	25.8	36.5	32.9	4.9
Kamarkhand	Sirajganj	31920	25.0	49.4	22.1	3.6
Royganj	Sirajganj	77104	15.3	46.5	28.8	9.3
Ullapara	Sirajganj	123630	17.1	50.7	29.2	3.0

Source: Population Census, 2011

184. According to the statistical data mentioned above it can be said that the sanitary facilities are better in the semi-urban areas than the rural areas. Particularly, in the Sirajganj Sadar and Kamarkhand area have better sanitary facilities than the other upazilas along the road alignment.

5. Transport and Communication

185. The existing highway is an important way of country's transport network which connects different parts of Bangladesh. The project road is connected with national highways, village roads, and railways in certain locations. The common types of transports are bus, truck, microbus, car, CNG, motorcycle, van and rickshaw. Mobile and wire telephone services are available in most of the areas. During the field survey, it is found that there are many roads crossing present in the Elenga-Hatikamrul road alignment which connect the adjacent villages to the highway. A list of the crossings are presented in the below Table 28 and Photograph.9 shows a dangerous road crossing.



Photograph 9: Dangerous Road Crossing at Elenga-Hatikamrul Road

Table 28: List of Crossings along the Alignment

Sl. No.	Chainage (KM+M)	Name of Road	Type of Road
1	69+400	Bazar Khola to Bollat Pur	Pucca Road
2	71+270	Patakandi to Babla	Village Road
3	74+900	Anailla Bari to Anailla Bari	Earthen Road
4	77+675	Shalla Bazar to Narainda	Village Road
5	78+060	Golabari to Niklari Bari	Village Road
6	78+520	Nirhamjani Miya Para to Nirhamjani	Earthen Road
7	79+780	Potol to Nikrail Bazar	Village Road
8	94+070	Sirajganj to Belkuchi	Pucca Road
9	95+650	Sirajganj to Belkuchi	Pucca Road
10	97+300	Chala to Jawel	Village Road
11	100+190	Bondut Bazar to Pikosa Bazar	Pucca Road
12	102+200	Kamarkhanda to Dukuria	Pucca Road
13	103+700	Moddo Vodrogate to Shealkol	Village Road
14	105+800	Kamarkhanda to Nalka	Pucca Road
15	108+300	Borobar to Ratonkandi	Pucca Road

Source: Baseline Environmental Survey, May, 2013

E. Important Environmental and Social Features

186. The socio-cultural aspects include the educational institutions, hospitals/health centres, religious structures, cultural structures, burial grounds, cremation yards, market places, industrial structure, water bodies, etc., few of which would be affected directly and indirectly through implementation of the both routes. Such sites could be termed as important environmental and social features (IESFs) in relation to project activities and, hence, need to be dealt carefully during the construction phase. Locations of major IESFs along the road alignment are shown in the Table 28.

187. There are no archaeological and historic sites in the RoW of the Elenga-Hatikamrul road project. Among the cultural sites, four mosques, one school, three filling stations and one mazar (shrine) fall within the RoW of the road alignment (Table 28). List of the cultural and sensitive areas located within 500 m from the RoW boundary is presented in Table 29.

Table 29: Locations of Important Environmental Components (IECs) along the Road Alignment

IECs	Within RoW	From RoW boundary upto 500 m PIA on each side			
		Chainages (km) Right	Distance from Alignment (m)	Chainages (km) Left	Distance from Alignment (m)
Mosque	97+700, 101+700, 106+600, 109+700	70+175, 77+390, 79+450, 97+800, 98+040, 98+650, 100+220, 103+720, 106+050, 109+950	100, 70, 40, 450, 450, 200, 100, 400, 420, 100	75+100, 77+350, 77+360, 79+490, 93+300, 93+500, 93+500, 97+800, 98+040, 102+200, 103+700, 103+950, 106+050, 106+980	150, 400, 400, 450, 150, 160, 150, 400, 400, 100, 400, 420, 200, 500
Cemeteries	-	100+850	450	92+110	200
School	108+200	74+800, 75+300, 79+450, 80+890, 99+500, 100+300, 106+060, 107+000, 107+950, 109+700	100, 35, 500, 70, 450, 450, 450, 200, 300, 350	69+800, 69+810, 77+340, 92+100, 92+200, 95+425, 97+320, 98+000, 106+980, 108+290, 108+320	400, 450, 500, 200, 300, 350, 120, 450, 500, 100, 150
College	-	79+450, 100+300, 106+060, 106+680	500, 250, 450, 150	70+750, 93+300, 94+200, 98+300, 98+300	220, 450, 150, 150, 150
Madrasa	-	77+370, 79+450, 100+850, 103+750, 104+550, 107+950	35, 500, 200, 400, 420, 300	70+450, 81+000, 94+100, 98+000, 102+200	450, 400, 300, 450, 500
Graveyard/Mazar (Muslim Shrine)	109+000 (Mazar)	72+130	30		
Eidgah	-	72+510	500		
Filling Station	106+800, 109+700, 109+400				
Gas Valve Station	-			81+900, 90+800, 106+100	45, 40, 80
Network Tower	-	69+430, 69+435, 69+780, 77+790, 79+510, 80+720, 95+640, 104+550	120, 50, 150, 150, 250, 50, 100, 60	69+780, 71+930, 72+100, 82+700, 107+940, 108+580, 110+145, 110+150	400, 300, 150, 200, 90, 50, 65, 70
Brickfield	-	100+400	500	101+350, 108+450, 108+900, 109+600	200, 400, 150, 150

IECs	Within RoW	From RoW boundary upto 500 m PIA on each side			
		Chainages (km) Right	Distance from Alignment (m)	Chainages (km) Left	Distance from Alignment (m)
Wooden Garden	70+290, 70+950, 98+600, 100+520, 102+960, 103+800	70+090, 70+100, 70+380, 78+580, 80+695, 94+300, 94+600, 94+750, 95+590, 100+380, 101+400, 105+500, 108+800	150, 100, 30, 40, 70, 80, 40, 50, 40, 150, 50, 100, 100	98+950, 100+350, 107+660	180, 30, 100
Hut/Bazar	69+300-70+000				
Hospital	-	95+490	50		
Road Crossing	69+400, 71+270, 74+900, 77+675, 78+060, 78+520, 79+780, 94+070, 95+650, 97+300, 97+670, 100+190, 102+200, 103+700, 105+800, 108+300				
Pond		70+580, 96+050, 103+870, 107+500, 108+900	30, 40, 150, 20, 200	69+750, 70+940, 70+970 – 71+400, 71+800 – 72+080, 72+120 – 72+800, 72+820 – 73+500, 73+510 – 74+200, 74+210 – 74+900, 74+910 – 75+100, 75+300 – 75+600, 75+620 – 76+300, 76+310 – 77+000, 77+010 – 77+700, 77+710 – 78+300, 78+400 – 78+750, 79+110 – 79+500, 91+900 – 92+350, 94+200, 94+210 – 94+600, 95+430 – 95+700, 95+750 – 96+050, 96+100 – 96+920, 97+750 – 98+000,	30, 50, 60, 50, 60, 55, 60, 60, 50, 50, 55, 60, 60, 60, 60, 50, 50, 150, 75, 75, 100, 70, 70, 50, 50, 50,

IECs	Within RoW	From RoW boundary upto 500 m PIA on each side			
		Chainages (km) Right	Distance from Alignment (m)	Chainages (km) Left	Distance from Alignment (m)
				100+700–101+300, 102+985, 103+940-104+200, 104+330, 104+550 – 105+100, 105+200 – 105+650, 107+500, 108+310, 108+650	150, 50, 50, 40, 150, 80, 30
Beel	98+300, 105+850, 98+300, 105+850			92+800	120
Canal	72+100, 77+700, 99+500				
Khal	-	92+800	120		
River	106+305-106-540, 95+425				
Source: Baseline Environmental Survey, May 2013; and Census and IOL Survey February-March 2014					



Photograph 10: Photographs of IECs along the Elenga-Hatikamrul Road.

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. General

188. The current environmental assessment is based on the potential sensitive issues and impacts identified during site visits, consultation with local administrations, and the public. This section identifies the overall impacts on the physical, biological and socio-economic environment of the project area. An environmental impact is defined as any change to an existing condition of the environment. Identification of potential impacts has been done on the basis of baseline data collected from secondary and primary sources. Environmental impacts assessment was carried out considering present environmental setting of the project area, and nature and extent of the proposed activities. Potential environmental impacts associated with the proposed project activities of both the project are classified as:

- (i) impacts during pre-construction/design phase
- (ii) impacts during construction phase and
- (iii) impacts during operation phase.

189. Qualitative and quantitative techniques have been applied for direct and indirect impact identification. Impacts are classified as being insignificant, minor, moderate and major.

190. The important impacts related to the project have been discussed in the following sections according to the different phases of project implementation. Adequate mitigation measures are devised to mitigate/minimise all likely environmental impacts and the same have been presented along with the impacts.

1. Project Corridor

191. The Project corridor is delineated based on two criteria: right of way (RoW); which the RHD is legally entitled to, and Corridor of Impact (Col), i.e. the width of the corridor that will be impacted, directly or indirectly, by the proposed project during the construction and operational phases.

2. Project Right of Way (RoW)

192. The proposed project corridor will have a well-defined RoW that will be 50 meters (164 ft) for the entire length of the highway. Major construction works will generally remain confined within the RoW. All the infrastructure and commercial activities within the existing or proposed RoW need to be relocated as they will have direct impact of the project.

3. Corridor of Impact (Col)

193. The Corridor of the proposed Impact (Col) was delineated as the extent, which has direct or indirect impact of project. Direct impacts of the project are relocation of houses, utilities and air and noise pollution impact on workers during construction. All direct impacts are constrained within the RoW. Indirect impacts, caused by noise, dust emissions, camp sites and borrow sites could be beyond the RoW. The direct Col of the surface water bodies will be confined within the RoW of the proposed project and will be temporary only for the construction period.

194. According to the Department of Environment (DoE) guidelines, the project impact area is divided into two sections. One, those related to the project which is 50m for the project. Another

section is those related to the background environmental features of the project site. This should cover not only the project site in proper, but generally an area of 5km radius around the site. In this project 500m from the RoWs have been considered as core impact zone and 5km as buffer zone for better understanding.

4. Evaluation of Significant Impacts

195. As is the case for most development projects, potential negative impacts sometimes could be far more numerous than beneficial impacts. Whereas the anticipated negative impacts could be dealt with through carefully selected and undertaken efficient mitigation measures and good management practices, beneficial impacts could still be augmented through mobilizing and strengthening the realization about the positive outcomes of the project among all the stakeholders and project officials as well as contractors performing works related to various stages of implementation. It is generally expected that the long-term benefits of any development intervention will ultimately trickle down for the benefit of the local population and make contributions toward improvement of life quality.

- i. **Intensity of the effect:** The intensity of the effect refers to the level of disruption to the component. Three levels have been defined:
 - 1) Low: Little change in the characteristics of the component. Difficult to quantify;
 - 2) Average: Change in certain characteristics of the component. The change may be quantifiable;
 - 3) High: Change in all or in the main characteristics of the component. The change is quantifiable
- ii. **Duration of the effect:** Duration means the time dimension of the effect. The terms permanent, temporary and short are used to describe the period of time:
 - 1) Short-lived: the effect disappears promptly;
 - 2) Temporary: the effect is felt during one project activity or, at most, throughout implementation of the project;
 - 3) Permanent: the effect has repercussions for the life of the infrastructure.
- iii. **Scope of the effect:** The scope describes the spatial dimension of the effect caused by an action in the environment. It refers to the distance or area covered by the disruption. The terms regional, local and limited are used to describe the scope:
 - 1) Limited: the scope is limited when the action affects only one environmental element located near the project;
 - 2) Local: the scope is local when the action affects the study area;
 - 3) Regional: the scope is regional when the action affects areas beyond the study area
- iv. **Assessment of the potential effect:** These three parameters are incorporated into a multi-criteria matrix, making it possible to place the potential effect into one of three categories:
 - 1) Major (MAJ): signifies an effect that is permanent and that affects the integrity, diversity and sustainability of the element. Such an effect substantially or irretrievably alters the quality of the environment.
 - 2) Medium (MED): signifies a perceptible, temporary and/or low-return effect that has little impact on the environmental component and is not irreversible. Such an effect is short-lived and/or limited in scope.
 - 3) Minor (MIN): signifies that the effect is non-existent or virtually non-existent, that it does not affect the environmental component in any observable or

quantifiable way and that it is related to a randomly occurring natural effect. As a rule, this would be a short-lived effect, limited in scope.

Intensity	Duration	Short-lived	Temporary	Permanent
	Scope			
Low	Limited	MIN	MIN	MED
	Local	MIN	MIN	MED
	Regional	MIN	MED	MAJ
Average	Limited	MIN	MED	MED
	Local	MED	MED	MAJ
	Regional	MED	MAJ	MAJ
High	Limited	MED	MAJ	MAJ
	Local	MED	MAJ	MAJ
	Regional	MAJ	MAJ	MAJ

196. The potential impacts due to implementation of the Elenga-Hatikamrul road project are identified by using the above Leopold Matrix for environmental assessment by project implementation stages. In this developed checklist, actions, which may affect the various Important Environmental Components (IECs) pertaining to the areas adjacent to the alignment during the various stages of the project activities, are listed and the degrees of Significant Environmental Impacts (SEIs) are shown. The terms Major, Medium and Minimum are used in the checklists to evaluate the magnitude of SEIs. In the checklist, each of the pre-construction, construction and operational phases of the Elenga-Hatikamrul road are considered separately in order to distinguish the short term and long term impacts as well as reversibility and irreversibility of impacts in terms of their duration.

197. Identification and evaluation of potential/significant impacts due to project location, site preparation, construction and operation at the project has been done using the 'Impact Matrix' by identifying all stages of activities (pre-construction to operation and maintenance) and assessing the potential impact of each operation upon individual environmental components.

198. As can be observed from the checklist in Table 30, major environmental components, which will be adversely affected by activities related to the project, are: air quality, noise hazard, loss of trees, accidental risk, hydrology/drainage and occupational health and safety and socio-economic environment. It should be noted that the environmental factors indicated in the table relate to the changeability or un-changeability of the existing situations due to interventions of the project and significant level of impact without mitigation of negative impacts.

Table 30: Evaluation of Significant Impact Using Leopold Matrix

Environment	Envisaged Impact Factors	Project Activities																			
		Pre-Construction				Construction								Post-Construction					Operation		
		Site Mobilization	Construction of Temporary Facilities	Maintenance of Traffic	Utility Shifting	Existing Pavement Stripping	Soil Stripping	Excavation/Earthworks	Pavement Construction	Bridge Construction	Management of Wastes	Transportation	Equipment and Machineries	Deconstruction of Structures	Demobilization of Worksite	Demobilization of Bridge Site	Management of Wastes	Transportation	Equipment and Machineries	Presence of Road	Maintenance & Repair
Physical	Climate																				
	Physiography							MIN													
	Topography		MIN	MIN	MIN		MIN	MIN			MIN		MIN	MIN							
	Geology																				
	Seismicity																				
	Soil		MIN	MIN	MIN	MIN	MED	MIN	MIN		MIN			MIN			MIN			MIN	MIN
	Surface Water		MIN	MIN	MIN		MED	MIN	MIN	MED	MIN		MIN			MIN	MIN			MIN	MIN
	Groundwater										MIN										
	Air Quality		MIN	MIN		MED	MED	MAJ	MED	MIN	MIN	MED	MIN	MIN	MIN		MIN	MIN	MIN		MIN
Noise		MIN	MIN		MED	MED	MED	MED	MED		MED	MIN	MIN	MIN		MIN	MIN	MIN		MIN	
Biological	Bio-ecological Zones																				
	Terrestrial Flora		MIN		MIN		MIN	MED													
	Terrestrial Fauna		MIN		MIN		MIN	MED			MED										
	Aquatic Flora		MIN		MIN		MIN	MIN		MED					MIN					MIN	
	Aquatic Fauna		MIN		MIN		MIN	MIN		MED					MIN					MIN	
	Fishes		MIN		MIN		MIN	MIN		MED					MIN						
	Biodiversity/Environmentally Sensitive Area																				
Socio-economic	Demography	MIN																		MED	
	Settlement & Housing Pattern		MIN		MIN															MED	
	Land Use Patterns		MIN						MIN											MED	
	Water Supply and Sanitation				MED									MIN	MIN					MED	MIN
	Transport and Communication					MED		MED	MED	MED		MED	MED		MIN			MIN		MED	

B. Climate Change

1. Impact Due to Changes in Climatic Condition

199. Climate change and its associated impacts will be experienced through changing temperatures and precipitation, rising sea levels, changes in the frequency and severity of climate extremes and in the dynamics of hazardous conditions (IPCC, 2007). Developing countries are vulnerable to climate change because of their exposures and sensitivities to climate-related extremes, and especially because of their limited adaptive capabilities to deal with the effects of hazardous events.

200. Climate change is a global issue. The world's climate is changing and will continue to change in the coming century. It is a normal part of the Earth's natural variability, which is related to interactions among the atmosphere, ocean, and land, as well as changes in the amount of solar radiation reaching the earth. However, the term "Climate Change" is defined by the United Nations Framework Convention on Climate Change (UNFCCC) as "*A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods*" (IPCC, 2007). The risks associated with these changes are real but highly uncertain.

201. Bangladesh is recognized worldwide as one of the most vulnerable countries to the impacts of climate change. This is due to its unique geographic location, dominance of floodplains, low elevation from the sea, high population density, high levels of poverty, and overwhelming dependence on nature, its resources and services. The country has a history of extreme climatic events claiming millions of lives and destroying past development gains. The people and social system have knowledge and experience of coping with the effects of such events—to some degree and extent. Historically, Bangladesh is trying to adapt with the changing environment. The Intergovernment Panel on Climate Change (IPCC) has identified the country as one of the most vulnerable countries to climate change, which may severely affect lives and livelihoods of millions of Bangladeshi people in coming decades. In this regard, Bangladesh has already prepared the National Adaptation Programme on Action (NAPA) and Climate Change Strategy and Action Plan (MoEF, 2005 and MoEF, 2009).

202. According to the fourth assessment report of IPCC, continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century, which would very likely be more severe than those observed during the 20th century would.

203. The climate change impacts are described for the following two aspects:

- Likely changes in the climatic conditions with respect to temperature, flooding and drainage aspects.
- Greenhouse gas emission reduction.

2. Estimation of Changes in Climate Parameters

204. The global changes in climate also have impacts on regional basis. The climatic parameters of Bangladesh are also changing along with the global climate change. The increasing trend of temperature shows that it will increase 1.3°C by the 2050s while rainfall will increase by 8%. The maximum estimated change in temperature for Dhaka, Rajshahi and Barisal divisions are 2°C, 2.14°C and 1.72°C respectively in 2050s. These possible changes should be considered

in road design as the Elenga-Hatikamrul road travels through Dhaka and Rajshahi division. The rainfall might increase by more than 30% in Dhaka division. Additional drainage capacity might be required for the proposed road in this regard (IEE, 2011).

3. Climate Change Impacts on Flooding

205. **Impact.** Future flood damages will depend heavily on settlement patterns, land-use decisions, the quality of flood forecasting, warning and response systems, and the value of structures and other property located in vulnerable areas as well as on climatic changes per se. The secondary impacts of climate change are not only in magnitude but also in frequency. For example, there are chances of not only increasing of flood water levels but also reduction of flood return periods. This indicates that a 20-year return period flood might become a 15- year return period flood under climate change scenarios.

206. **Mitigation.** Additional road embankment height to incorporate climate change induced flooding is required in road design. As the roads are designed mainly based on 20-year return period, suggested additional heights should be applied over the design road heights for 20-year return period (not the existing road levels) including freeboard and other additional components. Due to climate change the river water level will rise and as a result the bridge clearances will be lower. So, the bridge height also need to be increased. The bridges in the proposed roads are designed for 1 in 50-year return period. Consequently, the additional height requirements for bridges and road embankment are presented in Table 31.

Table 31: Additional Height Requirement

Road Section	Additional Height Requirement (cm)	
	Road Embankment	Bridges
Hatikumrul-Tangail	36.80	35.70

Source: IEE, JCTE-, 2011

***These values do not include the additional safety factor (1.5). The designers should decide whether to consider that or not.*

4. Climate Change Impacts on Drainage

207. **Impact.** The future trans-boundary inflows of the three major rivers (Ganges, Brahmaputra and Meghna) during the monsoon period indicate that inflows into Bangladesh are on average projected to increase over the monsoon period (driven primarily from increased basin precipitation). Because of increased discharges, the drainage structures throughout the roads have to drain much more water under climate change scenario.

208. **Mitigation.** There are 15 bridges and 27 culverts on the Elenga-Hatikamrul road. One of the bridges is over 100m in length and is located on the Fuljor River. The rest of the structures are mostly across undefined channels and carry only seasonal flow. Many bridges are located over depressions and low lying ditches. Culverts are located in depressions and at low lying agricultural land and operate merely as balancing structures, equalizing water levels in either sides of the road embankment.

209. The Elenga-Hatikamrul road area might have to drain 20% additional discharge due to climate change induced higher rainfall during extreme events. Therefore, adequate numbers of drainage facilities along with larger openings should be considered in designing the structures for the proposed roads (IEE, 2011).

5. Greenhouse Gas (GHG) Emission

210. Impact. GHG emissions likely to be generated from the project roads have been computed using the Transport Emissions Evaluation Model for Projects (TEEMP)¹³ developed by Clean Air Asia¹⁴. TEEMP was utilized to assess the CO₂ gross emissions with and without the project improvements. Total CO₂ emissions at business-as-usual, with-project (excluding construction emissions) and with project (including construction emissions) scenarios were estimated at 712,882 tons/year, 305,460 tons/year and 404,370 tons/year, respectively. This is above the significance threshold of 100,000 tons of CO₂ equivalent per year. ADB requires the borrower (the Government of Bangladesh through the Roads and Highways Department) to evaluate feasible and cost effective options to reduce or offset project related greenhouse gas emissions.

211. Mitigation. As the SPS 2009 recommends the borrower to promote the reduction of project-related anthropogenic greenhouse gas emissions appropriate to the nature and scale of project operations and impacts, some of the recommended GHG reduction measures that can be undertaken under the project include: (i) implementation of manufacturer recommended engine maintenance programs; (ii) replacement of less fuel efficient vehicles; (iii) conversion of high-use vehicles to cleaner fuels, where feasible; (iv) installation and maintenance of emissions control devices (e.g., catalytic converter); (v) implementing regular vehicle maintenance and repair program (vi) driver training on driving practices that reduce accident risks and fuel consumption; (vii) enhance the tree replanting program.

C. Pre -construction Phase

212. Following is the brief description of impacts envisaged during the Pre-construction/ Design Phase:

1. Topography

213. Impact. With the proposed planning for the project, the topography of the project area is not expected to be affected significantly other than from excavations for borrow pits. If not selected carefully, the borrow pits can lead to spoilage of agricultural land. The topography in the project area will change to some extent because of construction of the proposed project related structures such as embankments, bridges, flyovers, interchanges etc. Visual changes to the topography would be permanent and minor negative in nature.

214. Mitigation. It is recommended that all requisite borrow pits shall be located outside the RoW or in uncultivated areas or private land with concurrence and agreed borrow pit rehabilitation plan with landowners. Visual changes to the topography will be of permanent but slightly adverse in nature and need no mitigation measures except that the project design should consider aesthetic concerns.

2. Removal of Trees

215. Impact. The project implementation activities, at different locations, will invariably involve trees and vegetation to be removed for the up gradation, widening and geometric improvement

¹³ TEEMP is an excel-based, free-of-charge spreadsheet models to evaluate emissions impacts of transport projects.

¹⁴A network of 250 organizations in 31 countries established by the Asian Development Bank, World Bank, and USAID to promote better air quality and livable cities by translating knowledge to policies and actions that reduce air pollution and greenhouse gas emissions from transport, energy and other sectors.

of the project road. According to the census and IOL survey a total of 31,450 trees of different sizes (large=3,432, medium= 7,318, small= 17,383 and saplings= 3,317) (details in Appendix D) will be directly affected being located within ROW.

216. Mitigation. All efforts shall be made to minimize the tree cutting by selecting road-widening option based on technical consideration. There will be consultations with the public and NGOs prior to cutting of old trees. Option may also be explored at detailed design stage to widen the road on other side of trees leaving them in the middle of the road as divider.

217. RHD will be responsible for the compensatory tree planting program by forming an 'Environmental and Social Team' in coordination with the Forest Department (FD). The tree cutting programme will not start until RHD will get permission from Forest Department. RHD will inform the Upazilla Forest Officer regarding tree cutting and the compensatory tree plantation programme. The respective Forest Officers will encourage the local community (especially women) to participate in this programme. RHD's compensatory planting will be in rows as per the prescription of FD e.g. two tree seedlings to be planted for each tree felled, after the project construction activities are completed. This ratio may be more in the case of social forestry trees as per any mutual understanding arrived with tree owners before cutting the social trees. These trees shall be planted primarily along the road within RoW. The social forestry can be planted on the area allocated by local authorities. Minimum of 62,900 saplings shall be planted following tree plantation plan (**Appendix E**) on the slopes of the road, on the boundary of physical cultural sites and on the suitable locations in the subproject area. Permission from the Forest Department will also have to be sought for cutting trees from the roadside or along the water courses within the RoW. Planting should be done as soon as the construction of the road is completed. Maintenance is the key to the establishment of the plantation. Regular monitoring of plantation should be carried out by the executing agency.

218. The suitable trees for planting, among others, on homestead platforms are am (*Mangifera indica*), jam (*Syzigium cumini*), kul (*ziziphus spp.*), litchi (*Litchi chinensis*), jambura (*Citrus grandis*) amra (*Spondias pinnata*), kathal, (*Artocarpus heterophyllus*), jalpai (*Elaeocarpus floribundus*), and guava (*Psidium guajava*),. Many of these species are multipurpose tree species (MPTS) with timber fruit and fuel wood potentials.

219. The compact plantation shall be effective live screens against night glare, dust, noise and pollutant emissions. These vegetated strips shall develop into a complete ecosystem. Flowering and fruiting shrubs can be planted along the road to beautify the landscape. Planting should however be done keeping in view the principles of landscape designing.

3. Land Acquisition

220. Impact. One of the major project related impact will be the land acquisition for the Project RoW that will result in causing disturbance to the affected residents of the project area. The project activity involves widening of road. The required RoW of 50m is available with RHD almost along the entire road length and proposed bridges and flyover locations. The total land to be acquired is 8.87 ha of which 5.47 ha (61.7%) is crop land, 1.17 ha (13.20%) is commercial land, 0.81 ha (9.12%) is fallow land and 0.51 ha (5.79%) is homestead. Most of the land to be acquired is cropland, commercial, fallow and homestead land.

221. The construction activity for road widening and bridge/flyovers construction will temporarily change the land use for use of construction site, access road, and construction camp. Due to

these interventions, agricultural, seasonal wet land area and social forestry tree around these areas may get affected adversely.

222. Mitigation. This impact related to land acquisition would be permanent and major negative in nature. The mitigation measures include:

- Careful alignment and route selection by the designer to minimize the impacts by avoiding the important environmental components, settlements etc.
- As far as possible the proposed alignment follows the existing alignment, with concentric widening.
- The land acquisition will be restricted to bare minimum required.
- Provision of protection works like retaining/toe wall to confine the embankment within in RoW /minimizing the width to be acquires.
- Developing proper judicious compensation package for affecters and giving compensation amount before the affecters shifting.

4. Loss of Structures (Dwellings, Commercial Buildings and Industrial Structures)

223. Impact. To implement the Elenga-Hatikamrul road way, 181,083 square feet primary structures (as described in section 4.4.2) will be affected and structures to be resettled from the project alignment. Few homesteads will be acquired throughout the road alignment. There are some other rural and urban markets and shops along the alignment which will also be relocated for the implementation of the project.

224. Mitigation. The mitigation measures include:

- Resettlement Specialists have calculated that the amount needed to compensate for the loss of land, house, trees, structures, crops, wage income, etc.
- To ensure similar or better living conditions for project affected persons (PAPs) for the limited period of time their livelihood may be interrupted.

5. Educational Institution, Religious Structure, Culturally Sensitive Structures

225. Impact. According to the DOE guideline, the Project Influence Area (PIA) has to be 5 km radius of the development of the project activities. The PIA for the project alignment of road project was confined within a radius of 0.5 km from the alignment of the development since the nature of the project is such that most of the potential impacts are likely to occur within this area. However, there are some educational, religious, and cultural aspects were investigated in the PIA that directly and indirectly affected from the project activities (Refer to Table 4.20).

226. Mitigation. The project implementation should take in to consideration construction of the alignment or making provision of allocating alternative land and financial resources (for rehabilitation of the Madrasah, Mosque and the educational institution falling within the alignment). As alignment is chosen, provision should be made of, at least, two rows of trees along the ROWs of the alignment and suitable noise barriers to absorb the noise and vibration to be caused by vehicle movement.

6. Public Utility

227. **Impact.** Due to the proposed project, public utilities will be affected creating disruption of public services and inconvenience to the local residents. This impact is temporary and may be considered as moderately negative in nature.

228. **Mitigation.** Mitigation measures will include:

- Provision in the design and budget for the relocation of the existing utility infrastructures wherever required; and
- All public utilities (e.g. gas pipes, power/ telephone lines likely to be affected by the proposed highway will be relocated well ahead of time before the actual commencement of the construction work.

D. Construction Phase

229. Environmental effects of the construction phase are expected to be temporary. Construction impacts are considered to be minimal as all the construction works will be carried out within the site boundary of the acquired land and will be controlled via the mitigation measures defined in the EMP section. Following is the brief description of impacts envisaged during the construction phase:

1. Change in Hydrologic Regime

230. **Impact.** No major impacts are expected on hydrological aspects of the river due to bridge constructions. However, river hydrological, morphological, and ecological aspects have direct bearing on bridge location selection. All the new bridge shall be constructed at the same existing locations.

231. The dredging and use of dredged material if involved may have its impact in terms of localised sedimentation level increase and dispersion of pollutants present in the dredged material in the river water.

232. The proposed project area is in flood prone areas at some places but the project activities are to development of existing road alignment therefore, no major changes in hydrological regime will occur. However, the road alignment crosses the Jamuna and Fuljor River but the crossing will be carried out by new bridge at the existing bridge location therefore no change in water flow pattern will be caused. The major bridges (>100) will be constructed beside the existing bridges. Moreover, water flow of these rivers is not vigorous but most of them are remain dry during dry season. Thus the hydrologist does not suggest a separate morphological study for these rivers due to bridge construction. From the environmental perspective, it is also realised that the morphological study is not essential as there will be no changes in river hydrology due to bridge construction. For the crossing of canals and drains small bridges will be constructed. For the crossing of water courses, culverts and other possible arrangement will be done. Run off from storage of construction material near water bodies, or uncontrolled disposal may cause temporary drainage congestion, especially near the locations of small bridges, culverts, service areas, and construction sites. The direct Col of the surface water bodies will be confined within the RoW of the project, and it will be minor and temporary in nature.

233. **Mitigation.** Possible impacts are temporary and minor negative, however following mitigation measures will be incorporated:

- Proper design of bridges on the rivers and canals to accommodate design flows;
- Small bridges will be constructed on canals and drains coming in the RoW;
- Provision of box culverts to control flood damages and provision of safety of embankments;
- Provision of sufficient sizes of drains to take design flows;
- Wastes should not be disposed near any water body. All waste depending on its characteristics, should be disposed off in a controlled manner;
- The dredged material from the riverbank shall be tested for presence for heavy metals and other pollutants before its use.

2. Drainage Congestion & Flood

234. **Impact.** Run off from storage of construction material near water bodies, or uncontrolled disposal may cause temporary drainage congestion, especially near the locations of small bridges, culverts, service areas, and construction sites. Project design has made provisions of about many lesser bridges and culverts. Hence, no significant impact is anticipated on these water bodies during this phase. Stockpiling of fill materials dredged from the riverbeds for construction of the embankment may result erosion and subsequent deposition in the adjacent crop fields. The hydrological impacts of the project are primarily limited due to faster post monsoon drainage caused due to faster fall of water level in the drainage channels following the monsoon season.

235. The project area is prone to flood. The average flood return period for the project area is 2.33 years. The road stretches likely to be threatened due to flood, increase with increase in the return period. As per assessment and considering the existing road levels some parts of the road stretch is likely to be affected by flood respectively.

236. **Mitigation.** Construction will be carefully planned to minimize drainage congestion. Wastes should not be disposed near any water body. All waste depending on its characteristics, should be disposed in a controlled manner. Adequate cross drainage structure shall be provided to easily drain off water to canals and other lowland areas. Drainage works can also be designed with the provision of lower volume of water to drain in other low-lying areas, but the regulators are to be provided in such cases to permit controlled drainage rates and the consequent water levels. The road elevation level in the project area should be designed considering the flood threat levels. Provision of 1m free board is proposed.

3. Soil Erosion and Siltation

237. **Impact.** Soil erosion is observed at various locations of the road. Soil erosion levels depend on various factors like slope of an area, geological structure, soil type, and climatic variation. During construction phase, some trees, shrubs, and grasses will be cleared and existing road pavement will be removed. This may create localised soil erosion problems during the rains.

238. The potential risk of river or water bodies' erosion will increase after implementation of the project road if the bridge crossings are provided with waterway width less than the regime width of the water bodies. The portion of the road that is in contact with river will be provided with slope protection measures. The bank erosion in certain sections of the project in contact with the rivers is mild to minimal. The project is not expected to worsen the erosion risk particularly in areas where soil and topography are less vulnerable to erosion.

239. **Mitigation.** The following mitigation measures are proposed to alleviate or avoid potential impacts:

- Adopt good engineering & construction practices particularly at above identified locations.
- The road embankments and road cuttings shall be vegetated with a fast growing crop and a native seed mix immediately after fill placement to prevent scour and to encourage stabilization. Use of stone pitching or riprap shall be made at appropriate places especially around overpasses, bridges, culverts.
- Based on morphological consideration provide adequate bank protection and structures.
- The erosion tendency increases at water logged areas as well. Adequate drain and slope protection measures shall be applied at such locations specially as identified above.
- Spraying of water over the road bed from time to time and use of geo-grids on a layer by layer basis for better bonding in the pavement structure must be carried out to resist erosion.
- Particular attention needs to be taken while designing the bridge, which will be provided for the regime waterway width without narrowing the natural channel width. The portion of the highway that is in contact with river, channel and canal will be provided with slope protection measures.

4. Soil compaction and contamination

240. Impact. Due to construction of the proposed project, soil contamination may take place around borrow pits, road cuttings, embankments, construction camps, workshop areas, equipment washing yards, asphalt plants, batching plants, fuel and chemical storage areas, etc. Soil contamination may affect the road stability in worst cases may reduce the economic productivity of land and biodiversity in the project area.

241. During transportation of machine and materials, the cultivable lands beyond the proposed ROW may get compacted due to movement of vehicle and construction equipment, setting up construction camps, resulting in reduction in agriculture yield. Dumping of construction debris on fields adjoining the acquired areas, may lead to impairment of soil for agriculture, especially when the nearby areas to the alignment is largely agricultural. Parking of vehicles by the side of roads also leads to soil compaction and may spoil the soil characteristics necessary for cultivation. Soil in the project area may also get contaminated particularly from the bituminous wastes, spillage of oil and grease, mixing with construction materials, at the construction sites. The impacts of soil contamination would be temporary and moderate negative.

242. Mitigation. The movement of construction vehicles, machinery and equipment will be restricted to the corridor or identified route. The unusable, non-saleable, non-hazardous construction waste shall be disposed of in the properly delineated places. The compacted land will be restored for agricultural use.

243. All efforts shall be made to prevent soil contaminations. Following measures shall be taken to prevent the same:

- The construction vehicle shall be fuelled or repaired/serviced at the designated place with proper arrangement of waste collection and disposal. The arrangement shall include, cemented floor with dyke around for fuel storage and filling as well as repairing of construction equipment.
- Soil contamination by bitumen, fuel and chemical storages shall be minimized by siting them on an impervious base within an embanked area and secured by

fencing. The base and walls of the embankment shall be impermeable and of sufficient capacity to contain of the total volume of stored fuels and chemicals.

- The disposal of waste asphalt shall be made in approved locations such as borrow pits or natural depressions and shall not be within the RoW. Unless located in areas with impervious soils, encapsulation with pre-laid impervious liners including walls and capping is required with the objective to prevent water percolating through the waste materials and leaching toxic chemicals into the surrounding soils. On completion of disposal at the site, the area shall be capped with a compacted thickness of impermeable soil covered and with the top soil and shall be finally landscaped.

5. Top Soil

244. **Impact.** The potential impacts on top soil are:

- Removal of top soil for construction from outside the RoW.
- Compaction of top soil.
- Loss of top soil by wind and water erosion.
- Covering of top soil by project works.

245. **Mitigation.** Mitigation measures will include:

- The stockpiles will be done in slopes of 2:1 to reduce surface runoff and enhance percolation through the mass of stored soil.
- Locate topsoil stockpiles in areas outside drainage lines and protect from erosion.
- Construct diversion channels and silt fences around the topsoil stockpiles to prevent erosion and loss of topsoil.
- Spread the topsoil to maintain the physico-chemical and biological activity of the soil. The stored top soil will be utilized for covering all disturbed area and along the proposed plantation sites.
- Prior to the re-spreading of topsoil, the ground surface will be ripped to assist the bonding of the soil layers, water penetration and revegetation.
- Limit equipment and vehicular movements to within the approved construction zone.
- Remove unwanted materials from top soil like grass, roots of trees and similar others

6. Air Quality

246. **Impact.** During construction phase, there are two main sources of air emissions i.e. mobile sources and fixed sources. Mobile sources are mostly vehicles involved in construction activities while emissions are from fixed sources that include diesel generator sets, construction equipment (e.g. compressors) and excavation/ grading activities. Certain amount of dust and gaseous emissions will be generated during the construction phase from road construction machineries. Pollutants of primary concern include Suspended Particulate Matter (SPM) and Respirable Suspended Particulate Matter (RSPM). However, suspended dust particles are coarse and settle within a short distance of construction area. Therefore, impact in nearby inhabited area will be direct but temporary and restricted within the closed vicinity of the construction activities only.

247. Localised emissions are also anticipated from hot mix plants and batching plants. These emissions would be in the form of coarse particulate matter and will settle down in close vicinity of construction site. Further, this will be a temporary phase. Hence, no significant impact is expected during the construction phase. Emissions may be carried over longer distances depending upon the wind speed, direction, temperature of surrounding air and atmospheric stability. Construction work involves breaking up, digging, crushing, transporting, and dumping large quantities of dry material. During construction, the continuous operation of machinery and movement of heavy trucks and vehicles may generate gaseous emissions. It will inevitably lead to an increase in suspended particulate matter (SPM) in and around the construction zones. Emissions from crushers and quarry sites can cause health impacts (e.g., coughing, flu, difficulty in breathing, irritation in eyes and reduction in visibility). This impact is temporary and major negative in nature.

248. **Mitigation.** Mitigation measures will include:

- The stockpiles of construction material shall be sprinkled with water. Water should be sprayed at asphalt mixing site and temporary service and access roads. After compacting, water should be sprayed on the earthwork regularly to prevent dust. Construction equipment will be maintained to a good standard and idling of engines will be discouraged. Machinery causing excessive pollution (e.g. visible clouds of smoke) will be banned from construction sites;
- The Contractor(s) will submit a dust suppression program to RHD prior to construction. The plan will detail action to be taken to minimize dust generation (e.g. spraying of roads with water), and will identify equipment to be used.
- Road pavement design should be such that tyre friction due to vehicle movement will be reduced. Vehicles delivering loose and fine materials like sand and fine aggregates shall be covered to reduce dust pollution on existing road.
- Dust control by equipping asphalt hot mix and batching plants with fabric filters or wet scrubbers to reduce the level of dust emissions;
- Hot mix plants should be located at least 500 m away from the populated areas and be fitted with high stack (30m) to allow adequate dispersion of emissions. Further, the hot mix plants must be sited at least 1 km in the downwind direction from the nearest human settlement. Regular maintenance of machinery and equipment shall be carried out. Diesel Generating (DG) sets shall be fitted with stacks of adequate height. Low sulphur diesel will be used in DG sets as well as machineries. Dust mask will be provided to the workers. Proper dust collection system should be ensured at crushers and continuous sprinkling of water;
- Air pollution monitoring shall be carried out as per monitoring plan and corrective action shall be taken in case of deviation.

7. Noise & Vibration

249. **Impact.** During construction, noise is likely to be generated from site clearing, excavation, concrete mixing, crushers, and piling during bridge construction. The general noise levels during construction phase due to heavy earth moving equipment and machineries installation may sometimes go up to 100 dB(A) or more at the work sites¹⁵. Under worst case scenario, it is

¹⁵ The noise level from various construction equipment /machinery is (all levels are in dB(A)): Dozers (95-100), front Loaders (72-84), Backhoes (72-93), Tractors (76-96), Toppers/Truckes (82-94), Concrete mixers (75-83), Concrete pumps (75-83), Concrete pumps (81-83), Cranes (movable) (75-86), Vehicular Traffic (construction material & plant

assumed that all these equipment generate noise from a common point. The increase in noise levels due to operation of various construction equipment is expected to increase from 100 dB (A) at a distance of 1 m to 52.1 dB (A) at a distance of 250 m from the sources. The vehicular increase during construction is likely to be limited and may not have any significant contributions to increase in ambient noise level.

250. Vibrations caused by movements of heavy construction equipment, pile driving operations, operation of crushing, ballasting and aggregating plants will disturb the local residents unless operation times are fixed by discussing with local representatives. The vibration caused by some of the construction activities such as the roller compaction of the embankment, movement of heavy material transport vehicles, driving of piles and erection of bridges may be detrimental to the neighbouring structures.

251. **Mitigation.** Mitigation measures to minimize the impacts of noise and vibration include:

- Selection of latest equipment and plant with reduced noise level ensured by suitable in-built damping techniques and appropriate muffling devices.
- All powered mechanical equipment and machinery shall be fitted with noise abating gear such as mufflers for effective sound reducing, in full compliance with the DoE regulations.
- Vehicles and equipment should be fitted with silencer and maintained well. Mufflers should be used during pile driving hydraulic mechanism to ensure noise level is below 85 dB(A).
- The noisiest operations should be performed during daytime. Proper equipment maintenance and restricted operation between 0700 to 1800 hours will reduce noise.
- The construction equipment/machinery (stationary) shall be placed away from inhabited areas. Provision of temporary noise barrier shall be made near sensitive locations like schools, religious places and hospitals. If temporary noise barriers are not feasible then regulate construction activity and timing so as the impact intensity is minimized.
- The workers should be provided with personal protection devices as earplugs and earmuffs.
- In areas, where there are structures likely to be affected by vibrations because of the construction activities, precaution will be taken to minimize the vibration and the resulting impact.
- Noise and vibration monitoring shall be carried out as per the suggested monitoring plan.

8. Siting of Construction Camps

252. **Impact.** The precise locations for construction camps and other facilities such as workshops, equipment washing yards, borrow pits, quarries, crushing plants, asphalt plants, batching plants, construction material storage areas, haul routes and disposal sites for construction waste will be finally decided by RHD in consultation with Contractors. However, the siting of these facilities may cause a number of issues such as loss of plantation and vegetation,

& Machinery) (85-98), Dg Set (90-95), Pumps (69-71), Compressors (74-86), Pneumatic Wrenches (83-88), Jack Hammer and rock drills (81-98), Pile Drievrs (peak) (95-105).

permanent physical and visual impact on the area, siltation and pollution risks if construction materials are extracted from the river bed.

253. The construction process will take several years, with the result that the camps will take on a semi-permanent appearance. The people and the changes they bring can have significant impacts on the local communities and social structures. Substantial numbers of workers will inhabit the area in temporary camps loading local infrastructure and causing ambient social influence. Most important aspects are: contamination risk of soil and surface water due to sanitation of the camps; waste and garbage from the camp.

254. **Mitigation.** Mitigation measures include:

- The construction camps and workshops shall not be located in sensitive areas and shall not be within 500-meter distance from the existing settlements or might be selected after consultation with local people.
- Conducting special briefing and/or on-site training for the contractors and workers on the environmental requirement of the project to understand the environmental requirements of the project and implementation of mitigation measures.
- Efforts will be made to minimize vegetation loss while making site arrangements for construction camps and other facilities;
- The crushing plants, sites for borrow pits, asphalt hot mix and batching plants will not be located in environmentally sensitive areas, productive land or existing settlements;
- The construction material storage areas shall not be located in sensitive areas and shall be sheltered or sited within fence;
- Water and good sanitation facilities should be provided for the camps.
- Solid waste and sewage shall be managed according to national regulations. Solid waste must not be dumped, buried or burned at or near the project site, but shall be disposed of at the nearest sanitary landfill or site having and complying with the necessary permits.
- The sites for camps and associated facilities shall be reinstated by the Contractor(s) after decommissioning of the project.

9. Quarry

255. **Impact.** The precise locations for quarries will be finally decided by RHD in consultation with contractors. Quarries (together with borrow sites) are important construction material sources. Impacts from quarry operation ranged from loss of vegetation, erosion, siltation, pollution risks, noise and air quality deterioration, as well as aesthetic impact in the area.

256. **Mitigation.** The contractor has to ensure that the construction materials to be used for road construction will only be sourced from quarry with government clearance. Transportation of materials from quarry areas should be done by using special vehicles to avoid spillage along the road and they should be covered. During closure and reclamation of quarry sites, the contractor has to ensure that stripped materials will be levelled to facilitate water percolation and make natural grass planting possible. The contractor also has to ensure the restoration of river's natural flow to its previous state. Closure will be in accordance with the set guidelines in the EMP and in accordance with the country's environmental regulations.

10. Surface Water

257. **Impact.** The project road crosses two important rivers. One major bridge is proposed on the Fuljor River. Dredging and piling activities may have localised impact in terms of increase in total suspended particulates (TSS) level in river water. Since this will be a temporary phenomenon, no significant adverse impact is anticipated during this phase.

258. Surface water might get contaminated due to the disposal of construction waste generated due to the project activity. Uncontrolled dumping of wastes, sewage, dredge materials, and accidental spillage of fuels and chemicals will pollute these water bodies. Disposal of sewage and wastes from the construction camps to surface water bodies without treatment will deteriorate the water quality. The seasonal canals and ponds are unlikely to be affected from construction activities. This contamination will not only endanger the aquatic life but will also result in jeopardizing the health of people that use this water for meeting domestic requirements. The impact on these water bodies will be only during construction phase.

259. **Mitigation.** Proper care will be taken during construction of project road above or near the water channels so that no damage could be made during construction activities. To maintain the surface water flow/drainage, proper mitigation measures will be taken along the road, like drainage structures in urban areas.

260. Proper construction management including, training of operators and other workers should be ensured to avoid pollution of water bodies by the operation of construction machinery and equipment. Temporary construction facilities including structures and material stockpiles shall be located at least 50 m away from water bodies. Avoid disposal of wash water, solid waste as discarded packing etc., waste from concrete agitator cleaning operations and excavated material on water bodies adjacent to or within the vicinity of the project.

261. Construction of bridges and culverts should be done during dry season as much as possible. Cast-in-place concrete pile should be used in bridge and culvert construction. During the boring in the river cofferdams will be installed to prevent silt from mixing with river water. When large amounts of boring slag are produced, this slag will be hauled to spoiled disposal areas.

11. Groundwater

262. **Impact.** Increased demand for groundwater is anticipated during the construction phase for construction activities and domestic purposes. Since ground water is likely to be contaminated with arsenic at large places, consumption of arsenic contaminated groundwater may have adverse health effect on workers. Uncontrolled extraction of water may also affect availability of water to locals. In addition to that, construction waste, if left unattended will result in forming leachate which will percolate through the soil strata and will reach underground water table and hence, will end up contaminating it.

263. **Mitigation.** It is necessary that arrangement for safe drinking water is made prior to start of work. Water shall be supplied for consumption only after adequate analysis and requisite treatment. The workers may also be trained on the need for judicious use of freshwater resources. The contractors must be advised to use water judiciously. The water reserves will be adequately protected from any source of contamination such as the construction and oily waste that will degrade its potable quality.

12. Construction Waste

264. **Impact.** Due to construction activities, waste will be generated at construction and contractors camp site. The construction waste will include wastewater, oil spillage from machinery and solid waste etc. This will result in unhygienic conditions, and health risks to work force and general public at the camp site.

72. Following are the types and sources of construction waste:

- Oil, grease etc. from construction machinery;
- Solid waste from waste construction material and food;
- Wastewater from washing and sprinkling; and
- Sanitary waste from staff toilets.

265. **Mitigation.** This impact is temporary and moderate negative in nature. Mitigation measures will include:

- Wastewater effluent from contractor's workshop and equipment washing yards would be passed through gravel/ sand beds to remove oil/ grease contaminants before discharging it into natural streams;
- Waste will be disposed at designated sites and no waste will be disposed in the productive agricultural field;
- The hazardous waste will be transported to nearby incineration facility;
- Solid waste generated during construction will be safely disposed in approved and demarcated waste disposal sites and the contractor will not dispose waste into productive agricultural lands and will also provide a proper waste management plan;
- Sanitary wastes generating from staff and labour camps must be disposed of in environment friendly manner, i.e. provision of septic tank etc. for toilet wastes; and
- Aggregate waste material of existing road will be reused in road improvement.

13. Dredging and Dredged Materials

266. **Impact.** Development of road embankment will require filling material to provide prescribed height of the embankment thinking the regional land elevation. Huge amount of filling materials will be collected from the nearby rivers bed. Dredging in the river has some physical and ecological impacts. The dredging activities have the chance of increasing river bank erosion and higher flood risk downstream. During dredging the existing aquatic habitats will be dislocated. The surface water quality will be affected and there is chance of spilling/seepage of oil in the river. While collecting filling materials from the nearby ponds and lands, it may affect the surrounding agricultural land and local people will be temporarily disturbed due to noise and dust creation.

267. **Mitigation.** All reasonable steps must be taken to prevent the transport of sediments beyond the worked stretch. All reasonable steps must be taken to avoid increased erosion of the banks and bed work must not be carried out when fish are likely to be spawning in the affected surface water, or in the period between spawning and the subsequent emergence of juvenile fish. While dredging, special care must be given to prevent any spillage/seepage of oil from the dredging machines and wastes from the workers on the river water. If some of the owners of the ponds and lands nearby to the road alignment want to use their area for fisheries project, the contractor may collect filling materials from that area through proper contract and dredging guidelines.

14. Flora

268. **Impact.** There would be no major impact on flora except cutting of trees during project intervention in the project area. There is no protected forest, reserved forest or sanctuary etc. present in these areas. About 31,450 different tree species with different sizes in Elenga-Hatikamrul road section are located along the road alignment and will be affected due to the project (refer to section 4.3.2 for details). In addition, many social forestry trees are likely to be cut. Trees are of timber value, fruit bearing and medicinal in nature. The medicinal plants are common in the project area.

269. Establishment of contractor's camps and warehouses for storage of equipment, material etc. shall involve clearing of vegetation from the area causing negative impact. During the entire construction period, dust laden polluted air will form a dust film on the leaves, thus blocking sunshine and stomata, thereby hindering photosynthesis process and cause quaintly causing detrimental effect on the plant health. Also, during construction activities, the contractor's workers may damage the vegetation including trees (for use as firewood to fulfil the camp's requirements). This may affect the ecological habitat of the area. This impact will be permanent and moderate negative in nature.

270. **Mitigation.** Mitigation measures will include:

- All efforts shall be made to minimize the tree cutting by selecting road-widening option based on technical considerations. There will be consultations with the public and NGOs prior to cutting of old trees. Option may also be explored at detailed design stage to widen the road on other side to prevent cutting of trees. Uncut trees will serve as road divider for the project;
- The Forest Department recommended that two trees will be planted for every tree cut. This value will be greater for social forestry. These trees shall be planted primarily along the road within ROW. The social forestry can be planted on the area allocated by local authorities;
- Flowering and fruiting shrubs will be planted along the RoWs to provide aesthetics in the surrounding landscape;
- An awareness campaign targeted on the neighbourhood farmers shall be run to popularize the planting of trees;
- The contractor's staff and labour will be strictly instructed not to damage any vegetation such as trees or bushes. Staff will be instructed to utilize paths and tracks for movement and will not be allowed to trespass through farmlands.
- Construction vehicles, equipment's and machinery will remain confined within their designated areas.
- Contractor will supply gas cylinders at the camps for cooking purposes and cutting of trees/bushes for fuel will not be allowed.
- Camp sites and asphalt plants will be established on waste/barren land rather than on forested or agriculturally productive land. However, if such type of land is not available, it will be ensured that minimum clearing of the vegetation is carried out and minimum damage is caused to the trees, under growth and crops.
- Compensation for trees to be cut within the RoW of road must be paid to farmers/owners based on market rates.

15. Wildlife

271. **Impact.** There are no endemic wild animals within the project area. The project will pose minor negative impact on the fauna present in the project area. There are no game reserve nor wild life sanctuary along the project alignment, therefore no negative impact will happen.

272. **Mitigation.** The following mitigation measures will be taken:

- Illegal animal hunting will not be allowed and punishment will be enforced in case of violation;
- All efforts shall be made to prevent cutting of large tree. All efforts shall be made to ensure that these trees are cut only on one side of the road by making suitable adjustment in the road design.
- Only new and machineries and equipment in good condition will be used in construction;
- Work will only be carried out during day time so that there will be no disturbance to local birds and animals;
- Contractor will ensure that the no hunting nor trapping of animal will be carried out during construction; and
- Borrow pits will be fenced to protect animals from intrusion.

16. Fisheries

273. **Impact.** There will be loss of fish productivity in the pond fishery and borrow pit fishery due to filling of ponds along the road areas. Fish species such as Sheat Fish, Carp, Pale Carplet, Salmon, Prawn, Kakila, Aire, Tengra, Bele, Mrigal and Olive Barb migration takes place in Elenga-Hatikamrul road Section (in Jamuna and Fuljor). Migration is more prominent between June and August. Construction of bridges might have negative impact during the rainy season and without due consideration of maintaining the deep-water channel of migration of these fishes.

274. **Mitigation.** Adequate cross drainage structure shall be provided in all water logged or pond extending both sides of the road areas. No construction shall be undertaken during the high flood when water depth is usually maximum 6m. During dry period (from November to May) the river is almost dry up and no flow occurred in the river. Further, it is recommended that construction along the riverbanks must be avoided during the fish breeding season (July to September).

17. Land Use

275. **Impact.** Land use changes along the road corridors are anticipated. These shall bring about a change in the characteristics of the adjacent lands. The construction activity for road widening and Bridge/flyovers construction will temporarily change the land use for use of construction site, access road, and construction camp. Due to these interventions, agricultural, seasonal wet land area and social forestry around these areas may get affected adversely.

276. A substantial earth is required for widening and elevating the road with existing levels. The RHD borrowed earth from the roadside during the previous construction activities. Earth has been borrowed mostly within RoW. The borrowed areas are seen left without rehabilitation or interconnectivity to maintain the natural drainage at various locations. These borrow pits are being used as fishpond. However, these are also causing water logging since no drainage is planned in these areas. Additionally, RHD has the practice of issuing of contract for sourcing borrow earth

without specified controls for borrowing the earth or preservation of top soil or borrow areas rehabilitation. Similar practice for proposed road widening activity will have direct impact on land use, top soil preservation and drainage pattern around the road.

277. Mitigation. GOB has adopted the practice of encouraging construction of roadway embankment with river sand rather than clayey agricultural soil. The same option is proposed for the project road. Wherever earth to be borrowed for cladding with cohesive soil, following mitigation measures should be taken to minimise the impact on land use:

278. Preference shall be given to borrow earth from RoW itself wherever feasible. However, due care shall be given for protecting the road embankment with slope protection measures. Each borrow pit shall have a side opening for flow of accumulated water. It shall be put to community preferred used for fishing or other activity. Alternatively, it shall be rehabilitated and used for tree plantation using the preserved top soil.

279. Wherever borrow earth not available from the RoW, preference shall be given to land, which farmers want to convert either into a fishpond or lowering the agriculture field level to increase its water retention capacity. No land acquisition shall be made for borrow areas.

- While borrowing, the earth top soil shall be preserved. The borrow pits shall be rehabilitated after borrowing the earth;
- Borrow areas should not be located on cultivable lands. However, if it becomes necessary to borrow earth from temporarily acquired cultivated lands, their depth should not exceed 45 cm. The topsoil to a depth of 15cm shall be stripped and set aside. Thereafter, soil may be dug out to a further depth not exceeding 30cm and used in forming the embankment.
- Borrow pit shall be selected from wasteland at least 500m away from the road;
- Priority should be given to the borrowing from humps (including from digging of wells) above the general ground level within the road land;
- Priority should be given to the borrowing by excavating/enlarging existing borrow areas;
- Borrowing should be from land acquired temporarily and located at least 500m away from the road;
- In case of settlements, borrow pits shall not be selected within a distance 800m from towns or villages. If unavoidable, earth excavation shall not exceed 30cm in depth
- The haulage distance from site should not be too far.
- Good engineering and construction practices should be followed.
- While issuing the contract, all above conditions shall be included in the contract and monitored as well.

18. Traffic Congestion

280. Impact. Due to construction activities, traffic management may be a problem in the project area. This may result in traffic jams and cause inconvenience to the people passing through the road crossings at interchanges due to movement of vehicles carrying construction materials.

281. Mitigation. This impact is temporary and minor negative in nature and can be mitigated by providing proper alternative traffic management plan during construction of the road. Interchanges will be constructed in a way that traffic flow is not disturbed; alternative routes will

be clearly defined. Proper traffic management with marking should be done on the road crossings near interchanges.

19. Cultural Sites

282. **Impact.** There are no physical cultural resources as listed in UNESCO World Heritage list of archaeological sites exist along the entire alignment. There will be some impacts like noise and dust pollution on the nearby socio-cultural structures from the road alignment such as the schools, colleges, mosques, and graveyards etc. (as stated according to the Table 4.20) due to construction activities.

283. **Mitigation.** This impact is temporary and minor negative in nature. Mitigation measures will include:

- Timely completion of the construction work and provision of alternative routes during the construction;
- Establishment of construction site camp and labour camp must maintain proper distance from the cultural sites.

20. Income and Employment

284. **Impact.** Normal living of the local people will be affected for a certain period. Income loss in a lower scale will be happened due to the loss of agricultural lands and rehabilitation of the households. Some local roads will be disturbed being located on the road alignment during developing the road embankment. Unplanned occupation of roadside land for habitation and commercial purpose may alter the land use of the project area beyond the project-acquired area.

285. During construction activities, local unemployed people will get employment and increased income. The immediate benefits to the poorest residents in the project impact areas include employment in construction activities; and subsistence allowances and other benefits under resettlement, and increased income from petty business during construction. It is also expected that during the construction phase several other employment opportunities with contractor's office would be available for local people.

286. **Mitigation.** To minimize income loss, contractors as far as practicable will recruit construction workers from the locality, and shall maintain gender equity while employing the locals. Priority shall always be given to people from the PAPs and from those unemployed and belong to the lower income group. Additional benefits will be derived by setting aside areas within contractor camps/labour shed for local people to sell their products or to provide additional services to the workers. Replacement on a suitable location in a better form will be done with the help and consent of the affected local community.

287. Project authorities shall take necessary actions as per the recommendation of Resettlement Plan (RP) and Social Impact Assessment.

21. Occupational Health & Safety

a. Occupational Health and Safety of Workers

288. **Impact.** Health risks and workers' safety maybe compromised if working conditions are unsafe and/or unfavourable working environment due to storage, handling and transport of

hazardous construction material. Construction workers are at risk of accident due to moving vehicle, and other construction related activities. Workers are also exposed to high levels of dust, exhaust from vehicles and noise levels. Workers are often required to work irregular working hours resulting in fatigue and increased risk of accidents.

289. Mitigation. Mitigation measures will include:

- Obligatory insurance for labourers/workers;
- Providing basic medical training to specified work staff and basic medical service and supplies to workers;
- Layout plan for camp site, indicating safety measures taken by the contractor, e.g. firefighting equipment, safe storage of hazardous material, first aid, security, fencing, and contingency measures in case of accidents;
- Protective devices (ear muffs) will be provided to the workers doing job in the vicinity of high noise generating machines;
- Provision of adequate sanitation, washing, cooking and dormitory;
- Provision of protective clothing for labourers handling hazardous materials, e.g. helmet, adequate footwear for bituminous pavement works, protective goggles, gloves, etc.;
- Adequate signages, lighting devices, barriers, yellow tape and persons with flags during construction to manage traffic at construction sites, haulage and access roads

b. Occupational Health & Safety of Community

290. Impact. The construction activities and vehicular movement at construction sites and access service roads may result in road side accidents particularly inflicting local communities who are not familiar with presence of heavy equipment. This is a temporary and minor negative impact. Quality of groundwater and surface water resources available in the nearby local communities may be affected due to construction activities, oil spillage and leakage, roadside accidents etc. Labourers with infectious diseases may infect local residents. The borrow pit areas located near the residential, settlements, may cause accident for the people moving near to those areas.

291. Mitigation. Mitigation measures will include:

- There should be proper control on construction activities and oil spillage leakage of vehicles.
- Labourers with infectious diseases should be restricted within the construction site and advised to seek medication.
- Efforts will be made to create awareness about road safety among drivers operating construction vehicles;
- Close consultation with local communities to identify optimal solutions for diversions to maintain community integrity & social links;
- Provision of proper safety and diversion signages, particularly at urban areas and at sensitive/accident-prone spots.
- Reducing the impacts of vector borne diseases on long-term health effect of workers should be accomplished through implementation of diverse interventions aimed at eliminating the factors that lead to disease;

- During construction work, pedestrian and vehicular passages should be provided for crossing near settlement
- Use of water should not disturb public water availability. Source of water should be selected carefully.

22. Impacts due to Bridge Construction

292. The Elenga-Hatikamrul road alignment will necessitate construction of one major bridge longer than 100m at chainage 106+310 Km over the Fuljor River at Sirajanj. However, this bridge is within the same activities of Elenga-Hatikamrul road construction thus there is no separate environmental impact assessment for these bridges. But details impacts and mitigation measures for major bridges has been covered in this EIA and additionally this section will discuss some major impacts and mitigation measures due to this bridge construction. Since construction of such bridge will involve earthwork, piling, concrete structures across rivers and over both the river-banks, restriction to plying of country boats, blockage of aquatic biodiversity movement, etc., (for river bridges), environmental impacts due to such activities will be different from those due to the construction of the project road and, hence, different will be the environmental components and parameters to be addressed during the impact assessment and management processes.

23. Navigation Channel Obstruction

293. A small quantity of construction materials and equipment are to be transported using water transports that might create disruption in movements of mechanized and non-mechanized water-transports unless dealt with carefully and properly. The piling, dredging and other construction related operations might also disrupt movement of navigational transports in the main river channels. These disruptions however will only be localized and will last during construction only.

24. Erosion and Drainage

294. With the project area, being low elevation flood plain, erosion is not the major concern but drainage is. Nevertheless, at the location near the bridge crossings, the banks of the river are steep and might be prone to minor erosion. Proper river training measures will be adopted upstream and downstream of the bridge crossings for an appropriate reach length.

25. Soil and Water Quality Degradation

295. Spillage of fuel, solvents, lubricants and paint by leakage of tanks or careless handling of chemical waste can cause severe pollution of soil, groundwater and surface water. Soil pollution and groundwater pollution by liquid wastes can have serious effects on the quality of drinking water in the project area for several years. Handling and storage of potential contaminants will be organized under strict conditions and preventive measures to avoid contamination during construction of the bridge.

26. Vibration and Pile Driving Noise

296. The piles for the bridge foundations will be cast in place reinforced concrete piles. Therefore, the vibration will not be significant and noise level will also remain at low level. However, noise level will rise due to other construction activities, transportation and loading, unloading of construction materials, dredging and electricity generation. It is expected that the noise caused by these activities will still be within acceptable levels.

27. Fisheries

297. The main project-related potential causes of adverse impacts on fisheries are:

- hydrocarbon spills and leaks from river transport
- disposal of construction and construction camp wastes into rivers and streams
- sediment-laden runoff from construction sites and camps
- construction within waterways.

298. The amount of river transport involved in the project will be low as only the Fuljor River is of navigation significance and most construction materials will be brought to site by road transport. This makes the potential for riverine spills to be less.

299. The construction contract specifications and EMP place high emphasis on the proper environmental management. A full-time supervision consultant will be engaged to ensure compliance with these requirements for both disposals of wastes as well as the control of sediment laden-runoff for the project site. There will be rigorous control of hazardous materials, although for a road design project,3 these are not expected to be present in large quantities.

300. With the exception of Nalka Bridge over the Fuljor River, all the bridges and culverts are to be constructed across low-lying areas and non-perennial streams, thereby limiting the potential for disruption of waterways and fisheries. The bridgeworks will be of a conventional nature and the bored pile foundations which will generate some sediments, but the levels are not expected to be high compared with the natural sediment load in that river.

28. River Transport

301. The use of construction and dredging barges has the potential to cause some traffic disruption in Fuljor River. Construction barges may be employed for bridge construction and conventional management practices will be able to mitigate any adverse effects on river navigation by identifying the navigation channel through use of aids such as buoys, beacons and lighting. Similar practices will minimise any effects on river traffic from sand dredging.

E. Operation Phase

302. Due to increased activities and efficient operational systems, there will be some impacts on the environmental set-up in the project area, which are discussed hereunder. To achieve sustainability of the development works, it is necessary to ensure the effectiveness of mitigation measures even after construction, as some adverse environmental impacts may result from the operation of the project facilities. Therefore, to reap the full environmental benefits of the activities and ensure environmental enhancement it would be necessary to implement the following which are beyond the purview of this project and may require national level involvement.

1. Soil Erosion and Quality

303. **Impact.** No soil erosion is anticipated during the operation phase except where shoulders are not well maintained and its damage trigger the erosion of road embankment. However, soil erosion may take place at different road structures (bridges, embankments, culverts etc.), which may increase the flood risk by rapid flash of storm-water runoff that will undermine these structures. Contamination of soil is not likely to happen other than due to accidental spillage from vehicle movement. Soil contamination can take place on border areas by road runoff containing

heavy metals (e.g. lead). If these areas are used for growing vegetables for human consumption, it can have adverse impacts on human health. The research has shown that the increase in heavy metals is generally limited to a narrow border along the edge of the road and concentrations rapidly fall away with distance from the hard shoulder.

304. **Mitigation.** The following mitigation measures are proposed to reduce the impacts on soil:

- In case soil erosion takes place, proper remedial measures will be undertaken to stop future impacts of loss of soils and the associated impacts caused by soil erosion;
- Slope protection measures by grass turfing and vegetation must be ensured.
- Proper measures must be ensured to prevent any oil spillage and leakage from vehicles.
- Depending on the nature and magnitude of spill, appropriate land remediation measures shall be employed by the concerned authorities.

2. Noise and Vibration

305. **Impact.** During the operational phase, the noise levels are anticipated to increase due to traffic related noise pollution; vibrations from engines and tires and mainly use of pressure horns. The main source of noise during the operation phase is the traffic. It can be estimated that ambient noise level will increase due to the increased traffic. However, the better road condition and less congestion on roads will reduce the net noise levels at market and other crowded places. The Noise levels are likely to reach the acceptable levels at a distance of 500 m from the road. Some sensitive locations within 500m of the road may be affected due to higher noise levels than the stipulated 45 dB(A). Overall, impact on noise environment is considered moderate during the operation phase.

306. **Mitigation.** This impact is permanent and moderate negative in nature. Mitigation measures will include:

- It is suggested that suitable engineering measures such as noise barriers, road pavement design, underpasses/foot over bridges at market areas as feasible should be adopted to minimize the noise generation.
- According to monitoring results, additional sound barriers in form of trees and hedges will be discussed with the affected people and planted if agreed;
- It is also suggested that surface roughness of the roads are maintained as per the design characteristics and honking should be discouraged through signboard displays.
- Signs for sensitive zones (health centres / educational institutions etc.) to disallow the use of pressure horns;
- Enforcement and penalties against traffic rules violators; and
- Noise monitoring shall be carried out as per the suggested monitoring plan.

3. Air Quality

307. **Impact.** The bad road conditions, the idling of vehicles and congestions are the main causes of the air and noise pollution at present. The improved road conditions will change this scenario, which will result in the improved ambient air quality. However, in the longer run, increased traffic levels and congestion will lead to PM₁₀ pollution levels above the

national/international standards, which may result in causing public health risks, nuisance and other impacts on bio-physical environment.

308. These conditions will result in the rise of vehicular emissions (CO, NO_x, SO_x, PM₁₀) associated with the adverse effects on the environment and human. This impact is permanent and positive, in case of improvement of road conditions and minor negative, when traffic volume is increased.

309. **Mitigation.** Mitigation measures will include:

- It is proposed to maintain the road conditions especially the shoulders and embankment turfing.
- Setting up of a system to monitor air quality along project area in accordance with the applicable standards/limits;
- Roadside tree plantations as applicable and feasible under harsh climatic conditions; plants should be selected in accordance to their ability to absorb emissions;
- Densely populated trees shall be planted close to school, and religious places.
- Provision of slip road shall be made in urban and congested areas as feasible to separate slow moving and localised traffic.
- Regular road maintenance to ensure good surface condition;
- Regular vehicle check to control/ensure compliance with air quality standards;
- Best traffic management practices shall also be adopted to regulate the traffic. Enforcement and penalties against traffic rules violators.

4. Water Quality

310. **Impact.** The surface water bodies may get flooded and polluted due to uncontrolled release of contaminated storm-water/road runoff from road surfaces. The pollutants associated with the road-runoff include, hydrocarbons, heavy, corrosive products and suspended solids including insoluble heavy metals as colloidal materials from traffic. The worst contamination generally takes place during the first flush of runoff from roads after a spell of dry weather. The level of pollution is directly related to the traffic volume. The pollution risk from accidental spillage may increase moderately. In the long run, the increased traffic volume and faster traffic speeds would increase the risk of accidental spillage, which could have medium adverse impact on surface water quality. The natural drainage of road runoff across embankments or discharge of runoff into water bodies from large area of carriageway may have medium adverse impacts on ponding and the flood risk to downstream locations.

311. Groundwater may get polluted due to contaminated road runoff on earthen shoulders and embankments planted with grasses. Additionally, the project may lead to faster urbanization near the project area especially near the intersections. This will exert stress on the availability of groundwater in the project area.

312. **Mitigation.** The following mitigation measures are proposed to mitigate water quality related impacts:

- In order to discharge rapid removal of storm-water/road runoff, cross slopes and longitudinal drainage will be provided in the design. Well-designed cross drainage structures limit ponding across embankments;

- Proper drainage system with sedimentation ponds and oil separators will be provided to avoid contamination by run-off and oil spills, especially drainage will be provided for oil spills near water channels to prevent any contamination;
- Retention basins with reedbeds provided in the design will improve the quality of polluted storm-water/road runoff;
- Drainage and collection structures on the road project, particularly in areas near the river and irrigation canals, shall be designed such that spills of hazardous materials shall not result to contamination of these watercourses;
- Prior to operation, an emergency response plan for spills of hazardous materials and oil will be prepared;
- The surface water quality monitoring will also be carried out at defined intervals and for environmental quality monitoring parameters suggested in the Environmental Monitoring Plan. If these parameters are above the prescribed limits, suitable control measures will be taken;
- Groundwater quality monitoring will be carried out as per schedule suggested in the Environmental Monitoring Plan.

5. Land Use

313. Impact. The project road will induce land use changes in the form of development of commercial establishments (restaurants, petrol and gas filling stations), educational institutes etc. The existing settlements will be shifted due to resettlement and the agricultural land will be changed into road, with heavy traffic passing on it. The changes in land use may affect the land value, which will vary depending upon the location. The impacts on land use would be permanent and both moderate negative especially for those whose land values have not increased and medium beneficial for businessmen and those having escalated land values (especially near interchanges). Unplanned occupation of roadside land for habitation and commercial purpose may alter the land use of the project area beyond the project-acquired area.

314. Mitigation. The mitigation measures include:

- All the facilities with the exception of restaurants and petrol/gas filling stations likely to pop up in the future will be prohibited within the RoW.
- The permission will be sought from the concerned authority for the development of any establishment along the project corridor.
- Project authorities shall take necessary actions as per the recommendation of Resettlement Plan (RP) and Social Impact Assessment.

6. Wildlife

315. Impact. The project activities will bring some negative impacts on the fauna of the project area such as the uneasiness of movement and increased probability of accidents, if the animals/livestock approach the road. This impact is permanent and minor negative in nature. Noise and air pollution caused due to heavy and fast traffic on highway, shall be a source of disturbance to the fauna of the area and especially to the avifauna of the area, which is an another minor negative impact.

316. Mitigation. Rising of dense plantation of shady trees on both sides of the RoW shall provide resting, nestling and roosting habitat to the fauna and especially to the avifauna which is a major positive impact. Provision of small net on the both side of the road shall be made where the animal movement is frequent.

7. Fisheries

317. **Impact.** Fisheries resources will be affected due to the damage of 2 ponds, 2 ditches and disturbance to fisheries species during construction of bridge & culvert over rivers and canals to build the Elega-Hatikamrul road embankment. After completion of building the road embankment, proper steps must be taken to regain the fisheries resources in the project area. When the water level recedes in the post rainy season, the big fishes may get fragmented due to reduced water or unavailability of deep water channel especially the places where sedimentation is high.

318. **Mitigation.** During the operation phase, RHD needs to take initiatives to enrich fisheries resources. In this case, RHD can provide logistic support to the PAPs of the water bodies to culture fish in other places in the PIA. Moreover, RHD can consult with the local fisheries department to enrich the fisheries resources in the PIA. Efforts shall be made as an enhancement measure to maintain deep-water stream up to certain distance on both end of the bridge.

8. Cultural Sites

319. **Impact.** Loss of ancestral property, graveyards and mosques may cause some lasting stress on the affected people. Cultural and sensitive areas adjacent to 50 m away from the RoW boundary may be affected due to the noise originating from the moving traffics.

320. **Mitigation.** Proper rehabilitation of the affected people and the religious and cultural monuments and structures will eventually ease out the stresses and this will not remain a significant issue over the time. Noise barrier through plantation on the boundary of the affected cultural sites may reduce the magnitude of noise level.

9. Road Safety

321. **Impact.** The increased vehicular movement and speed may result in road safety issues like traffic accidents. The accidents may also be due to tiredness. This impact is permanent but moderately adverse in nature, since the frequency of accidents may be lowered, but their intensity may be quite severe due to enhanced speeds at which vehicles will move.

322. **Mitigation.** Mitigation measure will include strict enforcement of speed limits, installation of speed guns and channelization of traffic with respect to categories (heavy vehicle traffic and light vehicle traffic) and enforcement of penalties for the violators. Traffic signs will be provided to facilitate road users about rest areas, eating establishments etc. All the lanes, median, sharp bends will be reflectorized to facilitate travellers in the night time. Proper lighting arrangement on the RoW will be done at required places.

F. Evaluation of Significant Impacts

323. As is the case for most development projects, potential negative impacts sometimes could be far more numerous than beneficial impacts. Whereas the anticipated negative impacts could be dealt with through carefully selected and undertaken efficient mitigation measures and good management practices, beneficial impacts could still be augmented through mobilizing and strengthening the realization about the positive outcomes of the project among all the stakeholders and project officials as well as contractors performing works related to various stages of implementation. It is generally expected that the long-term benefits of any development

intervention will ultimately trickle down for the benefit of the local population and make contributions toward improvement of life quality.

324. The potential impacts due to implementation of the Elenga-Hatikamrul road project are identified by using DOE formatted matrix for environmental assessment by project implementation stages. In this developed checklist, actions, which may affect the various Important Environmental Components (IECs) pertaining to the areas adjacent to the alignment during the various stages of the project activities, are listed and the degrees of Significant Environmental Impacts (SEIs) are shown. The terms none, minor, moderate and major are used in the checklists to evaluate the magnitude of SEIs. In the checklist, each of the pre-construction, construction and operational phases of the Elenga-Hatikamrul road are considered separately in order to distinguish the short term and long term impacts as well as reversibility and irreversibility of impacts in terms of their duration.

325. Identification and evaluation of potential/significant impacts due to project location, site preparation, construction and operation at the project has been done using an 'Impact Matrix' by identifying all stages of activities (pre-construction to operation and maintenance) and assessing the potential impact of each operation upon individual environmental components. Within the matrix, each potential interaction is represented by an impact category, as defined below:

- Type - beneficial or adverse
- Effect - direct or indirect
- Duration - short term or long term
- Change - reversible or irreversible
- Extent - local or wide
- Significance - low or high

326. The 'Matrix Rating' figures assume no mitigation measures were implemented.

327. As can be observed from the checklist in Table 32, major environmental components, which will be adversely affected by activities related to the project, are: air quality, noise hazard, loss of trees, accidental risk, hydrology/drainage and occupational health and safety and socio-economic environment. It should be noted that IECs indicated in the checklist relate to the changeability or un-changeability of the existing situations due to interventions of the project and significant level of impact without mitigation of negative impacts.

Table 32: Checklist of Important Environmental Components (IECs)

Project Phases	Activity Important Environmental Components	Types of Impact	Significance of Impact	Duration of Impact
Pre- Construction Phase	Climate Change	Adverse, Direct	Low	Long term
	Loss of Trees	Adverse, Direct	Low	Medium term
	Land Acquisition	Adverse, Direct	Localized, Low	Short term
	Loss of Structure	Adverse, Direct	Low	Long term
	Educational, Cultural, Religious/Historical sites	Adverse, Direct	Localized, Low	Short term
	Public Utility	Adverse, Direct	Localized, Low	Short term
Construction Phase	Hydrology	Adverse, Direct	Minor, Reversible	Short term
	Drainage and Flood	Adverse, Direct	Minor, Reversible	Short term
	Soil Erosion and Siltation	Adverse, Direct	Localized, Reversible	Short term
	Soil Contamination	Adverse, Direct	Minor, Reversible	Short term
	Noise	Adverse, Direct	Localized, Reversible	Short term

Project Phases	Activity Environmental Components	Important	Types of Impact	Significance of Impact	Duration of Impact
	Air		Adverse, Direct	Localized, Reversible	Short term
	Groundwater		Minor	Low	Short term
	Surface Water		Adverse, Direct	Localized, Reversible	Medium term
	Waste Pollution		Adverse, Direct	Localized, Reversible	Short term
	Dredging		Adverse, Indirect	Localized, Low	Short term
	Flora		Adverse, Indirect	Moderate, Reversible	Medium term
	Wild Life		Adverse, Direct	Localized, Reversible	Short term
	Fisheries		Adverse, Direct	Localized, High	Short term
	Traffic Congestion		Adverse, Direct	Moderate, Reversible	Short term
	Income and Employment		Beneficial, Direct	Localized, Moderate	Short term
	Cultural and Religious Sites		Adverse, Direct	Localized, Reversible	Short term
	Educational Institutions, Health Facilities		Adverse, Direct	Localized, Reversible	Short term
	Occupational Health & Safety		Adverse, Direct	Minor, Reversible	Short term
Operation Phase	Soil Erosion and Quality		Adverse, Direct	Localized	Short term
	Flora		Positive, Direct	Localized	Long term
	Noise		Adverse, Direct	Localized	Persistent
	Air		Adverse, Direct	Localized	Persistent
	Water Quality		Adverse, Direct	Minor, Reversible	Persistent
	Land use		Positive, Direct	Moderate	Long term
	Wild Life		Positive, Direct	Moderate	Long term
	Fisheries		Adverse, Indirect	Moderate, Reversible	Medium term
	Cultural Sites		Adverse, Indirect	Localized	Persistent
	Road Safety		Adverse, Indirect	Localized, Reversible	Short term

VI. CLIMATE CHANGE ASSESSMENT

A. Greenhouse Gas Emission

328. Bangladesh generated 190 million metric tons of greenhouse gas (expressed in MtCO₂e) in 2012, with the agriculture industry contributing about 40% to overall emissions.¹⁶ This is followed by the energy sector, of which transportation is one of the subsectors, with 33% contribution. The Bangladesh Climate Change Strategy and Action Plan in 2009 identified improving transportation sector energy consumption as a priority since its share of emissions is growing faster than any other sector.

329. GHG emission likely to be generated from the project roads have been computed using the Transport Emissions Evaluation Model for Projects (TEEMP)¹⁷ developed by Clean Air Asia¹⁸, the Institute for Transportation and Development Policy and with funding from ADB. TEEMP is an excel based tool to assess the equivalent CO₂ gross emissions without (business as usual or BAU) and with the project improvements (with project scenario or WPS). The main improvement from the project that was considered for the model are better surface roughness with less than 2.5m/km, and widening of project road from 2 lanes to 4 lanes. These were translated into increase in traffic speed and hence fuel consumption. The model has also been used for CO₂ emission assessment during construction stage. The model also allows for the inclusion of impacts related to traffic congestion with and without project through provisions for inserting data on the traffic numbers, lane width, number of lanes and volume/capacity saturation limit. The model also computes for emission and emission intensity of PM and NO_x.

330. Few assumptions made in this software are:

- a. Fuel efficiency as reckoned in business as usual (BAU) and with project scenario (WPS) is given in Table 33. It is assumed that the fuel efficiency of the vehicles would increase due to improvement of the roads.
- b. It is assumed that there would be no or minimum number of vehicles with vintage year before 2000 using Euro-I fuel type after 20 years (Table 334). Pre Euro vehicles are assumed to be completely discarded for vehicle categories except for 3 wheelers.

Table 33: Fuel efficiency in km/l

Scenario	2017			2036		
	Petrol	Diesel	LPG	Petrol	Diesel	LPG
2-Wheeler	50.00			50.00		
3-Wheeler	30.00	20.00	30.00	30.00	20.00	30.00
Car	15.00	18.00		11.00	18.00	
Multi-axle		8.00			8.00	
Bus		6.00			6.00	
2-axle		8.00			8.00	

¹⁶ World Resources Institute. Climate Access Indicators Tool (WRI – CAIT) 2.0. 2015.

¹⁷ TEEMP is an excel-based, free-of-charge spreadsheet models to evaluate emissions impacts of transport projects.

¹⁸A network of 250 organizations in 31 countries established by the Asian Development Bank, World Bank, and USAID to promote better air quality and livable cities by translating knowledge to policies and actions that reduce air pollution and greenhouse gas emissions from transport, energy and other sectors.

Table 34: Emission Standards of Fleet (%)

Vehicle Type	Current Scenario				Post 20 Years		
	Pre-Euro	Euro I	Euro II	Euro III	Euro I	Euro II	Euro III
2 Wheeler		20%	80%		20	60%	20%
3 Wheeler	100%					50%	50%
Car			20%	80%		20%	80%
Multi-axle		10%	20%	70%	10%	20%	70%
Bus		10%	20%	70%	10%	20%	70%
2-axle		10%	20%	70%	10%	20%	70%

331. The model requires basic information and parameters from the project such as the type of road (expressway, rural or urban road), number of sections to be assessed, project's useful life, induced traffic elasticity, and maximum passenger car units (PCUs). TEEMP also requires physical details (lane width, lane length, number of lanes and roughness coefficient); traffic and trip details per section (average traffic volume per day, average trip distance, % share of local traffic, and trip distance for local trips); and fleet details (% breakdown of vehicles per fuel type, fuel efficiency at 50 kph, % breakdown of different vehicle fuel types by Euro standards, PCU equivalent of different vehicles, occupancy and loading factors).

332. Traffic forecasts were taken from Detailed Project Report and is shown in Table 35. The corresponding growth rates for different vehicle types are indicated in Table 36.

Table 35: Annual Average Daily Traffic (AADT) for Elenga-Hatkamrul Road

Vehicle Type	2017	2020	2025	2030	2036
2-Wheelers	860	1,017	1,352	1,808	2,576
3-Wheelers	1,643	1,999	2,773	3,846	5,694
Car	769	935	1,297	1,799	2,664
Multi-axle	416	507	703	975	1,443
Bus	6,030	7,337	10,176	14,113	20,896
2-axle	9,540	11,609	16,100	22,329	33,061

Table 36: Normal Traffic Growth Rates for Different Category of Vehicles

Period	2-Wheelers	3-Wheelers	Car	Multi-Axle	Bus	2-Axle
2017~ 2019	4.70%	7.48%	7.48%	7.48%	7.48%	7.48%
2020 ~ 2024	4.82%	7.74%	7.74%	7.74%	7.74%	7.74%
2025 ~ 2029	4.82%	7.74%	7.74%	7.74%	7.74%	7.74%
2030 ~ 2034	4.82%	7.74%	7.74%	7.74%	7.74%	7.74%
2035 ~ 2036	4.82%	7.74%	7.74%	7.74%	7.74%	7.74%

333. Input parameters as considered for all the project roads are as given in Table 37. Design period is considered to be 20 years and volume capacity saturation limit is considered based on the current traffic velocity and is considered as 2.0 for the entire project road.

Table 37: Input Parameters for TEEMP

No.	Particular	BAU	WPS
1	Lane width (m)	3.5	3.65
2	Lane length (km)	41.7	41.7
3	Number of lanes	2	4
4	Roughness (m/km)	6	2.5

No.	Particular	BAU	WPS
5	Induced Traffic		0.2
6	Start of Assessment Year	3	3
7	AADT	2017	2,036
	2-wheelers	860	2,576
	3-wheelers	1,643	5,694
	Car	769	2,664
	Multi-axle	416	1,443
	Bus	6,030	20,896
	2-axle	9,540	33,061

334. Maximum PCU for 2 and 4 lanes were considered as 36,000 and 80,000, respectively. In the absence of emission factors data for vehicles in Bangladesh, emission factors were mostly taken from the CPCB/ MoEF&CC, India (2007) Draft Report on Emission Factor Development for Indian Vehicles, The Automotive Research Association of India, and C. Reynolds et. al (2011) Climate and Health Relevant Emissions from in-use Indian three-wheelers rickshaw as presented in Table 38.

Table 38: CO₂ Emission Factors for different vehicle types

Vehicle Type	CO ₂ Emission Factor (kg/L)	
	Gasoline	Diesel
2-Wheel	1.37	
3-Wheel	2.12	2.63
Cars	2.24	2.59
Multi-axle		3.21
Bus		3.61
2-axle		3.50

335. It was assumed that the 2-wheelers and 3-wheelers have average trip distance of about 5 km in each section, whereas all other vehicles do use the entire length as average trip distance. Furthermore, 2-wheelers and 3-wheelers constitute 90% each of the total local traffic, whereas car, multi-axes, bus and 2-axes constitute 0% respectively of the total local traffic.

336. Emissions from road construction were estimated by using the emission factor for rural/urban roads, by using ADB - Carbon footprint 1 (<http://www.adb.org/documents/reports/estimating-carbon-footprints-road-projects/default.asp>), which is equivalent to 48,400 kg CO₂/km of road construction.

337. The proposed road widening and upgrading resulting to surface roughness and road capacity improvements have implications in CO₂ emissions. Improved roughness results to higher speed and lesser emissions while increase in vehicles in the new road increases emissions. These factors are further affected by traffic congestion once the volume/capacity saturation limit was reached.

338. The project road section-wise CO₂ emission intensity is provided in Table 37. The design life of road is 20 years. Total CO₂ emission at business-as-usual, project without induced traffic, and project with induced traffic were estimated as 14,257,636 tons, 6,106,116 tons, and 8,084,304 tons, respectively. CO₂ emission from construction phase was estimated at 3,087 tons.

339. Emissions from PM and NOx were likewise shown in Table 39. PM and NOx emissions are higher during with project scenario, as a result of more vehicles using the road compared to the BAU scenario.

Table 39: Output and Output Intensity of CO₂, PM and NOx

Parameters	GHG / Pollutants	Project Scenario		
		BAU	WPS (without induced traffic)	WPS (with induced traffic)
Output (tons)	CO ₂	14,257,636	6,106,116	8,084,304
	PM	1,007	1,222	1,454
	NOx	35,886	43,567	51,829
Output Intensity (tons/year)	CO ₂	712,882	305,460	404,370
	PM	50.33	61.11	72.70
	NOx	1,794.28	2,178.35	2,591.47

340. In terms of intensity, total CO₂ emissions at business-as-usual, with-project (without induced traffic) and with project (with induced traffic) scenarios were estimated at 712,882 tons/year, 305,460 tons/year and 404,370 tons/year, respectively. These values are significantly above the 100,000 tons CO₂e/year threshold¹⁹ set in ADB SPS 2009. ADB requires the borrower (the Government of Bangladesh through the Roads and Highways Department) to evaluate feasible and cost effective options to reduce or offset project related greenhouse gas emissions.

B. Climate Adaptation

1. Introduction

341. The Elenga - Hatikamrul road sub-project is mainly linked to transport engineering aspects of augmentation, rehabilitation and in majority cases new infrastructures initiatives with the primary objective to supporting national poverty reduction. This climate risk and vulnerability Adaptation (CRVA) is a crucial component where under ADB's requirements and for the purposes of subsequent project approval, the study needs to demonstrate that climate considerations have been integrated into the detailed designs of the road project.

2. Synopsis of Climate Change Risks and Vulnerabilities by Literature Review

342. The Bangladesh Climate Change Strategy Action Plan²⁰ (BCCSAP 2009) recognizes that climate change will exacerbate many of the current problems and natural hazards the country faces. It is apprehended that climate change will lead to: increasingly frequent and severe tropical cyclones, with higher wind speeds and storm surges leading to more damage in the coastal region; heavier and more erratic rainfall during the monsoon season resulting in: higher river flows, causing over-topping and breaching of embankments and widespread flooding, severe river bank erosion and increased sedimentation.

¹⁹Page 38, Appendix I, footnote 10 of SPS 2009

²⁰ A publication by Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, Sep. 2009; http://www.climatechange.org.bd/Documents/climate_change_strategy_2009.pdf

3. Climate Change Impacts and Vulnerabilities

343. The most authoritative study on climate change impacts in Bangladesh is the “Bangladesh Climate Change Impacts and Vulnerabilities²¹, (BCCIV 2006). The specific objective of the study was to prepare a synthesis for the general readership on climate change issues for Bangladesh. The modality of achieving this objective was to take note of all the important findings in published literature and put it in a form so that the product helps the readership to clearly understand the dynamics of climate change and relate it within the contexts of various relevant sectoral development initiatives. The report expects to help create awareness among the stakeholders and in near future, lead to an ‘informed decision making’ while considering development decisions in vulnerable areas and/or sectors.

344. By BCCIV 2006 study, for Bangladesh, efforts were made to develop climate change scenarios using various generic methods as under: (a) In early stages of assessing climate change impacts, and in the absence of appropriate models and modeling facilities, researchers have used ‘expert judgments’ to come up with climate scenarios; (b) With the proliferation of computer assisted Atmosphere-Ocean Global Circulation Models (AOGCM), scientifically more rigorous and acceptable scenarios have been developed in the second stage; and (c) Further with development of regional models as well as strengthening of computational capabilities, scenarios have been developed by using Regional Climate Models (RCM).

345. Under (a) above, Mahtab (1989) speculated that a general surface warming of 0.3 to 5°C would occur by the year 2050. It is also thought that rainfall would increase by 5 to 20%. For sea level rise, a range of 30 to 150 cm was assumed by the year 2050. However, Mahtab (1989) considered a median value by taking the mean of the two limits and adding 10cm for local subsidence, which provided for 100 cm ‘net sea level rise’ by the year 2050.

346. In another instance, the effects of 2°C and 4°C change in average temperature were speculated for defining ‘moderate’ and ‘severe’ climate change scenarios, respectively (BCAS-RA-Approtech, 1994). The two scenarios also speculated a rise in peak monsoon rainfall by 18 and 33%, respectively. It was anticipated that the increase in monsoon rainfall would cause an increase in river discharge during peak flow periods by 8 and 15%, respectively, for the two scenarios. The corresponding sea level rise was speculated to be 30 and 100 cm, with a corresponding rise in cyclonic intensity by 10 and 25%, respectively.

347. Further yet, Ali (1999) considered 2°C and 4°C changes in average temperature as lower and upper bound thresholds for 2010, respectively, in order to analyze impacts of climate change on cyclonic storm surge along the Bay of Bengal. The same study speculated rise in sea level by 30 and 100 cm, for the two scenarios, respectively. The base case however considered no change in sea level.

348. Under (b), and starting early 1990s, several attempts have been made to generate climate change scenarios by the use of available General Circulation Models (GCM). The earliest BUP-CEARS-CRU (1994) study reported 0.5^o C to 2.0^o C rise in temperature by the year 2030 under ‘business as usual’ scenario of IPCC. The same modeling effort estimated 10 to 15% rise in average monsoon rainfall by the year 2030. The study could not draw an inference in relation to

²¹ Bangladesh Climate Change Impacts and Vulnerabilities, A Synthesis, A .U. Ahmed, Climate Change Cell, Department of Environment, Comprehensive Disaster Management Programme, Government of the People’s Republic of Bangladesh, July 2006.

change in sea level, however it commented that both sedimentation and subsidence were likely to complicate an expected net change in sea level along the Bangladesh coast.

349. A subsequent ADB (1994) study made use of four GCMs: CSIRO9, CCC, GFDLH, and UKMOH. A host of IPCC scenarios available at that point have been considered which provided a number of scenarios. In order to avoid complications, only the IPCC IS92a and its results (modeling outputs) were summarized in the study. It was reported that, for 2010 the temperature would rise by 0.3° C and for 2070, the corresponding rise would be 1.5° C. The four models used for developing scenarios all provided different results for monsoon rainfall. The high-estimating GFDL model (GFDLH) projected 59% higher rainfall in South Asian monsoon with a corresponding withdrawal of dry season rainfall by 16%. The CCC model, however, projected an increase of monsoon rainfall by 20% and withdrawal of dry season rainfall by 6%. Both considered a doubling of CO₂ concentration in the atmosphere (therefore, time independent). A time-dependent modeling provided a medium scenario for South Asian rainfall: the monsoon rainfall was projected to increase up to 5% by 2010 and between 5 to 30% by the year 2070, while the dry season rainfall was projected to vary between -10 to +10% by the year 2070.

350. The BCCIV 2006 states that it is important to note here that the two above modeling experiments haven't tried validation of the GCM outputs for Bangladesh. This is why the area-averaged results for the South Asian domain were used in a bid to develop climate change scenarios for Bangladesh. Recognizing the fact that, the extent of monsoon rainfall diminishes as the front advances towards northwestern parts of the sub-continent, technically one may argue that South Asian domain might not have represented the country-specific rainfall conditions.

351. Under (c), major attempts to generate model-driven climate change scenarios were made under the 'Climate Change Country Studies Programme' (Ahmed et al., 1996; Asaduzzaman et al., 1997 and Huq et al., 1998). A number of GCMs have been used including Canadian Climate Centre Model (CCCM), Geophysical Fluid Dynamics Laboratory equilibrium model (GFDL), and 1% transient model of GFDL (i.e., GF01). Observed climate data were supplied by the CLIM database, as provided by National Center for Atmospheric Research (NCAR), USA. The outputs of the three GCMs for the 1990 base year were validated against long-term 'climate normal', as provided in published report (FAO-UNDP5, 1988). The downscaling of climate data for Bangladesh down from GCM scale was possible by comparing different GCM outputs. The GFDL 1% transient model represented the long-term climate normal the best and was considered for the development of time-bound climate change scenarios (Ahmed et al., 1996). Three climate change scenarios by various authors which were largely used for a number of subsequent national assessments, as given in the BCCIV 2006 report, are tabulated below.

Table 40: Climate Change Scenarios as Presented in BCCIV, 2006

2.1(A): Source: Ahmed, A.U. and Alam, M., 1998												
Year	Average Temp., °C			Temp. Increase, °C			Average Precipitation, mm/month			Precipitation Increase, mm/month		
	W	M	Av.	W	M	Av.	W	M	Av.	W	M	Av.
1990	19.9	28.7	25.7	0.0	0.0	0.0	12	418	179	0	0	0
2030	21.4	29.4	27.0	1.3	1.3	1.3	18	465	189	+6	47	10
2075	22.0	30.4	28.3	2.1	1.7	2.6	00	530	207	-12	112	28
2.1(B): Source: Agrawala et al., 2003												
	Temperature Change, °C, Mean (standard deviation)						Rainfall Change, %, Mean (standard deviation)					

	Annual	DJF	JJA	Annual	DJF	JJA
2030	1.0 (0.11)	1.1 (0.18)	0.8 (0.16)	2.3 (2.30)	-1.2 (12.56)	+4.7 (3.17)
2050	1.4 (0.16)	1.6 (0.26)	1.1 (0.23)	+5.6 (3.33)	-1.7 (18.15)	+6.8 (4.58)
2100	2.4 (0.28)	2.7 (0.46)	1.9 (0.40)	+9.7 (5.8)	-3.0 (31.6)	+11.8 (7.97)

2.1(C): Source: Adopted from the Bangladesh NAPA Document (GOB, 2005)

	Temperature Change, °C, mean			Rainfall Change, %, mean			Sea Level Rise, cm
	Annual	DJF	JJA	Annual	DJF	JJA	
2030	1.9	1.1	0.8	5	-2	6	14
2050	1.4	1.6	1.1	6	-5	8	32
2100	2.4	2.7	1.9	10	-10	12	88

4. Findings from Other Available Online Climate Change Literature on Bangladesh

352. Review of findings from other published and online available literature on climate change in Bangladesh indicate risks and vulnerabilities due to changes of temperature, rainfall, temperature and rainfall related extreme events, cyclones, floods, and sea level rise. Climate change in Bangladesh is likely to result in: **(1) higher annual precipitation and daily temperature; (2) greater temperature and rainfall extremes; (3) increased flooding, both in terms of extent and frequency; (4) increased cyclone and storm surges both in terms of extent and frequency; (5) low river flow during dry periods; and (6) sea level rise and increased salinity intrusion.**²² Similarly a working paper²³ by World Bank cites Bangladesh as one of more “potential impact hotspots” threatened by, “extreme floods, more intense tropical cyclones, rising sea levels and very high temperatures”.

Table 41: Climate Change Scenarios in Bangladesh based on Available Online Literature

Climate Change Risks	Description
Rainfall	<ul style="list-style-type: none"> • Significant increase of average annual rainfall of Bangladesh at a rate of 5.52 mm/year over the time period 1958–2007 • number of wet months is increasing and the number of dry months is decreasing both in monsoon and pre-monsoon in most parts of the country • Heavy rainfall days (>200mm) in Bangladesh have increased significantly by an amount of 1.2 days/decade.
River Water Level and Flooding	<ul style="list-style-type: none"> • While the magnitude and duration of average flood events in Dhaka have decreased or remained the same over time, the frequency of the most extreme events has increased • Flood severity has increased in Bangladesh in the recent years.
Change in Temperature	<ul style="list-style-type: none"> • An increase of mean temperature of Bangladesh by 0.097°C/decade has also been observed at 95% level of confidence in the last fifty years

²² Vulnerability of the power sector of Bangladesh to climate change and extreme weather events; Regional Environmental Change, 12(3): 595-606, Shahid, S. (2012)

²³ <http://climatechange.worldbank.org>

Climate Change Risks	Description
	<ul style="list-style-type: none"> The trends in number of hot days (maximum temperature > 30°C) and heat wave frequency (consecutive three days with maximum temperature greater than the 90th percentile) for the time period 1958-2007 increased by 1.16 days/year at 99% level of confidence.
Tropical Cyclones	<ul style="list-style-type: none"> The rate of land falling tropical storms has increased by 1.18 per year since 1950 (Islam and Peterson, 2009). Flooded area, flooding depth and surge intrusion length will be substantially larger under intensified surge conditions.
Sea Level Rise	<ul style="list-style-type: none"> It has been reported that the sea level in the coastal region of Bangladesh will increase by about a meter by 2100 (World Bank 2000). The 2007 Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) projected that global mean sea levels would rise by 18 – 59 cm above 1990 levels by the 2090s
Salinity in River Water	<ul style="list-style-type: none"> Salinity in some parts of the coastal region of Bangladesh has increased by 124% in the last 30 years Reduction in rainfall and low river flow during the dry season may aggravate the salinity levels in the coastal rivers of Bangladesh.

5. Discussions on Climate Change Risks and Adaptation Measures for the Elenga - Hatikamrul Road

353. The main climate change induced concerns on the road project will need to adequately address the following:

C. Flooding

354. With increases projected both in terms of magnitude and intensity of precipitation, the concern is that of flood discharge. Although there is the need for new design and maintenance criteria to be based on future climate projections, the projection of flood values based on global or regional climate change scenarios is a difficult task, and is shrouded with some degree of uncertainty. Further, there is the lack of long-term measurement series on precipitation and runoff in the project area and that makes statistical work and future projections challenging. Possible ways of temporarily compensating for the lack of measurement data and predicted runoff are the use of more conservative return periods, or increasing the design capacity by an additional climate factor.

355. Indeed, section 5.3.3 of the EIA [1] report of the Elenga – Hatikamrul road acknowledges concerns of climate change impacts particularly by flooding. The report states that there are chances of not only increasing of flood water levels but also reduction of flood return periods under an uncertain future climate. Weather is a complex system and so is climate change in which the prediction of absolute time and magnitude of future events cannot be envisaged with certainty. However, the EIA considers adaptation measures against flooding as described under:

1. Additional road embankment height to combat climate change induced flooding:

356. Risk can be defined in terms of the recurrence interval, or the probability of a flood of stated magnitude, being equaled or exceeded in any given year. Drainage structures are designed to accommodate a flow of a given return period or probability of occurrence. The selection of the design flood recurrence interval involves an evaluation of the risk of disruption or damage to the road, possible loss of life, property damage, interruption of traffic, and the economic consequences.

357. The EIA [1] states that roads in Bangladesh are designed for 20 year recurrence period, which by the CRVA finds it to be low particularly when the EIA report admits to reduction of return periods under a changed future climate. However, as a safeguard, the EIA report suggests that additional height should be applied over the design road height of 20 year return period (i.e. existing height). Thus the design of the road embankment considers an additional 102.4 cm from the existing road surface. The embankment design envisages a 37 cm rise in flood level under a changed future climate and together with allowances for freeboard and other additional components makes to 102.4 cm.

2. Additional Freeboard for Bridges to combat climate change induced flooding:

358. The EIA reports that there are 15 bridges and 27 culverts along the Elenga - Hatikamrul road alignment. One of the bridges is over 100m in length and is located on the Fuljor River. The rest of the structures are mostly across undefined channels and carry only seasonal flow. Most bridges are located over depressions and low lying ditches. Culverts are also located in depressions and at low lying agricultural land and operate merely as balancing structures, equalizing water levels on either side of the road embankment.

359. Bridge designs are commonly based on a criterion to withstand the n-year flood event. For example, a highway bridge might be designed to pass the 100-year flood. Failure may occur if the structure faces an event larger than this. Climate change may necessitate different design criteria because of changes to flood frequency behavior.

360. As an adaptation measure presented in the EIA report, the design of bridges in the project area advocates a 37 cm increase from existing levels in line with the envisaged increase in flood level under a changed future climate. The bridges in the proposed roads are designed for 1 in 50 year return period. The climate change adaptation concept for bridges in the project area takes the bridge design to protect against a 1 in 50 year flood (i.e. 2% chance of occurrence of a 50-year flood magnitude in any given year), with an additional a 37 cm allowance for climate change.

3. Run-off and necessary drainage capacity

361. Higher precipitation intensity increases the risk of floods that exceed the capacity of the drainage infrastructure serving the road system. In Bangladesh where cyclonic storms are an annual occurrence and whose frequency has been observed to be on the rise, this will further aggravate the risk. This is an important safety issue that should be considered when discussing the capacity of drainage systems.

362. In line with the climate change literature summarized in Section 2 of this report, Section 5.3.4 of the EIA [1] report acknowledges that inflows from the three major rivers Ganges,

Brahmaputra and Meghna into Bangladesh are on average projected to increase over the monsoon period (driven primarily by increased basin precipitation). As a result of these increased discharges, the drainage structures throughout the roads have to drain much more water under climate change scenario.

363. The EIA report states that the present Elenga – Hatikamrul road has no longitudinal drainage system and the existing cross-drainages are inadequate in terms of discharge capacity. The report estimates that the road area will need to drain about 20% additional discharge due to climate change induced by higher rainfall during extreme events. As an adaptation measure, the proposed road will incorporate longitudinal drains along the total highway length, increase the number of cross drainages per unit distance and replace existing pipe culverts with box culverts that provide larger discharge openings.

4. Engineering Improvement in Road Design

364. Technological improvement is an option to address the emerging requirements linked to changes in climate. This is happening not only in the field of construction materials, aiming at providing a wider climate range of application, but also in the design of innovative structures for the operation of transport infrastructure.

365. Increased precipitation will lead to local elevation of groundwater levels. This, in addition to more infiltration into the road structure from above, will increase water content in the road sub-grade. This will lead to rutting of asphalt pavements (as is the case with higher temperature extremes) as a result of faster deterioration of materials in the road sub-base. The sub-base is meant to act as a drainage layer between the sub-grade and road base by preventing the sub-grade from wetting up to the road base. The design of the Elenga – Hatikamrul road envisage to improve the sub-base as an effective drainage layer, by, in terms of quality of granular material required at that layer to barricade the upwards movement of moisture and lessening the deterioration of the road base.

5. Adaptation to High Temperature

366. It is well known that rutting is one of the main distresses in the asphalt pavements under the action of heavy traffic and high road surface temperatures, followed by cracking under the action of UV radiation. By literature cited in Section 2.2.3, climate models estimate a steady increase in temperature for Bangladesh and predict an average increase of temperature of 1.4°C in 2050 and 2.4°C in 2100. The trends in number of hot days (maximum temperature > 30°C) and heat wave frequency (consecutive three days with maximum temperature greater than the 90th percentile) for the time period 1958-2007 increased by 1.16 days/year at 99% level of confidence.

367. Paragraph 108 (page 34) of the EIA report presents an average monthly maximum and minimum temperature from a representative station for data years 1991 - 2012. However, many practical problems require knowledge of the behavior of extreme values as the infrastructures we depend upon for food, water, energy, shelter and transportation are sensitive to changes in climate extremes rather than averages. By the EIA report the highest recorded temperature is stated to be 37.5°C during the period 1991-2012.

368. The pavement binder bitumen is an essential component of any road pavement and is used widely throughout Bangladesh. General literature on bitumen suggests that road pavement made from viscosity grade (VG) bitumen will have better performance, because the viscosity value measured at 60°C correlates well with rutting behavior and viscosity value at 135°C gives

sufficient idea about the mixing and compaction temperature and as a result pavement life is improved. IS 73:2013²⁴ classifies four grades of bitumen based on viscosity at 60°C, and recommends applicability for maximum air temperature as given below:

Grade	Grade Suitable for 7-day Average Maximum Air Temperature, °C
VG10 (80/100)	< 30
VG20	30-38
VG30 (60/70)	38-45
VG40 (30/40)	>45
<i>NOTE — This is the 7 day average maximum air temperature for a period not less than 5 years from the start of the design period.</i>	

6. Climate Change Adaptation Costs for the Elenga - Hatikamrul Road

369. Since there are enough evidences that climate change will modify actual risk levels and therefore challenge design guidelines and procedures for the operation and maintenance of the road infrastructure, a budget of \$9.79 million was allocated for engineering measures as climate change adaptation costs. These cover increase in road embankment height by 37 cm for 33.4 km length of the Elenga-Hatikamrul road; increase in bridge height by 37 cm for 15 bridges with a total length 809 meters; addition of new box culverts and replacing pipe culverts with box culverts; installation of longitudinal drainage system to quickly drain out the water for heavy rainfall; and improvement of subgrade as drainage layer to lessen the deterioration of the road base.

²⁴ Bureau of Indian Standard (BIS, 2013); (Note: Literature on Bangladesh Standards for Bitumen could not be traced.)

VII. ENVIRONMENTAL MANAGEMENT PLAN

A. General

370. This section contains comprehensive Environmental Management Plan (EMP) for the Elenga - Hatikamrul Road project. As described in Environmental Safeguards policy principle, EMP includes the proposed mitigation measures, environmental monitoring and reporting requirements, related institutional or organizational arrangements, capacity development and training measures, implementation schedule, cost estimates and performance indicators.²⁵ The EMP for the Elenga - Hatikamrul Road describes the activities, the proposed mitigating measures, the monitoring indicators, performance targets, location, and the institutional responsibilities for implementation and supervision of proposed mitigating measures. This EMP will be included as an integral part of the environmental safeguard requirements in the bid documents.

B. EMP Objective

371. The main objective of EMP formulation is to ensure environmental sustainability of project and to integrate environmental considerations in all aspects of road civil works. EMP recommends a set of environmental safeguard measures to address adverse environmental and social impacts of the project. Moreover, performance indicators as well as performance targets are incorporated to lessen ambiguity in monitoring. The EMP also has assigned implementation and supervision responsibilities to mitigate potential impacts. All mechanisms are put in place to ensure compliance with EMP requirements and environmental regulations of Bangladesh.

372. The EMP is necessary to manage the environment by offsetting the negative impacts with recommended mitigation measures and enhancing the positive impacts, within the allocated budget for the project. Thus, EMP for the implementation of Elenga - Hatikamrul Road project will:

- i. Define the responsibilities of the project proponents during design pre-construction, construction and operation;
- ii. Facilitate the implementation of the mitigation measures by providing the technical details of each project impact, and proposing an implementation schedule for the proposed mitigation measures;
- iii. Define a monitoring mechanism and identify monitoring parameters to ensure that all proposed mitigation measures are completely and effectively implemented;
- iv. Identify training requirements at various levels and provide a plan for the implementation of training sessions;
- v. Identify the resources required to implement the EMP and outline corresponding financing arrangements; and
- vi. Provide a cost estimate for all proposed EMP actions.

²⁵ Safeguards Policy Statement 2009, page 16.

Table 42: Environmental Management Plan

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
IMPLEMENTATION PHASE: DESIGN/PRE-CONSTRUCTION								
P01 _{EMP}	Provision of Early Training	Awareness on environmental protection aspects relevant to good construction practices to avoid or lessen potential environmental impacts of construction activities	<ul style="list-style-type: none"> RHD to provide training as part of the overall awareness and training program to be delivered before construction. 	<ul style="list-style-type: none"> Proof of completion. Posting of proof of completion at worksites 	Safeguard Compliance Orientation	Location to be confirmed	RHD	RHD
P02 _{EMP}	Removal of Trees	Cutting of 31,450 trees of different species.	<ul style="list-style-type: none"> Minimize tree cutting by selecting road widening options based on technical and legal considerations. Secure permit from Forestry Department prior to tree cutting / removal Afforestation of tree saplings at ratio of 1:2 For social forestry afforestation, ratio shall be as per the consultation with tree owner. Raised median will be planted with grasses and shrubs which may not attain height of more than two meters.; Compact plantation will be done on both sides; In consultation with Forestry Department, only indigenous 	<ul style="list-style-type: none"> No. of trees cut and planted 75% survival of trees No. of IEC campaigns conducted 	Compliance with national guidelines	Throughout the project area	Design Consultants (DC)	RHD

²⁶ P – Pre-construction; C – Construction; O - Operation

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			<p>trees most suited to the tract will be planted;</p> <ul style="list-style-type: none"> Conduct information, education and communication (IEC) campaign on importance of planting trees. 					
P03 _{EMP}	Climate Change	<ul style="list-style-type: none"> Changes in climate and long term impacts on the environment 	<ul style="list-style-type: none"> Consider potential impacts from extreme climate change scenario in designing bridge and culverts. 	<ul style="list-style-type: none"> Consideration of climate change in project design 	Compliance with National guideline	Throughout the project area	Design Consultant (DC)	RHD
P04 _{EMP}	Topography	<ul style="list-style-type: none"> Change in topography due to construction-related structures such as bridges, flyovers, and footbridges; and Visual changes to topography. 	<ul style="list-style-type: none"> Implementation of tree planting program to reduce erosion due to change in topography 	<ul style="list-style-type: none"> Transport route and worksite cleared of any dust/mud 	Compliance with National guideline for land use policy.	Throughout the project areas and other suitable land identified by RHD	Design Consultant (DC)	RHD
P05 _{EMP}	Land Acquisition	<p>Acquisition of 8.87 ha of land, 5.47 ha of which is agricultural land;</p> <p>Resettlement of Affected Persons (APs).</p>	<ul style="list-style-type: none"> Careful alignment and route selection to minimize resettlement; Develop compensation package for APs based on Land Acquisition and Resettlement Plan Entitlement Matrix 	<ul style="list-style-type: none"> Land substitution Cash compensation of properties acquired. 	Compliance with RP	Throughout the project areas	Design Consultant (DC)	RHD
P06 _{EMP}	Loss of residential, commercial and industrial structures	<ul style="list-style-type: none"> A total of 181,083 square feet of primary structures will be affected²⁷ 	<ul style="list-style-type: none"> Compensation for the loss of land, house, trees, structures, crops, wage/income to be included in the Resettlement Plan. 	<ul style="list-style-type: none"> Number of grievances related to resettlement Number of complaints 	Compliance with RP	Throughout the project area	Design Consultant (DC)	RHD

²⁷ Structures used for residential (bed room, kitchen, store room, etc.) and commercial purposes or community interest (EIA, page 67)

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			<ul style="list-style-type: none"> In case of relocation provision of similar or better living conditions for project affected persons (PAPs). 	from sensitive receptors				
P07 _{EMP}	Civil work activities near educational, institutional, religious and other sensitive receptors	<ul style="list-style-type: none"> Disturbance and other physical inconvenience on the people utilizing the structures 	<ul style="list-style-type: none"> Dialogue with the institutions on the schedule of construction works Implement national guidelines on chance find procedures 	<ul style="list-style-type: none"> Number of meetings with institution heads on details of construction works Records of chance finds Provision of temporary access 	Compliance with RP	Throughout the project area	Design Consultant (DC)	RHD
P08 _{EMP}	Damage to Public Utilities	<ul style="list-style-type: none"> Disruption of services 	<ul style="list-style-type: none"> Provision in the design and budget for the relocation of the existing utility infrastructures, wherever required; All public utilities (e.g. water/gas pipes, power/telephone lines, mobile tower likely to be affected by the proposed project road expansion will be relocated before construction work. Inform all hospitals, schools, places of worship, and affected communities well in advance; Secure approval from agencies on removal of utilities; Repair of damaged utilities at contractor's expense. 	<ul style="list-style-type: none"> Number of complaints from sensitive receptors Number of electric poles relocated; Temporary power supply Number of approval to relocate or remove utilities 	Compliance with RP and emergency response plan	Throughout the project areas	Utility service providers	RHD

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			<ul style="list-style-type: none"> Reconnect utilities at shortest practicable time before construction commences. It is necessary to separate the live parts and insulating material from underground water pipes/gas pipes. To prevent short circuit fires, electric fire alarms (short circuit fire alarms) should be installed in the necessary locations. 					
IMPLEMENTATION PHASE: CONSTRUCTION								
C01 _{EMP}	Changes to hydrologic regime	<ul style="list-style-type: none"> Temporary blockage of drainage in small bridges, culverts, service areas, and construction sites Increased flood risk from rapid and higher levels of runoff 	<ul style="list-style-type: none"> Provision of high capacity drains; Non-disposal of wastes in body of water 	<ul style="list-style-type: none"> Designs of both Cross and side drains; Number of culverts; Number and size of pipes 	Compliance with Design Report	Bridge and culvert sites	Contractor	RHD/Supervision Consultants (SC)
C02 _{EMP}	Drainage changes	<ul style="list-style-type: none"> Drainage congestion due to waste / sediment disposal and construction of road embankment; Erosion and subsequent deposition in the 	<ul style="list-style-type: none"> Regular cleaning of channels to avoid choking. Provision of adequate cross drainage structures to easily drain off water to canals and other lowland areas; Ensure that storm water drains and highway drainage systems are periodically cleared to maintain storm water flows during construction. 	<ul style="list-style-type: none"> Designs of both cross and side drains; Number of culverts; Number and size of pipes 	Compliance with Design Report	Drainage structure sites	Contractor	RHD / Supervision Consultants (SC)

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
		adjacent crop fields.	<ul style="list-style-type: none"> • Clear mark-up of all irrigation canals along the alignment to prevent accidental dumping of fill materials into these canals. 					
C03 _{EMP}	Soil Erosion and Siltation	<ul style="list-style-type: none"> • Soil erosion due to construction activities, earthworks, cut and fill operations and from stockpiles 	<ul style="list-style-type: none"> • Adopt good construction practices. • Replanting with native varieties of trees and shrubs • Construction schedule for bridges during dry season. • Turfing of embankments to protect slopes. • Earth stockpiles to be provided with gentle slopes • Vegetate road embankments and road cuttings with fast growing crop and a native seed mix immediately after fill placement to prevent scour and to encourage stabilization. • Use riprap at appropriate places especially around overpasses, bridges, culverts. 	<ul style="list-style-type: none"> • Receipt of complaint regarding sediment loss or water turbidity. • Bridge locations; • Retaining walls • Number of any non-compliance reports 	<ul style="list-style-type: none"> • Compliance with National /International guideline limits for soil quality 	Full length of the road alignment	Contractor	RHD / Supervision Consultants (SC)
C04 _{EMP}	Soil Compaction and Contamination	<ul style="list-style-type: none"> • Compaction of soil due to movement of vehicles and equipment's • Contamination of soil due to leakage/spillage of oil, bituminous and non-bituminous debris 	<ul style="list-style-type: none"> • Construction vehicles, machinery, and equipment to be stationed in the designated ROW to avoid compaction. • Haul roads to be designated along the fallow and consolidated soil areas to reduce compaction of arable land. • Fuel storage and filling to be undertaken in areas with concrete surfacing, bunds and interceptor traps 	<ul style="list-style-type: none"> • Number of any non-compliance reports • Maintenance of temporary passages; 	<ul style="list-style-type: none"> • Compliance with National /International guideline 	Construction sites along the full length of the project	Contractor	RHD/ Supervision Consultants (SC)

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			<ul style="list-style-type: none"> Oil interceptors to be provided at wash down and refuelling sites Oil and grease spill and oil-soaked materials shall be sold off to authorized recyclers. 		limits for soil quality			
C05 _{EMP}	Topsoil removal	<ul style="list-style-type: none"> Removal of top soil for construction from outside the RoW. Compaction of topsoil. Loss of top soil by wind and water erosion. Covering of top soil by project works. 	<ul style="list-style-type: none"> The stockpile top surface slope to be no steeper than 2 (H):1 (V) to reduce surface runoff and enhance percolation through the mass of stored soil. Locate topsoil stockpiles outside drainage lines and protect stockpiles from erosion. Construct diversion channels and silt fences around the topsoil stockpiles to prevent erosion and loss of topsoil. Use stripped topsoil only to cover all disturbed areas and along the proposed tree plantation sites. Rip ground surface prior to the spreading of topsoil. Limit equipment and vehicular movements to within the approved construction zone. Remove unwanted materials from topsoil such as roots of trees, rubble and waste etc. 	<ul style="list-style-type: none"> Number of non-compliances observed/ reported 	<ul style="list-style-type: none"> Compliance with National /International guideline limits for soil quality 	Various construction sites throughout the road alignment	Contractor	RHD/ Supervision Consultants (SC)
C06 _{EMP}	Air Quality	<ul style="list-style-type: none"> Dust Generation due to construction activities and transport of construction materials. 	<ul style="list-style-type: none"> Vehicles transporting construction material to be covered; Construction equipment to be maintained to a good standard and idling of engines discouraged. 	<ul style="list-style-type: none"> Location of stockpiles; Number of complaints from sensitive receptors; 	<ul style="list-style-type: none"> Compliance with DoE and National guideline limits for 	Construction sites along the full length of the project	Contractor	RHD/ Supervision Consultants (SC) / Department of Environment

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
		<ul style="list-style-type: none"> Emissions from vehicles, equipment and machinery. 	<ul style="list-style-type: none"> Machinery emitting visible smoke to be banned from construction sites; Contractor to prepare a dust suppression program detailing action to be taken to minimize dust generation (e.g. spraying of roads with water), and the equipment to be used. Equipping asphalt hot mix and batching plants with fabric filters or wet scrubbers to reduce dust emissions; Locate asphalt and crushing plants away from residential areas and social infrastructure such as mosques, schools and madrasas. Clearance should be at least 500 m and consider the prevailing wind direction Dust masks to be provided to workers where dust hazards exist. Proper dust collection and control systems to be installed at crushers Air quality monitoring to be carried out as per the schedule in the environmental monitoring plan. 	<ul style="list-style-type: none"> Heavy equipment and machinery with air pollution control devices; Levels of SO_x, NO_x, CO, PM₁₀, PM_{2.5}, 	<ul style="list-style-type: none"> Air at sensitive receptors. Certification that vehicles are compliant with air quality standards. 			
C07 _{EMP}	Noise and Vibration	<ul style="list-style-type: none"> Noise from construction vehicles, equipment and machinery. 	<ul style="list-style-type: none"> Use of modern plant and equipment with appropriate muffling devices. All powered mechanical equipment and machinery to be fitted with noise abating gear 	<ul style="list-style-type: none"> Number of complaints from sensitive receptors; 	<ul style="list-style-type: none"> Equivalent day and night time 	Construction sites along the full length of the project	Contractor	RHD/ Supervision Consultants (SC) / Department

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
		<ul style="list-style-type: none"> Vibration caused by construction activities. 	<ul style="list-style-type: none"> such as mufflers for effective noise control, in compliance with DoE regulations. Construction operations to be restricted to 0700 to 1800 hours. Locate rock crushing, concrete mixing and material shipment yards away from residential areas, schools, colleges and hospitals. Install temporary noise barriers near sensitive locations such as schools, religious places and hospitals Providing the construction workers with suitable hearing protection like ear cap, or earmuffs etc. In areas, where structures may to be affected by vibrations from construction activities, take precautions to minimize the vibration and the resulting impact. Noise quality monitoring to be carried out as per the schedule in the environmental monitoring plan. 	<ul style="list-style-type: none"> Noise measurement data Use of silencers in noise-producing equipment and sound barriers; 	<ul style="list-style-type: none"> noise levels Compliance with DoE and National guideline limits for sensitive receptors. 			of Environment
C08 _{EMP}	Changes to Topography and Landscape	<ul style="list-style-type: none"> Land degradation due to careless excavation from borrow area 	<ul style="list-style-type: none"> Borrow pits to be opened within the road right of way and not on agricultural land Top soil to be preserved. Borrow pits to be rehabilitated. Borrow pits opened on private land, to be either closed or converted to ponds at the 	<ul style="list-style-type: none"> Worksite clear of hazardous wastes such as oil/fuel Worksite clear of any wastes, 	<ul style="list-style-type: none"> Compliance with National guideline for land use policy. 	Borrow areas	Contractor	RHD/ Supervision Consultants (SC)

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			<p>completion of work as per the written direction of the landowner.</p> <ul style="list-style-type: none"> • Construction wastes to be used in construction activities. 	<p>collected materials from drainages, unutilized materials and debris</p> <ul style="list-style-type: none"> • Transport route and worksite cleared of any dust/mud 	<ul style="list-style-type: none"> • Compliance with • Waste management plan 			
C09 _{EMP}	Siting of Construction Camps, Workshops and Processing Facilities	<ul style="list-style-type: none"> • Loss of plantation and vegetation. • Permanent physical and visual impact on the area. • Social disturbance for nearby community 	<ul style="list-style-type: none"> • Construction camps and workshops to be located away from sensitive areas and not within 500 metres of existing settlements. • Briefing and/or on-site training for the contractor's workers on the environmental requirement of the project and the implementation of mitigation measures. • Minimise vegetation loss while making site arrangements for construction camps and other facilities; • Crushing plants, sites for borrow pits, asphalt hot mix and batching plants to be located clear of environmentally sensitive areas, productive land or existing settlements; 	<ul style="list-style-type: none"> • Worksite clear of hazardous wastes such as oil/fuel • Worksite clear of any wastes, collected materials from drainages, unutilized materials and debris • Transport route and worksite cleared of any dust/mud 	<ul style="list-style-type: none"> • Compliance with • Waste management plan 	Construction camps, workshops and labour camps	Contractor	RHD/Supervision Consultants (SC)

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			<ul style="list-style-type: none"> Construct construction material storage areas away from sensitive areas; Water and good sanitation facilities to be provided for the camps; Solid waste must not be dumped, buried or burned at or near the project site, but shall be disposed of at the nearest sanitary landfill or site having and complying with the necessary permits. The sites for camps and associated facilities shall be rehabilitated after completion of the project. 					
C10 _{EMP}	Surface Water Bodies	<ul style="list-style-type: none"> Loss of surface water bodies and impact on fish 	<ul style="list-style-type: none"> No bituminous or hazardous materials to be used for filling of water bodies. 	No visible degradation to nearby drainages, khals or water bodies due to construction activities	<ul style="list-style-type: none"> Effectiveness of water management measures 	All water bodies likely to be affected along the project road	Contract or	RHD/ Supervision Consultants (SC)
C11 _{EMP}	Surface Water Quality	<ul style="list-style-type: none"> Contamination of surface water by disposal of construction waste. Pollution of domestic water supplies 	<ul style="list-style-type: none"> The workforce to be trained in proper means for storage and handling of materials and chemicals; Work camps and work sites to be provided with toilets and septic tanks; Proper drainage system with sedimentation ponds and oil separators to be provided to 	Areas for stockpiles, storage of fuels and lubricants and waste materials; Number of silt traps installed along trenches leading to water bodies	Compliance with National guideline limits for Surface water.	Construction sites along the full length of the project particularly beel / lowland / pond /	Contract or	RHD/ Supervision Consultants (SC) / Department of Environment

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			<p>cope with the rain water and oil spills.</p> <ul style="list-style-type: none"> Measures to be implemented to control oil spills near water channels Washing of machinery and vehicles in surface waters to be prohibited. Sealed washing areas shall be provided and wastewater shall be collected in a sedimentation/retention pond for treatment prior to release. Avoid or minimize damage to water channels; Conduct regular water quality monitoring based on set schedule; Prevent construction debris from entering drainage or irrigation canals; Construction work close to ponds or other water bodies to be minimised especially during monsoon season; Wastes to be collected, stored and taken to approved disposal sites. 	Records of surface water quality inspection Levels of pH, TOC, PO ₄ , TSS, DO, oil and grease		ditch areas		
C12 _{EMP}	Groundwater Quality	<ul style="list-style-type: none"> Contamination of underground water table from leachate of construction waste. 	<ul style="list-style-type: none"> Arrangements for safe drinking water to be made prior to start of work. Water for consumption to be supplied only after adequate analysis and requisite treatment. Train workers on the need for judicious use of freshwater resources. 	<ul style="list-style-type: none"> No breaches of Material Safety Data Sheet (MSDS) for hazardous substances. Levels of pH, CaCO₃, Cl⁻, 	<ul style="list-style-type: none"> Compliance with National guideline limits for Ground water. 	Construction sites along the full length of the project	Contractor	RHD/ Supervision Consultants (SC) / Department of Environment

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			<ul style="list-style-type: none"> Water reserves to be protected from contamination such as construction and oily waste. 	Mn, As, Fe, total coliform, fecal coliform				
C13 _{EMP}	Waste Pollution	<ul style="list-style-type: none"> Unhygienic conditions, health risks to workforce and general public at the camp site. 	<ul style="list-style-type: none"> Solid and liquid wastes to be disposed at designated sites and no waste to be disposed in productive agricultural land; Hazardous waste to be transported to nearby incineration facility; Sanitary wastes generating from staff and labour camps to be disposed of in an environmentally friendly manner, i.e. provision of septic tank etc. for toilet wastes; Pavement materials from the existing road to be incorporated in the upgrading works. 	<ul style="list-style-type: none"> Number of non-compliances observed/ reported 	<ul style="list-style-type: none"> Compliance with Waste management plan and national guidelines on management of wastes 	Construction sites along the full length of the project, and vehicle maintenance and refueling areas.	Contractor	RHD/ Supervision Consultants (SC) / Department of Environment
C14 _{EMP}	Dredging and Dredged Materials	<ul style="list-style-type: none"> River bank erosion and higher flood risk and pollution due to spilling/seepage of oil in the river. Increase in sedimentation and dispersion of pollutants in dredged material 	<ul style="list-style-type: none"> Permits/NOC to be obtained, from relevant authority such as BIWTA prior to extraction Work not to be carried out when fish are likely to be spawning or in the period between spawning and the subsequent emergence of juvenile fish (July to September). While dredging, special care to be given to prevent any spillage/seepage of oil from the dredging machines; If owners of the ponds and lands near the road alignment want to use their area for fisheries 	<ul style="list-style-type: none"> Results of dredged materials quality analysis 	<ul style="list-style-type: none"> Compliance with National / International guideline limits for dredged materials. 	Dredging sites	Contractor	RHD/ Supervision Consultants (SC)

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			<p>project, the contractor may collect filling materials from that area through proper contract and dredging guidelines.</p> <ul style="list-style-type: none"> Dredged material from the river bank to be tested for presence of heavy metals and other pollutants before its use. 					
C15 _{EMP}	Flora	<ul style="list-style-type: none"> Loss of habitat due to tree cutting Vegetation loss due to site preparation and construction activities 	<ul style="list-style-type: none"> Trees suited to the tract to be planted; Flowering and fruiting shrubs to be planted along the RoWs to enhance the landscape; Contractor's personnel to be directed not to damage any vegetation such as trees or bushes. Construction vehicles, equipment and machinery to be limited to their designated areas of movement. Gas cylinders to be used for fuel at the camps for cooking purposes. Cutting of trees/bushes for fuel not to be allowed. Camp sites and asphalt plants to be established on waste/barren land rather than on forested or agriculturally productive land. 	<ul style="list-style-type: none"> Number of complaints from sensitive receptors on disturbance of vegetation. Illegal felling of trees PMO and PIU to report in writing the number of trees cut and planted if tree-cutting will be required 	<ul style="list-style-type: none"> Compliance with Tree management plan 	Construction sites along the full length of the project	Contractor	RHD/ Supervision Consultants (SC) / Forestry Department
C16 _{EMP}	Wildlife	<ul style="list-style-type: none"> Hunting of wildlife and birds during construction. 	<ul style="list-style-type: none"> Wildlife Department to check and confirm that no hunting occurs; New and good condition machinery with low noise generation characteristics to be used in construction; 	<ul style="list-style-type: none"> Number of complaints from sensitive receptors on disturbance of poaching. 	<ul style="list-style-type: none"> Compliance with National /International 	Along the road alignment and bus depot	Contractor	RHD/ Supervision Consultants (SC) / Department

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			<ul style="list-style-type: none"> Construction work not to be carried out at night. Borrow pits to be fenced to protect animals. 	<ul style="list-style-type: none"> Illegal hunting 	guideline for wildlife			of Environment
C17 _{EMP}	Fisheries	<ul style="list-style-type: none"> Impact on fishing activity (production, spawning and breeding grounds) Disturbance to aquatic life including migration of fish due to bridge construction. 	<ul style="list-style-type: none"> Construction not to be undertaken during high flood. Construction along the riverbanks must be avoided during the fish breeding season (July to September). Deep water channel to be maintained during bridge construction. 	<ul style="list-style-type: none"> Number of complaints from sensitive receptors on disturbance of fishing; Any evidence of fish mortality. 	Compliance with National/International guideline	Throughout the road corridor particularly in pond / ditch / river areas	Contractor	RHD/ Supervision Consultants (SC)
C18 _{EMP}	Land use	<ul style="list-style-type: none"> Land disputes, soil erosion, loss of potential cropland and vegetation, landscape degradation, and damage to road embankments. Land use change due to borrowing of earth. Land use change and loss of productive top soil. 	<ul style="list-style-type: none"> Agricultural areas not to be used as borrow areas. Land acquisition for borrow areas to be minimized. River sand to be used for embankment. Preference shall be given to borrow earth from right of way wherever feasible; Necessary permits to be obtained for any borrow pits from the competent authorities and all environmental considerations to be ensured; Topsoil from borrow areas to be preserved and borrow pits to be rehabilitated after completion of borrow operations ; Borrow pits to be sited on waste land and at least 500 m away from the road; 	<ul style="list-style-type: none"> Number of complaints from sensitive receptors; Records of sources of materials 	Compliance with National/International guideline	Construction sites along the full length of	DC, Contractor	RHD/ Supervision Consultants (SC)

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			<ul style="list-style-type: none"> • Priority to be given to borrowing from humps (including from digging of wells) above the general ground level; • Priority should be given to the borrowing by excavating/enlarging existing borrow areas; 					
C19 _{EMP}	Vehicle traffic	<ul style="list-style-type: none"> • Traffic jams causing inconvenience to the people 	<ul style="list-style-type: none"> • Provision to be made for passing traffic during construction • Traffic management shall be undertaken in coordination with the local traffic police department. 	<ul style="list-style-type: none"> • Traffic route during construction works including number of permanent signage, barricades and flagmen on worksite as per Traffic Management Plan; • Number of complaints from sensitive receptors; • Number of signages placed at project location; • Number of walkways, signage, and metal sheets placed at project location 	Compliance with Traffic management plan	Construction sites along the full length of corridor	Contractor	RHD/Supervision Consultants (SC)

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
C20 _{EMP}	Cultural Sites	<ul style="list-style-type: none"> Noise and dust pollution and movement of the people to the nearby schools, colleges, mosques, and graveyards etc. 	<ul style="list-style-type: none"> Timely completion of the construction work and provision for movement through or around the construction site; Workshops and storage / processing facilities and labour camp to be sited to maintain proper clearances from the cultural sites. 	<ul style="list-style-type: none"> No complaints from sensitive receptors 	<ul style="list-style-type: none"> Compliance with National guideline limits for Noise and dust. 	Along the project corridor	Contractor	RHD/ Supervision Consultants (SC)
C21 _{EMP}	Income and Employment	<ul style="list-style-type: none"> Income loss due to the loss of agricultural lands, private structures and common property resources and rehabilitation of the households. 	<ul style="list-style-type: none"> Contractor as far as practicable to recruit construction workers from amongst the locals and to maintain gender equity while employing the locals. Priority shall always be given to people from amongst the project affected persons, the unemployed and lower income groups. Set aside-areas within the contractor's camps/labour shed for local people to sell their products and to provide additional services to the workers. 	<ul style="list-style-type: none"> Employment records 	<ul style="list-style-type: none"> Compliance to Bangladesh Labor Law of 2006 and other applicable standards 	Along the road alignment	Contractor	RHD/ Supervision Consultants (SC)
C22 _{EMP}	Occupational Health and Safety of Workers	<ul style="list-style-type: none"> Health risks due to unsafe working conditions 	<ul style="list-style-type: none"> Worker's compensation insurance to be taken out for all project staff; Basic medical training to be given to specified work staff Basic medical service and supplies to be made available for workers; Appropriate personal protective equipment (hearing protection, safety glasses, helmets, 	<ul style="list-style-type: none"> Equipped first-aid stations Medical insurance coverage for workers Number of accidents Records of supply of 	Compliance to emergency response plan	Construction sites along the full length of the project	Contractor	RHD/ Supervision Consultants (SC)

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			<p>protective footwear and gloves, high visibility vests and other protective clothing) to be provided to all workers;</p> <ul style="list-style-type: none"> • Provision of adequate sanitation, washing, cooking and dormitory facilities including lighting; • Adequate signage, lighting, barriers, yellow tape and persons with flags during construction to manage traffic at construction sites, haulage and access roads. • Application of preventive and protective measures consistent with international good practices such as the World Bank Group’s Environment, Health and Safety Guidelines. 	<p>uncontaminated water</p> <ul style="list-style-type: none"> • Condition of eating areas of workers • Use of personal protective equipment % of moving equipment outfitted with audible back-up alarms • Permanent sign boards for hazardous areas • Signage for storage and disposal areas • Condition of sanitation facilities for workers. • Record of H&S orientation trainings 				
C23 _{EMP}	Health and Safety of community	<ul style="list-style-type: none"> • Health and safety risks due presence of construction camp and ongoing construction activities. 	<ul style="list-style-type: none"> • Barriers (e.g., temporary fence) to be installed at construction areas to deter pedestrian access to the roadway except at designated crossing points. • The workers with different transmittable diseases should be restricted to the construction site 	<ul style="list-style-type: none"> • Number of accidents; • Number of permanent signage, barricades and flagmen on worksite as per Traffic 	Compliance to emergency response plan	Construction sites along the full length of the project	Contractor	RHD/Supervision Consultants (SC)

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			<p>and sent for treatment or replaced as an urgent measure.</p> <ul style="list-style-type: none"> Local residents will not be allowed in high-risk areas, e.g., excavation sites and areas where heavy equipment is in operation and such sites will have a watchman to keep public out. Drivers operating construction vehicles to be trained in road safety awareness; Provision of proper safety and diversion signage. Crossing provision to be made for pedestrians and vehicles near settlements. Use of water not to disturb water availability for the public. Close consultation with local communities to maintain community integrity and social links and avoid conflict situations with respect to resource use. RHD to Prepare and implement plan for avoiding spread of STDs. To prevent short circuit fires, electric fire alarms (short circuit fire alarms) should be installed in the necessary locations. Separate the live parts and insulating material from underground water pipes/gas pipes. 	<p>Management Plan</p> <ul style="list-style-type: none"> Number of complaints from sensitive receptors; Number of walkways, signage, and metal sheets placed at project location Permanent sign boards for hazardous areas Agreement between landowner and contractors in case of using private lands as work camps, storage areas, etc. 				
IMPLEMENTATION PHASE: OPERATION								

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
O01 _{EMP}	Soil	<ul style="list-style-type: none"> Erosion due to damage of embankment and during transportation of sand by sand miners along river Soil contamination due to accidental spillage from vehicular movement. 	<ul style="list-style-type: none"> Turfing of embankment shall be maintained. Surveillance to protect the embankment from unauthorized accesses. Proper measures must be ensured to prevent any oil spillage and leakage from the locomotives. Efforts will be made to clean the spills of oil, toxic chemicals etc. as early as possible. 	No complaints from sensitive receptors	Compliance with National / International guideline limits for soil	Along the road alignment particularly at erosion prone area	RHD	RHD
O02 _{EMP}	Noise and Vibration	The noise levels are anticipated to increase due to traffic related noise pollution; vibrations from engines and tires and mainly use of pressure horns.	<ul style="list-style-type: none"> Based on monitoring results, additional sound barriers in form of trees and hedges will be discussed with the affected people and planted if agreed; Signs for sensitive zones (health centres / educational institutions etc.) to disallow the use of pressure horns; Enforcement and penalties against traffic rules violators; Monitoring to protect the trees. 	<ul style="list-style-type: none"> No complaints from sensitive receptors Levels of noise and vibration 	Compliance with National guideline limits for Noise level.	Along the road alignment particularly in the major road intersections and densely settlement areas	RHD	RHD/DOE
O03 _{EMP}	Air Quality	Increased traffic levels and congestion will lead to air pollution levels.	<ul style="list-style-type: none"> Ambient air quality monitoring should be carried out during operation phase; Roadside tree plantations as applicable and feasible under harsh climatic conditions; Regular road maintenance to ensure good surface condition; 	<ul style="list-style-type: none"> No complaints from sensitive receptors Levels of H₂S, SO_x, NO_x, CO, CO₂, TVOC, SPM, PM₁₀ 	Compliance with National guideline limits for Air quality.	Along the road alignment particularly in the major road intersections and densely	RHD	RHD/DOE

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			<ul style="list-style-type: none"> Regular vehicle check to control/ensure compliance with air quality standards; Enforcement and penalties against traffic rules violators. 			settlement areas		
O04 _{EMP}	Water Quality	<ul style="list-style-type: none"> Contamination of water bodies from runoff from the roads containing oils & grease; Groundwater may get polluted due to contaminated road runoff on earthen shoulders and embankments planted with grasses. 	<ul style="list-style-type: none"> In order to discharge rapid removal of storm-water/road runoff, cross slopes and longitudinal drainage will be provided in the design; Proper drainage system with sedimentation ponds and oil separators will be provided to avoid contamination by run-off and oil spills; Retention basins with reed beds provided in the design will improve the quality of polluted storm-water/road runoff; Prior to operation, an emergency response plan for spills of hazardous materials and oil will be prepared; Groundwater quality monitoring will be carried out as per schedule suggested in the Environmental Monitoring Plan. 	<ul style="list-style-type: none"> No visible degradation to nearby drainages, khals or water bodies due to construction activities Levels of pH, TOC, PO₄, TSS, DO, oil and grease (surface water) Levels of pH, CaCO₃, Cl⁻, Mn, As, Fe, total coliform, fecal coliform (groundwater) 	Compliance with National guideline limits for Surface and Ground water.	Throughout the road alignment particularly in khal/lowland/rivers/pond/ditch areas	RHD	RHD/DOE
O05 _{EMP}	Land Use	Development of commercial establishments, educational institutes etc., which may affect the land value	<ul style="list-style-type: none"> All the facilities except restaurants and petrol/gas filling stations likely to pop up in the future will be prohibited within the RoW. The permission will be sought from the concerned authority for 	<ul style="list-style-type: none"> Number of complaints from sensitive receptors 	Compliance with National/International guideline	Along the road alignment particularly in the urban and densely	RHD	RHD

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			<p>the development of any establishment along the project;</p> <ul style="list-style-type: none"> The bridge site may also be developed as tourist spot with further beautification; The designated RoW shall be maintained free of any encroachment. 			settlement areas		
O06 _{EMP}	Wildlife	Killing of animals in road accidents	<ul style="list-style-type: none"> Raising of dense plantation of shady trees on both sides of the RoW shall provide resting, nestling and roosting habitat to the fauna and especially to the avifauna which is a major positive impact; Low width under passes with the provision of small net on the both side of the road shall be made where the animal movement is frequent. 	<ul style="list-style-type: none"> Number of wildlife killed arising from road accidents 	Compliance with National /International guideline for wildlife	Along the road alignment	RHD	RHD/DOE
O07 _{EMP}	Fisheries	The damage of 2 ponds, 2 ditches and disturbance to fisheries species during construction of bridge & culvert over rivers and canals to build the road embankment.	<ul style="list-style-type: none"> Provide logistic support to the PAPs of the water bodies to culture fish in other places in the PIA. Consult with the local fisheries department to enrich the fisheries resources; Efforts shall be made to maintain deep water stream for certain length on both end of the bridge. 	<ul style="list-style-type: none"> Number of complaints from sensitive receptors on disturbance of fishing; Any evidence of fish mortality. 	Compliance with National/International guideline	Throughout the road alignment particularly in khal/lowland and/rivers/pond/ditch areas	RHD	RHD/DOE
O08 _{EMP}	Cultural Sites	Noise, vibration and whistling near to cultural sites like school, college, madrasa, health	<ul style="list-style-type: none"> Proper rehabilitation of the affected people and the religious and cultural monuments and structures; 	<ul style="list-style-type: none"> No complaints from sensitive receptors 	Compliance with National guideline limits for noise and dust.	Along the road alignment	RHD	RHD

EMP Code ²⁶	Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
		complex, temple, etc.	<ul style="list-style-type: none"> Noise problem can be mitigated through plantation of trees along the boundary of the cultural sites; Avoid unnecessary whistling at sensitive cultural sites. 					
O09 _{EMP}	Road Safety	Increase in the number of road accidents & animal kills	<ul style="list-style-type: none"> Speed limits shall be imposed. Safety signal shall be displayed along the road and speed limits be displayed as well as monitored especially along settlements; Traffic signs shall be provided to warn road users about speed limits, rest areas, eating establishments etc. Lanes, median, and sharp bends shall be reflectorized to improve road visibility at night time. Foot over bridge shall be provided near schools, markets, habitat areas for safe crossing of the roads Proper lighting shall be provided along the project road. 	<ul style="list-style-type: none"> No of road accidents 	Compliance with national laws on road safety	Along the road alignment particularly at road intersections	RHD	RHD
O10 _{EMP}	Tree Planting	Ensuring survival of flora and fauna in the new environment.	<ul style="list-style-type: none"> Monitor survival of replanted trees (also compensatory planting) and replant, as necessary. Undertake proper measures for watering, fertilizing and nursing of trees/ plants/ grasses. Plantation of additional varieties of trees that supports birds and having high wood value. 	<ul style="list-style-type: none"> No. of trees that survive 	Compliance with guideline of Forest Department and the tree management plan	Along the project corridor	RHD	RHD

C. EMP Implementation Schedule

373. An implementation schedule has been proposed based on the environmental components that may be affected during the construction and operation of the project. A comprehensive EMP implementation schedule is provided in Table 2. Monitoring Plan has been separately suggested for pre-construction, construction and operation phase.

D. Environmental Monitoring Plan

374. Environmental monitoring is an essential tool for environmental management as it provides the basic information for rational management decisions. The purpose of the monitoring program is to ensure that the envisaged purposes of the project are achieved and result in desired benefits to the target population. To ensure the effective implementation of the mitigation measures, it is essential that an effective monitoring program be designed and carried out. Compliance monitoring will be conducted in accordance with the environmental mitigation measures and monitoring plan provided with this report (Table 43).

E. Objectives

375. The objective of environmental monitoring during the construction and operation phases is to compare the monitored data against the baseline condition collected during the study period to assess the effectiveness of the mitigation measures and the protection of the ambient environment based on national standards. The main objectives of the pre-construction, construction and operation phase monitoring plans will be to:

- (i) Monitor the actual impact of the works on physical, biological and socioeconomic receptors within the project corridor for indicating the adequacy of the EIA;
- (ii) Recommend mitigation measures for any unexpected impact or where the impact level exceeds that anticipated in the EIA;
- (iii) Ensure compliance with legal and community obligations including safety on construction sites;
- (iv) Monitor the rehabilitation of borrow areas and the restoration of construction campsites as described in the EMP;
- (v) Ensure the safe disposal of excess construction materials.
- (vi) Appraise the adequacy of the EIA with respect to the project's predicted long-term impacts on the corridor's physical, biological and socio-economic environment;
- (vii) Evaluate the effectiveness of the mitigation measures proposed in the EMP and recommend improvements, if and when necessary;
- (viii) Compile periodic accident data to support analyses that will help minimize future risks; and
- (ix) Monitor the survival rate of avenue plantations.

F. Components to be monitored

376. Monitoring has two components: compliance monitoring, which checks whether prescribed actions have been carried out, usually by visual observation and use of checklists; and effects monitoring which records the beneficial and adverse consequences of activities on the biophysical and social environment. This is often by repeat measurements of a set of objectively verifiable indicators.

377. Monitoring for this project will concentrate on compliance monitoring to ensure that measures are being implemented on time and based on sound environmental principles.

1. Pre-Construction stage compliance monitoring

378. Compliance monitoring during the pre-construction stage has three components:

- (i) Checking that the project's design incorporates appropriate measures to avoid or minimize negative environmental impacts.
- (ii) Incorporation of appropriate protective clauses in the contract documents that are to be complied by the contractors.
- (iii) Acquisition of land issue and damages to properties are dealt with as per the Land Acquisition and Resettlement Plan (LARP) and compensated accordingly.

379. The detailed program of monitoring of various components is given in Table 3.

2. Construction stage compliance monitoring

380. Compliance monitoring during the construction stage comprises:

- (i) EMP which addresses the environmental issues in details to provide environmental protection.
- (ii) Contractors' compliance to the environmental clauses in their day-to-day activities.
- (iii) Implementation of tree planting and site clearance activities after completion of work.

381. The environmental impacts during construction are highly dependent on (i) the contractors' work practices, especially those related to the storage of construction materials and cleanliness of the work sites; (ii) cooperation by the local authorities with the contractor in terms of traffic management and use of public space and utilities; (iii) project management's strict enforcement of the correct construction practices and standards; and (iv) the incorporation of the mitigating measures identified in the EIA into bid documents and specifications.

382. Direct monitoring during the construction phase will involve the following activities:

- (i) Review of Contractor's proposed designs and working methods including a review at project start-up to ensure that the designs and working methods proposed by the contractors have taken account of the environmental constraints specified in the tender documents (geotechnical, ecological, social, safety).
- (ii) Site- specific review of contractors' temporary facilities; involving the inspection of contractor's worksites and work camps to ensure that the contractor's arrangements regarding temporary facilities are satisfactory.

- (iii) Regular site inspection during the construction period, involving scheduled and unannounced inspections to ensure that the stipulated procedures as defined in the EMP are being followed by the contractor(s). This monitoring will require the completion of systematic observations of site activities using checklists to be developed by RHD or its supervising consultants.
- (iv) Inspection of the certification of site clearance and restoration, to ensure that actual restoration has taken place, e.g., the temporary sewage works have been adequately disposed of.

G. Operation stage monitoring

383. The contractor will compile and maintain the environmental data and records gathered during the construction phase for reference during the operation phase. The contractor will coordinate with government departments and agencies, RHD in particular, will be responsible for overseeing monitoring with respect to air quality, water, noise and traffic.

384. The contractor in collaboration with the concerned department will organize monitoring of air quality and effects of the exhausts along the road project. Sensitive parameters including NO₂, SO₂ and particulate matters will be monitored and necessary measures will be taken to keep them within the limits set by government.

385. The noise levels will be monitored to see whether they are within the limits. When they are found to exceed these limits and disturb the nearby settlements, noise abatement measures, like plantation of trees and construction of sound barriers will be taken.

386. Monitoring will be done to ensure that both surface and groundwater quality will up to the standards. Mitigation measures will be taken in the design of new facilities and also from the point sources related to new developments and industry. Pollution control equipment's including wastewater treatment plants will be recommended for the local industry and accordingly monitored.

387. The contractor will monitor that flora and fauna of the area is not disturbed by the increase of population and other activities in the area of influence. Tree plantation will be done. Any activity of the nearby residents (such as disposal of waste, land use change, etc.), which affects the environment, will be brought to the knowledge of the competent authority for necessary action.

388. The above monitoring system will be fully controlled by the project proponent i.e. RHD. A monitoring schedule has been included as guideline for the stakeholders (Table 44).

H. Monitoring Program

389. Monitoring points have been selected based on the sensitivity of the location with respect to sensitive receptors. The schedule has been developed based on the possible occurrence of adverse impacts and required mitigation actions. However, this schedule is subject to change depending on the analysis results obtained. The protocol for changing the monitoring schedule is given below.

1. Tree Plantation

390. The 75% survival rate of re-plantation shall be monitored on the first year of the operation phase. If the survival rate is found below 75%, survival rate monitoring shall be again taken up after 3 years. This cycle should continue until the 75% survival rate is achieved.

2. Terrestrial and Aquatic Fauna including Fisheries

391. The fish productivity monitoring are important and sensitive issues. In case, any significant decline in terms of fish productivity in the khals/canals or ponds is noticed, the monitoring frequency shall be increased until the effectiveness of mitigation measures are established.

3. Soil Erosion and Drainage Congestion

392. No significant soil erosion problem is anticipated due to the project either in the construction phase or in the operation phase. However, in the construction phase, some localized soil erosion may be noticed owing to construction activities. However, if soil erosion is noticed during construction and operation phase, the corrective action shall be initiated and frequency of check be increased to assess the tendency of occurrence.

4. Air and Noise Quality

393. Due to the variability of the construction activities, namely changes in batch composition, type of construction activity and other anthropogenic influences, the ambient air quality of the project area may change. If the air quality with respect to any parameter exceeds by more than 25% of its last monitored value, the monitoring frequency shall be doubled and cause of the increase investigated. If the construction activities are found to be the reason for this increase, suitable measures should be adopted.

394. Similarly, due to the variability in traffic movement, namely changes in traffic volume, traffic compositions and other anthropogenic influences, the noise quality in the project area is likely to change. If the noise quality exceeds by 20% of the applicable ambient noise quality standard or 5% of its last monitored value, the monitoring frequency shall be increased and the cause of the increase investigated. If the construction activities are found to be the reason for this increase, suitable measures should be adopted.

5. Water Quality

395. No significant change in water quality is perceived due to the project in the operation phase. However, in the construction phase, the monitored values for pH, BOD, COD, TDS, DO and Oil & Grease might change owing to construction activities. Hence, it is suggested that if the monitored value for any water quality parameter exceeds by more than 20% of its last monitored status the monitoring frequency shall be increased. If the construction activities are found to be the reason for this increase, suitable measures should be adopted.

Table 44: Environmental Monitoring Plan

EMoP Code	Environmental Components	Parameters/ Units	Standards/ Guidelines	Location	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
						Implementation	Supervision
Pre-Construction Stage							
P01 _{EMoP}	Dredged materials	Lead (Pb), Cadmium (Cd), Chromium (Cr), Copper (Cu), Zinc (Zn), Manganese (Mn), Arsenic (As), Selenium (Se), and Mercury (Hg)	Government of Bangladesh (GoB) and international standard	Proposed dredging sites	Once prior to start dredging	Contractor	RHD/Construction Supervision Consultant (CSC)
P02 _{EMoP}	Air Quality	PM _{2.5} , PM ₁₀ , CO, SO ₂ , NO, NO ₂ , O ₃ , VOC, Temperature, Humidity, Wind Speed and Wind Direction	Air quality standard by DOE, Bangladesh	Major road intersections	Once	Contractor	RHD/CSC
P03 _{EMoP}	Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Major Road Intersections and inhabited locations and sensitive areas	Once	Contractor	RHD/CSC
P04 _{EMoP}	Water Quality	Surface water: pH, TOC, PO ₄ , TSS, Oil and Grease, and DO	Surface water quality standard by DOE, Bangladesh	Surface water near project site	Once	Contractor	RHD/CSC
P05 _{EMoP}		Groundwater: pH, Mn, As, Fe, Cl, Total Hardness, TC and FC	Groundwater quality standard by DOE, Bangladesh	Groundwater near project site	Once	Contractor	RHD/CSC
P06 _{EMoP}	Wildlife	Wildlife habitat and movement	None Specific	Areas alongside the road alignment	Once	Contractor	RHD/CSC

EMoP Code	Environmental Components	Parameters/ Units	Standards/ Guidelines	Location	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
						Implementation	Supervision
P07 _{EMoP}	Tree felling	<ul style="list-style-type: none"> ▪ Monitoring activities outlined in RP; ▪ Check whether proper compensation as mentioned in RP is received by PAPs. 	Inspection	ROW along the alignment	During tree felling and site clearing operations	Contractor/ NGOs/RHD	RHD/CSC
Construction Stage							
C01 _{EMoP}	Air Quality	PM _{2.5} , PM ₁₀ , CO, SO ₂ , NO, NO ₂ , O ₃ , VOC, Temperature, Humidity, Wind Speed and Wind Direction	Air quality standard by DOE, Bangladesh	Hot mix plant, concrete mixing plant/stone crushers at construction sites	2/year per site for 2 years	Contractor	RHD\CSC
C02 _{EMoP}	Dust	Dust control	Air quality standard by DOE, Bangladesh	Construction site and ROW along the alignment	Regularly	Contractor	RHD\CSC
C03 _{EMoP}	Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Construction sites and at every sensitive receptors	2/year per site for 2 years	Contractor	RHD\CSC
C04 _{EMoP}	Water Quality	Surface water: pH, TOC, PO ₄ , TSS, Oil and Grease, and DO	Water quality standard by MoEF, Bangladesh	Surface water near project site	2/year per site for 2 years	Contractor	RHD\CSC
C05 _{EMoP}		Groundwater: pH, Mn, As, Fe, Cl ⁻ , Total hardness, TC, FC	Water quality standard by MoEF, Bangladesh	Drinking water to made available to construction camps and	2/year per site for 2 years	Contractor	RHD\CSC

EMoP Code	Environmental Components	Parameters/ Units	Standards/ Guidelines	Location	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
						Implementation	Supervision
				ground water near project site			
C06 _{EMoP}	Soil Erosion	Visual check for Soil erosion and siltation	None Specific	All major water bodies	Once during rainy seasons of the construction period.	Contractor	RHD\CSC
C07 _{EMoP}	Drainage congestion	<ul style="list-style-type: none"> ▪ Check drainage plan implemented correctly ▪ Conduct regular inspection 	Monitoring	Construction site	Weekly during monsoon	Contractor	RHD\CSC
C08 _{EMoP}	Soil Pollution	<ul style="list-style-type: none"> ▪ Check liquid waste is carried out by experienced personnel and in proper way ▪ Careful and proper handling of oil and other hazardous liquids 	Monitoring	Construction Yard, dumping site	Regularly	Contractor	RHD\CSC
C09 _{EMoP}	Wildlife	Wildlife habitat and movement	None Specific	Areas alongside the road alignment	Quarterly	Contractor	RHD\CSC
C10 _{EMoP}	Waste	<ul style="list-style-type: none"> ▪ Check storage, transportation, disposal, handling of hazardous waste ▪ Waste and effluents to be collected and disposed safely from all camps. ▪ Wastes and 	Monitoring	Construction Yard, dumping site	Weekly	Contractor	RHD\CSC

EMoP Code	Environmental Components	Parameters/ Units	Standards/ Guidelines	Location	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
						Implementation	Supervision
		garbages from bridges construction sites to be disposed safely					
C11 _{EMoP}	Health and Safety	<ul style="list-style-type: none"> ▪ Check quality of food & accommodation at construction camp; ▪ Check safe water supply, hygienic toilet at camps, construction of drain at camp sites; ▪ Check toilets are close to construction site and separate toilet for female workers; ▪ First Aid Box with required tools & medicines; ▪ The heavy construction material to handled and stored safely putting due care on public safety; ▪ Heavy construction materials at bridges construction sites to be stored and handled safely; and ▪ Check of personal protective 	Monitoring	Construction site and labor camp	Regularly	Contractor	RHD\CSC

EMoP Code	Environmental Components	Parameters/ Units	Standards/ Guidelines	Location	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
						Implementation	Supervision
		equipment (PPE) for worker at the sites					
Operation Stage							
O01 _{EMoP}	Tree Plantation	Check that the planted trees are maintained as mentioned in tree plantation plan	Inspection to ensure proper plantation with proper species	Along the road	Regular during June/July	RHD	RHD\DOE
O01 _{EMoP}	Air Quality	PM _{2.5} , PM ₁₀ , CO, SO ₂ , NO, NO ₂ , O ₃ , VOC, Temperature, Humidity, Wind Speed and Wind Direction	Air quality standard by DOE, Bangladesh	Major Road Intersections	1 site/year for 3 years	RHD	RHD\DOE
O02 _{EMoP}	Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Major Road Intersections and inhabited locations and sensitive areas	1 site/year for 3 years	RHD	RHD\DOE
O03 _{EMoP}	Water Quality	Surface water: pH, TOC, PO ₄ , TSS, Oil and Grease, and DO	Water quality standard by MoEF, Bangladesh	Surface water near project site	1 site/year for 3 years	RHD	RHD\DOE
O04 _{EMoP}		Groundwater: pH, Mn, As, Fe, Cl, Total hardness, TC, FC	Water quality standard by MoEF, Bangladesh	Groundwater near project site	1 site/year for 3 years	RHD	RHD\DOE
O05 _{EMoP}	Accident and Public Safety	Record of accidents, different level of disabilities/fatalities.	None Specific	Thought out the project section	-----	RHD	RHD
O06 _{EMoP}	Soil Erosion	Visual check for soil erosion and siltation	None Specific	All major water bodies	After first precipitation	RHD	RHD

EMoP Code	Environmental Components	Parameters/ Units	Standards/ Guidelines	Location	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
						Implementation	Supervision
O07 _{EMoP}	Soil Quality	Heavy metals	None Specific	At each construction camp post restoration of construction camp site	Once at each construction site	RHD	RHD\DOE
O08 _{EMoP}	Wildlife	Wildlife habitat and movement	None Specific	Areas alongside the road alignment	Quarterly	RHD	RHD\DOE

I. Environmental Budget

396. The estimated budget for implementation of the mitigation and monitoring measures proposed in the EMP is presented in Table 45. The overall costs of the EMP will comprise:

- (i) Environmental monitoring through sample collection and analysis;
- (ii) Any remedial measures necessary to reduce or avoid environmental damage;
- (iii) Designing and implementing all mitigating and enhancement measures;
- (iv) Supervision staff from RHD and consultants including direct costs and travel subsistence.

397. The total budget is estimated US\$ 0.57 million.

Table 45. Environmental Budget for Elenka-Hatikamrul Road

Component	Item	Unit	Quantity	Rate (in BDT)	Amount (million BDT)
PRE-CONSTRUCTION STAGE					
Technical Support	Update of Environmental guidelines and performance indicators	Lump sum	-	5,00,000	0.50
Dredged Material	Measuring dredged material quality	No.	2	20,000	0.04
Air Quality	Measuring air quality	No.	2	60,000	0.12
Noise	Measuring ambient noise level	No.	4	15,000	0.06
Flora	Clearing of Roadside plantation	No. of tree	31,450	Covered in Eng. Cost	--
Water Quality	Surface water quality measurement	No.	2	20,000	0.04
	Groundwater quality measurement	No.	2	20,000	0.04
Land acquisition & resettlement	Compensation against land acquisition	Covered in R & R Budget			--
SUB TOTAL (PRE-CONSTRUCTION STAGE)					0.80
CONSTRUCTION STAGE					
Air Quality	Measuring air quality	No.	8	60,000	0.48
Noise	Measuring ambient noise level	No.	16	15,000	0.24
	Provision for additional tree plantation / Noise Barriers	No.	Covered in Engineering Cost		--
Flora	Clearing of roadside plantation	No.	Covered in Engineering Cost		--
	Compensatory afforestation (Minimum 1:2) (Plantation & maintenance for two years)	No.	71500	300/tree	21.45
Water Quality	Surface water quality measurement	No.	8	20,000	0.16

Component	Item	Unit	Quantity	Rate (in BDT)	Amount (million BDT)
	Groundwater quality measurement	No.	8	20,000	0.16
	Installation of oil and grease traps at construction sites @ 1 per site and 1 site per construction package (6)	No.	10	60,000	0.60
	Construction of soak pits at construction sites @ 2 per construction camp and 1 camp per package	No.	8	30,000	0.24
Agriculture	Institutional support for enhancing agricultural productivity (Development of demonstration plots for change in cropping pattern for cash crop or high yield variety)	Plots	6	1,00,000	0.60
	Technical Support to farmers	Lump sum	-	10,00,000	1.00
Fisheries	Conversion of derelict pond into culture ponds & other support (fisheries seed distribution, demonstration ponds, technical support)	Lump sum	-	10,00,000	1.00
Drainage Congestion	Provision of adequate opening	Covered in Engineering Cost			--
Erosion & Sedimentation	River bank protection measures	Covered in Engineering Cost			--
Soil	Maintenance cost in soil conservation	Covered in Engineering Cost			--
Slope /Embankment protection at approach Road	Turfing of embankment with grasses and herbs	Covered in Engineering Cost			--
Dust Management	Water sprayer / watering	Covered in Engineering Cost			--
Waste disposal and management	Disposal and management of construction waste	Lump sum	-	30,00,000	3.00
Traffic management	Road signages and traffic directional signs	Covered in Engineering Cost			--
Construction Safety	Accident risks in construction activity	Covered in Engineering Cost/Insurance			--
	General Safety (provision of PPE like ear muffs, gloves etc.)	Lump sum	-	4,00,000	0.40

Component	Item	Unit	Quantity	Rate (in BDT)	Amount (million BDT)
Health	Health checkup camps for construction workers	Camps	Camps/year	5,00,000	1.00
Environmental Monitoring in construction phase	Monitoring Tree Felling & Plantation	Lump sum	-	10,00,000	1.00
	Fisheries	Lump sum	-	4,00,000	0.40
SUB TOTAL (CONSTRUCTION STAGE)					31.73
OPERATION STAGE					
Air Quality	Monitoring air quality	No.	3 (1/year)	60,000	0.18
Noise	Monitoring ambient noise level	No.	3 (1/year)	15,000	0.045
Water	Monitoring surface water quality	No.	3 (1/year)	20,000	0.060
	Monitoring ground water quality & levels	No.	3 (1/year)	20,000	0.060
Fisheries	Maintenance of Derelict Ponds or rehabilitation of Borrow Areas	Lump Sum	-	10,00,000	1.00
Tree survival	Provision of additional tree plantation (Plantation and maintenance for two years)	No. of trees	7150	100/tree	0.715
Monitoring of performance indicators	Monitoring tree felling & plantation	Lump sum	-	5,00,000	0.50
	Fisheries	Lump sum	-	5,00,000	0.50
	Monitoring of waste disposal and management	Lump Sum	-	5,00,000	0.50
SUB TOTAL (OPERATION STAGE)					3.56
ESTABLISHMENT & TRAINING					
Establishment	Construction stage	Per month	24	1,00,000	2.40
	Operation stage	Per month	60	25,000 for first three years of operation and 15000 after three years additional two years	1.26
Training	Environmental training & awareness	Lump sum	As per training details	20,00,000	2.0
Management Information System		Lump sum	-	5,00,000	0.50
SUB TOTAL (ESTABLISHMENT & TRAINING)					6.16
SUB TOTAL (Pre-construction, Construction, Operation, establishment and training)					42.25
CONTINGENCIES @ 10 % on total Environmental Costs					4.225
GRAND TOTAL (in million BDT)					46.475
GRAND TOTAL (in million US\$) (@ 1 US\$ = 81.5 BDT)					0.57

VIII. INSTITUTIONAL ARRANGEMENT, CAPACITY BUILDING AND GRIEVANCE REDRESS MECHANISM

A. Institutional Arrangement

398. The Environmental Management Plan (EMP) implementation requires an organization support structure in the form of organizational requirements, training needs and plan, and information management system. The following section captures these institutional arrangements for EMP implementation by concerned officials of RHD, their consultants and working contractors.

399. The organizational structure of RHD is given in Figure 25. However, an organizational structure shall be developed at the corporate, regional and site level to aid effective implementation of the EMP document. Various departments will be involved during implementation of the project as shown in Figure 7.2. Contractor is responsible for implementation of EMP during works and Construction Supervision Consultant (CSC) is primarily responsible for supervision of monitoring of the implementation of the EMP. RHD will be supported by a Management Consultant (MC) to advise and assist RHD in quality and capacity enhancement and independent quality monitoring. Contractor will be responsible for implementation of EMP during work activities stage. Relevant departments responsible for implementation and supervision of proposed mitigation and monitoring measures are given in the EMP.

400. CSC will be responsible to monitor all activities of all contractors procured under the project. As several contractors will be working simultaneously for timely and speedy implementation of the project, it is important that CSC has an environmental unit to effectively supervise and monitor the environmental activities being implemented in the field. The CSC is also responsible to update or make necessary changes to the EMP if required based on the revised designs and locations.

401. A combined grievance redress committee is proposed to address grievances in both social and environmental issues. In addition, there will be NGOs working for plantation program and environmental awareness.

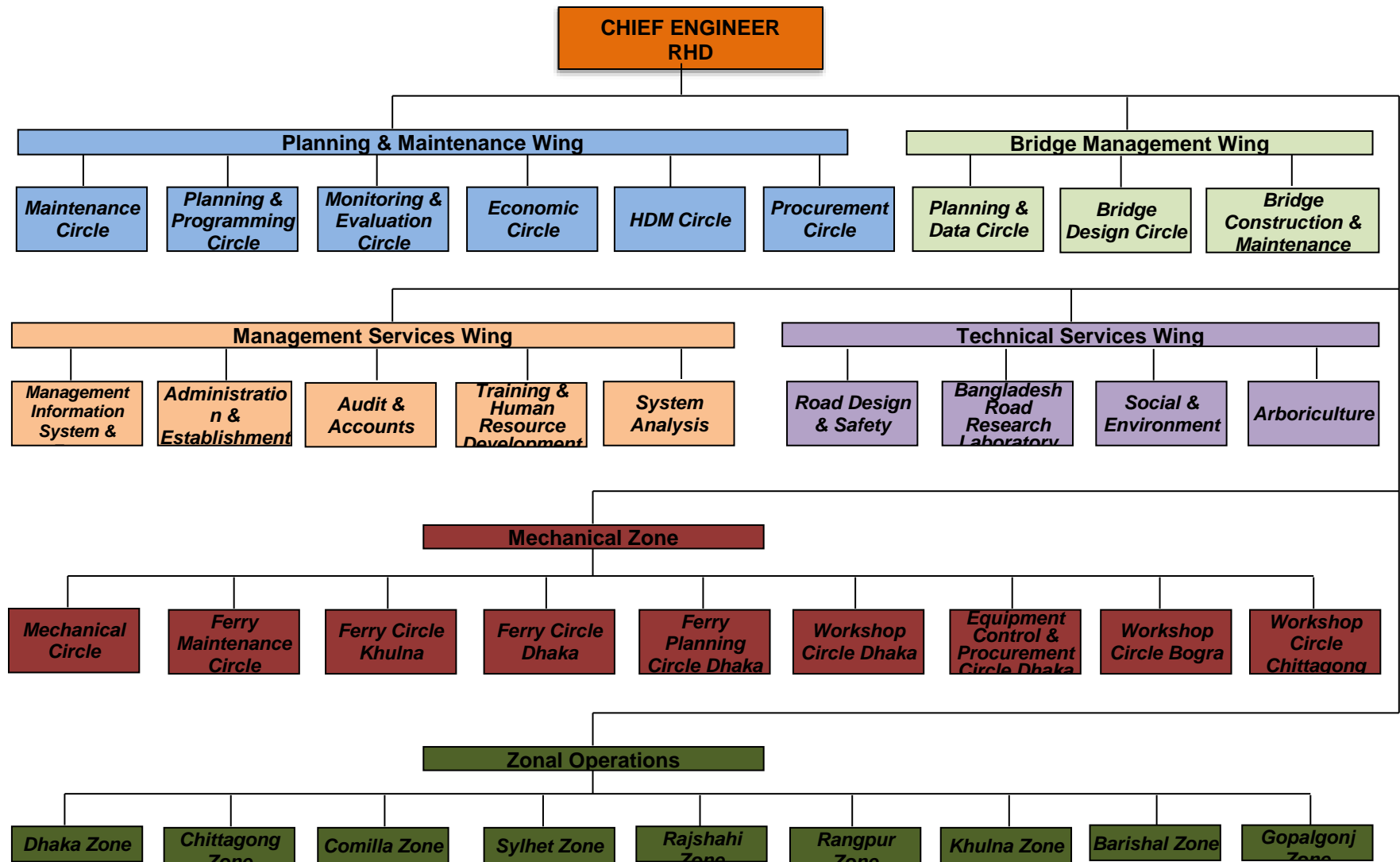


Figure 24: Organisation Structure of RHD

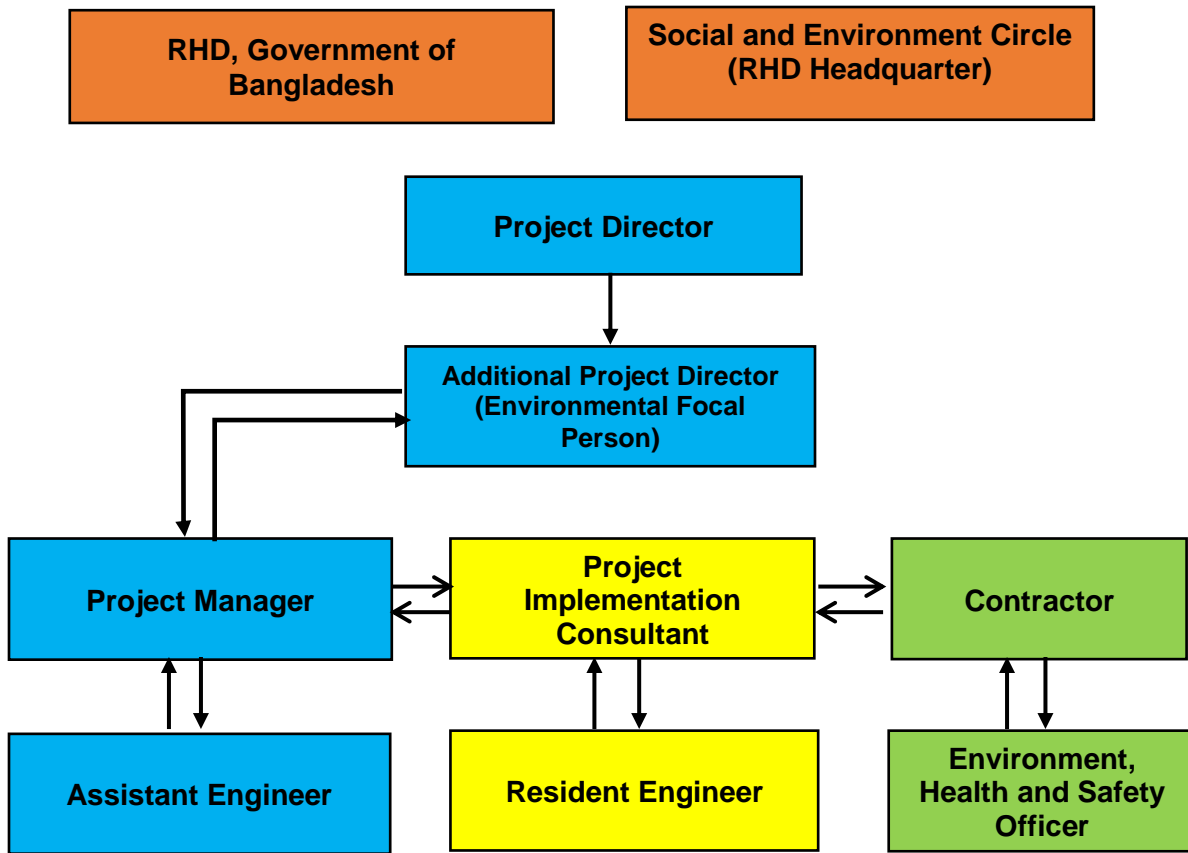


Figure 25: Proposed Organisational Structure for EMP Implementation of RHD for Elega-Hatikamrul Road Project²⁸

B. Institutional Roles and Responsibilities

402. The Roads and Highways Department (RHD) is the Executing Agency (EA) for the MFF and will be responsible for ensuring that all the components of the EARF are complied with. The RHD has the responsibility to ensure that the investment follows the legal requirements for environmental assessment. The RHD has an Environmental and Social Circle (ESC) headed by the Superintending Engineer who is supported by the Executive Engineer, Subdivision Engineer, Assistant Engineer and Sub-assistant Engineer.

403. Two Project Implementation Units (PIU) will be responsible for implementing phase 1 (Joydepur–Chandra–Tangail–Elega)²⁹ and phase 2 (Elega–Hatikamura–Rangpur)³⁰ of the MFF. Each PIU is headed by a Project Director (PD) who is supported by Additional Project Directors (APD). The PD for phase 1 is supported by 1 APD while the PD for phase 2 is supported by 3 APDs. At the site level there are 3 Project Managers (PMs) for the 4 contract packages under

²⁸ [Orange box] - Roads and Highways Department (RHD); [Blue box] - Project Implementation Unit; [Yellow box] - Project Implementation Consultant; [Green box] - Contractor

²⁹ Phase 1 is already under implementation under Loan 2949-BAN: South Asia Subregional Economic Cooperation Road Connectivity Project

³⁰ A new PIU for phase 2 has just been established

the phase 1 and 8 PMs for the 9 contract packages under the phase 2. Each PM is further supported by Deputy PM, Assistant Engineers and Sub Assistant Engineers.

404. The APDs serve as the environmental focal persons under each PIU. One of Assistant Engineers serve as the environmental focal person at the site level and support the respective APD on environment safeguard matters. Further the Project Implementation Consultant (PIC) responsible for supervising the civil works contractor will provide support to the respective PIU for day to day monitoring and reporting on environment safeguards.

405. The following elaborates the detailed responsibilities on environment safeguards:

1. RHD

406. As the EA for the investment program, RHD will be responsible for ensuring that all the environment safeguard requirements as provided in the Framework Financing Agreement (FFA), this EARF and the respective IEE and EMP are complied with.

2. RHD (Environment and Social Circle)

407. The RHD Environment and Social Circle (ESC) is responsible for managing environment and social safeguards including safeguards related capacity building for all RHD projects. They will not be involved in the day to day implementation of safeguards for specific projects such as this investment program. The respective PIU will seek their support and advise on an as needed basis. Their overall responsibilities are:

- Ensure that all RHD works and projects are executed in accordance with appropriate environmental and social standards and practices.
- Liaise with GOB organisations and other line agencies to ensure effective inter-agency cooperation on relevant projects.
- Ensure the provision or procurement of the necessary services for carrying out Environmental Assessment, Land acquisition and Resettlement studies.
- Disseminate the need for high social and environmental standards throughout RHD and to the concerned public through research, publicity, seminars and training.
- Coordination the preparation and implementation of environmental and resettlement management plans for RHD projects as needed.
- Monitor long-term, cumulative environmental impacts and ensure mitigation measures for project sustainability.
- Conduct site inspections on selected RHD projects as needed
- Provide feedback on all environmental issues of existing and ongoing RHD projects and works.
- Review and preparation of Request for Proposal (RFP) and tender documents for procurement of Environmental Services (IEE, EIA and EMP) for RHD projects.
- Assist the Director of RHD Training Centre in providing training to RHD officers in Environmental and Resettlement issues.
- Review and approve the Environmental Assessment reports and Environmental Monitoring reports produced by consultants/experts under RHD projects as needed.
- Establish and maintain environmental standards, guidelines and manuals in RHD.

- Identify environmental issues and constraints at project planning stage, suggest alternatives, options.
- Establish a reference library, containing relevant environmental documents (hard and soft copies) of domestic and overseas sources.
- Monitor long term environmental impacts on relevant RHD Projects
- Liaise with Road Safety Circle, Arboriculture Head and maintain intra-departmental co-ordination.

3. PIU (Environmental Focal Persons at Project Head Quarter and Site level)

408. The Additional Project Directors under the respective PIU will serve as the Environmental Focal Person at the Project Head Quarter level. At the site level an Assistant Engineer supporting the Project Manager will serve as the environmental focal person. The PIU will be responsible for ensuring proper implementation of environment safeguards in their respective projects including implementation of the EMP and EMoP, timely reporting and timely resolution of complaints and grievances. Their detailed responsibilities are:

- Prepare or engage consultants to prepare environmental assessment reports (IEE, EIA, EMP) for project components as necessary
- Review and comment on the environmental assessment reports and environmental monitoring reports prepared by consultants and ensure they are prepared in accordance with requirements of RHD, DOE and ADB
- Ensure that the consultants while carrying out work at site follow the environmental standards, guidelines and manual of RHD.
- Take necessary steps to ensure timely receipt of DoE Environmental Clearance
- Ensure that the EMP and relevant environmental clauses are included in the contractors bidding documents
- Conduct spot checks on-site to monitor contractor's compliance with the EMP
- Review and endorse quarterly monitoring reports prepared by the PIC
- Review and endorse annual environmental monitoring reports prepared by the PIC for further submission to ADB for disclosure on the ADB website
- If there are any non-compliance issues or unanticipated environmental impacts ensure that necessary corrective actions are taken and IEE and/or EMP is updated as necessary
- Ensure that all grievances and complaints received are addressed in a timely manner and properly documented
- Carry out all other activities on environment safeguards on behalf of the PIU as needed

4. Project Implementation Consultant (Environment Safeguards Team)

409. The proposed framework for implementation of the project shall utilize consultancy services from both international and national companies for the overall management and supervision of construction work on behalf of the EA. In addition to supervising the construction work of the contractor their role will be to check on conformity with the relevant clauses in construction contracts and national legislation and regulations. The following are the detailed responsibilities of the PIC.

- Review the IEE and EMPs of respective subprojects to understand the context and environmental issues of the project

- Establish monitoring and reporting protocols within the environment safeguards team at the site level and project headquarter level
- Require the civil works contractor to prepare sub-plans on environment safeguards such as camp layout plan, borrow area management plan, construction debris management plan, traffic management plan etc. as needed
- Review and approve all sub-plans on environment safeguards submitted by the civil works contractor
- Conduct regular (minimum of weekly) onsite inspections on implementation of the EMP by the contractor
- Ensure the contractor obtains all clearances, permits etc. related to environment safeguards on a timely basis
- Ensure the contract collects required environmental monitoring data (air, water, noise) as stipulated in the respective IEE report
- Provide on-site technical advice and training to the contractor as needed
- Organize training workshops on implementation of environment safeguards for the project team including PIU, RHD site offices, members of the PIC and civil works contractor
- Facilitate proper functioning of the grievance redress mechanism and maintain records of all complaints received and actions taken for inclusion in the environmental monitoring reports
- If there are any non-compliance issues or unanticipated environmental impacts ensure that necessary corrective actions are taken and update the IEE and/or EMP as necessary
- Review and approve the monthly progress reports submitted by the contractor
- Based on monthly progress reports submitted by the contractor and site inspections prepare quarterly environmental monitoring reports for review and approval by the PIU
- Based on the quarterly monitoring reports prepare annual environmental monitoring reports for review and approval by the PIU and further submission to ADB for disclosure on the ADB website
- Provide necessary technical support to the PIU on implementation of environment safeguards

5. Contractor (Environment Safeguards Team)

410. The tender for the construction of the project would be national/international competitive bidding contractors. The Contractor is legally mandated to implement the EMP and EMoP and obtain all environment related permits and clearances required for construction. The detailed responsibilities of the contractor on environment safeguards are the following:

- Recruit and appoint environmental focal persons and/or environmental health and safety officers on the construction site
- The contractor shall comply with all statutes and regulations concerning the execution of works as mentioned in DoE and RHD environmental guidelines.
- The contractor shall be responsible for familiarizing himself with all legislation relating to environmental protection that is relevant to his activities. Reference to rational environmental quality guidelines should be made.
- Implement the EMP approved by the PIC

- Prepare all sub-plans related environment safeguards such as camp layout plan, borrow area management plan, construction debris management plan, traffic management plan etc. as needed and submit for approval by the PIC
- Obtain all statutory clearances and permits on environment safeguards in a timely manner
- Conduct environmental quality monitoring (air, noise, water) as stipulated in the Environmental Monitoring Plan of the respective IEE report
- Take necessary measures to immediately address any complaints or grievances raised by local community or other stakeholders
- Prepare monthly progress reports on implementation of the EMP for approval by the PIC
- The contractor shall be responsible for the costs of cleaning up any environmental pollution resulting from his activities if methods for doing so are available and effective.

6. ADB

411. As a funding agency ADB is responsible for monitoring implementation of environment safeguards, providing technical guidance to the EA as necessary. Specific responsibilities entail the following:

- Review IEE reports including EMP provide feedback and disclose the reports on the ADB website as required by the ADB SPS;
- Provide assistance to RHD, if required, in carrying out its responsibilities and for building capacity for safeguard compliance;
- Monitor overall compliance of the MFF tranches and components to respective IEE and EMP through review missions;
- Review all environmental monitoring reports submitted by RHD, provide feedback and disclose the reports on the ADB website as required by the ADB SPS
- Provide guidance to the RHD and the PIU on issues related to inclusion of new component components, changes in component design, occurrence of unanticipated environmental impacts during component implementation, emergency situations and others as necessary.

C. Capacity Building

412. In Bangladesh, the environmental assessment process is established, but environmental awareness and capability for implementation of EMP in infrastructure projects are still developing. The project implementation unit (PIU) of RHD had some officers in the Environment and Social Circle Department (ESC) that are delegated environmental duties. The delegated officers have responsibility to bring environmental issues to the notice of senior management. Typically, the delegated officers have been moved to different departments due to promotions and operational needs after about every 3 years, and they move on to other engineering departments in RHD. The status quo is that ESC engineering officers are delegated to check environmental assessments prepared by consultants. The EIA and EMP are referred to the DOE in the Ministry of Environment and Forests (MOEF) for approval. The ESC in RHD is not directly involved with project implementation, but has more administrative responsibility to ensure environmental compliance and a general role to increase environmental awareness for RHD. It is therefore not clear if RHD/ESC has the capacity to check the adequacy of the developed EMP for this project.

413. The most significant challenge for environmental management on this project is the lack of human and financial resources and necessary infrastructure in PIU. To enhance the capacity of the RHD Environmental and Social Circle and PIU for effective implementation of proposed mitigation measures and monitoring the resultant effect, some training programs and awareness workshop are proposed. The detailed training plan is provided at Table 46.

Table 46: Training Plan

Target Group	Subject(s)	Method	Time Frame
Planning and Construction Stage			
All concerned PIU/RHD project staff	Environmental Overview: Environmental regulations, and national standards, process of impact assessment and identification of mitigation measures, importance of EMP & monitoring, and monitoring methodology	Lectures	Before beginning of the implementation of the project
Environmental engineers, field officers, contractors, supervision consultants	Implementation of EMPs: Basic features of an EMP, planning, designing and execution of environmental mitigation and enhancement measures, monitoring and evaluation of environmental conditions – during construction and operation	Workshops and Seminars	Before the construction begins
Environmental Engineers, field officers, contractors, supervision consultants	Environmentally Sound Construction Practices: Waste management and minimization in construction, pollution control devices and methods for construction sites and equipment, Environmental clauses in contract documents and their implications, Environmental monitoring during construction	Seminars, Lectures and Site visits	Before the construction
Project staff dealing in social/lands matters	Social awareness: Monitoring consultants/organizations specializing in social management and monitoring can provide training on social awareness and land acquisition and resettlement issues	Lectures, Workshops and Seminars	Before the construction begins
Environmental engineers, field officers, contractors, supervision consultants	Monitoring Environmental Performance during Construction: Monitoring, Air, Water, Soil Erosion, Noise, and effect on wild life and fisheries, Evaluation and Review of results, Performance indicators and their applicability, possible corrective actions, reporting requirements and mechanisms	Lectures, Workshop and site visits	During initial phases of construction

Target Group	Subject(s)	Method	Time Frame
Contractor's staff, construction labourers	Occupational Safety and Health: Monitoring consultants/ organizations specializing in occupational, health and safety issues can provide training on this issue	Workshops and seminars	During initial phases of construction
Construction labourers	Waste handling and sanitation at construction sites/construction camps	Workshops and signage	During initial phases of construction
During Operation Phase			
Environmental engineers, field officers, contractors,	Long-term Environmental Issues in Project Management: Designing and implementing environmental surveys for ambient air, noise, biological and water quality, data storage, retrieval and analysis, contract documents and environmental clauses, risk assessment and management, contingency planning and management and value addition	Workshops and seminars	During implementation of the project
General public and bridge users	Wildlife protection and environmental protection awareness programme	Signage, workshops	Construction and operation stage

414. It would be essential to understand the legislative framework and enhance capacity of Environmental and Social Unit of RHD and Field Officer (Environment) for analysing the applicability of various environmental legislations and clearances, approvals and compliance monitoring requirements. An environmental legislation applicability matrix framework has already been given in Chapter 2 above for ready reference.

D. Grievance Redress Mechanism

415. To facilitate the resolution of affected people's concerns, complaints, and grievances about the social and environmental performance of the project, a Grievance Redress Mechanism (GRM) is established which aims to provide a time bound and transparent mechanism to voice and resolve social and environmental concerns.

416. Grievances related to the implementation of the project, particularly regarding the environmental management plan will be acknowledged, evaluated, and responded to the complainant with corrective actions proposed using understandable and transparent processes that are gender responsive, culturally appropriate, and readily accessible to all segments of the affected people. The responsibility for addressing the grievances along with proper timelines will be clearly indicated. Records of grievances received, corrective actions taken and their outcomes will be properly maintained and form part of the environmental monitoring report for submission to ADB.

417. The Project Implementation Unit (PIU) of RHD shall make the public aware of the GRM with the support of PIC through methods such as public awareness campaigns. Grievances can be filed in writing or by phone with any member of the PIU or PIC. The following steps procedures will be followed under the GRM.

418. First tier of GRM: The Site Project Manager (PM) under the PIU shall be the designated officer for grievance redress at the first tier. Resolution of complaints will be done within 7 working days. Investigation of grievances will involve site visits and consultations with relevant parties (e.g., affected persons, contractors, traffic police, etc.) Grievances will be documented and personal details (name, address, date of complaint, etc.) will be included, unless anonymity is requested. A tracking number shall be assigned for each grievance, including the following elements:

- initial grievance sheet (including the description of the grievance), with an acknowledgement of receipt handed back to the complainant when the complaint is registered;
- grievance monitoring sheet, mentioning actions taken (investigation, corrective measures); and
- closure sheet, one copy of which will be handed to the complainant after he/she has agreed to the resolution and signed off.

419. The updated register of grievances and complaints will be available to the public at the PM office, construction site, and other key public offices along the project area. Should the grievance remain unresolved within 7 working days, it will be elevated to the second tier.

420. Second tier of GRM: The respective site level PM will activate the second tier of GRM by referring the unresolved issue (with written documentation). The GRC shall be established by the PIU before commencement of site works. The GRC will consist of the following persons: (i) project director; (ii) representative of city ward; (iii) representative of the affected persons; (iv) representative of the local deputy commissioner's office (land); and (v) representative of the Department of Environment (DOE) for environmental related grievances. A hearing will be called with the GRC, if necessary, where the affected person can present his or her concerns and issues. The process will facilitate resolution through mediation. The local GRC will meet as necessary when there are grievances to be addressed. The local GRC will suggest corrective measures at the field level and assign clear responsibilities for implementing its decision within 15 working days.

421. The contractor will have observer status on the committee. If unsatisfied with the decision, the existence of the GRC shall not impede the complainant's access to the government's judicial or administrative remedies.

422. The functions of the local GRC are as follows: (i) resolve problems and provide support to affected persons arising from various environmental issues, including dust, noise, utilities, power and water supply, waste disposal, traffic interference, and public safety, as well as social issues such as land acquisition, asset acquisition, and eligibility for entitlements, compensation, and assistance; (ii) reconfirm grievances of displaced persons, categorize and prioritize them, and aim to provide solutions within a month; and (iii) report to the aggrieved parties about developments regarding their grievances and decisions of the GRC.

423. The respective APD and PM will be responsible for processing and placing all papers before the GRC, maintaining database of complaints, recording decisions, issuing minutes of the meetings, and monitoring to see that formal orders are issued and the decisions carried out.

424. Third tier of GRM: In the event that a grievance cannot be resolved directly by the Project Implementation Unit (PIU) (first tier) or GRC (second tier), the affected person can seek alternative

redress through the city ward committees or in appropriate courts. The PIU or GRC will be kept informed by the city mayor authority.

425. The monitoring reports of the EMP and the resettlement plan implementation shall include the following aspects pertaining to progress on grievances: (i) number of cases registered with the GRC, level of jurisdiction (first, second, and third tiers), number of hearings held, decisions made, and the status of pending cases; and (ii) lists of cases in process and already decided upon, which may be prepared with details such as name, identification (I.D.) with unique serial number, date of notice, date of application, date of hearing, decisions, remarks, actions taken to resolve issues, and status of grievance (i.e., open, closed, or pending).

IX. INFORMATION DISCLOSURE, 3 AND PARTICIPATION

A. Background

426. This section deals with the information disclosure to the public and consultation sessions held with the different stakeholder groups that are likely to be affected by the implementation of the proposed project. The consultation process was carried out as per the guidelines of ADB's SPS 2009 and DOE environmental guidelines.

427. This consultation process had the following objectives:

- Share information with stakeholders on proposed improvement works and expected impacts on the physical, biological and socio-economic environment of the project corridor;
- Understand stakeholders' concerns regarding various aspects of the project, including the existing condition of the road, upgrading requirements, and the likely impact of construction related activities and operation of the improved road;
- Provide an opportunity to the public to influence project design in a positive manner;
- Obtain local and traditional knowledge, before decision making;
- Increase public confidence about the proponent, reviewers and decision makers;
- Reduce conflict through the early identification of controversial issues, and work through them to find acceptable solutions;
- Create a sense of ownership of the proposal in the mind of the stakeholders; and
- Develop the proposal which is truly sustainable.

B. Identification of Stakeholder

428. During the field survey, significant efforts were made to identify the possible categories of stakeholders and their stakes. During the field survey, different stakeholders identified were the villagers, local residents, government officials, shop owners, public representatives and general public.

C. Information Disclosure

429. The discussions were primarily focused on receiving maximum inputs from the participants regarding the project's acceptability and environmental concerns. The purpose of stakeholder consultations is to identify the views of major institutional and project affected persons (PAPs) to the project area being examined, and to identify issues of relevance to the study, as well as any impacts which the project may have on project planned by the stakeholders, and to assess any mitigation measures which may be undertaken to minimize any adverse impacts of the proposals under consideration. This project will indeed be helpful for socio-economic development for central region of the country by timely transporting of essential goods and products required for agricultural and industrial development. Subsequently, stakeholder consultation is one of the important parts of the EIA to address the environmental aspects as well as socio-economic issues from stakeholders' point of view.

430. Stakeholder consultations were held during the site visits from February to May 2013 in different stages of EIA report preparation. Public consultations and Focus Group Discussions (FGDs) with government officials and local people have been conducted continuously during the

EIA study in conformity with the ADB and DOE guidelines. Project staff conducted series of stakeholder consultations at different locations of the project.

431. During consultations, stakeholders were given a brief outline of the project's objectives, type and components of the project in a simplified manner and in their native language. A set of pre-determined common questions were provided to the stakeholders to seek their perception of the project. The discussions with the stakeholders were focused mainly on the following:

- Whether the project will help in providing safety to the people, their property and environment of the area;
- Any significant negative impact of the project on the overall environment of the area,
- Possible effects of the project on fisheries, trees, other habitats, agriculture, wetlands, drinking water availability and local economy;
- Possible impacts of the project during
- execution and commissioning;
- Impact on the flora and fauna was mainly discussed with the officers of the forest department. The effect of air and noise pollution due to the project (during the design and construction stage) and effect on river water quality were focus of discussion with Department of Environment. Biological environment, disturbance on fishing activities and fish productivity, productivity of beels in the study areas of the projects and proposed mitigation measures were discussed at length with Fisheries and Wildlife Department.

432. Roads and Highways Department will continue to carry out consultations with affected people and communities in all phases of the project, to identify and help address safeguard issues that may arise.

D. Compliance with Relevant Regulatory Requirements

433. Public consultation was undertaken as per the ADB and DoE requirements. All the five principles of information dissemination, information solicitation, integration, coordination and engagement into dialogue were incorporated during the task. A framework of different environmental impacts likely from the project was strengthened and modified based on opinions of all those consulted, especially in the micro level by setting up dialogues with the village people from whom information on site facts and prevailing conditions were collected. The requirement of public consultation during the implementation of the project is proposed as part of the mitigation plan.

E. Major Comments Received

434. While a wide range of people from different administrative, social and economic backgrounds were consulted, their concerns and outcome of the consultation along with suggestions made by them are detailed in the following section.

1. Government Officers' Comment

435. Stakeholders from different departments and institutes were consulted. Their concerns are summarized in Table 47.

Table 47: Details of Consultation with Government Authorities for Elenga-Hatikamrul Road Project

Department	Name and Designation of the Government Official	Comments	Suggestions
Roads and Highways Department (RHD)	Rowshan Ara Khanam Superintending Engineer	<ul style="list-style-type: none"> • Priority Roads are priority. • Department will be open to incorporate feasible environmental protection measures in road design. 	<ul style="list-style-type: none"> • Mitigation measures shall be simple and implementable. • RHD is open for the implementable ideas for institutional capacity building
	A. K. M. Mozammel Haque Executive Engineer		
Department of Environment (DOE)	Md. Shahjahan Additional Director General	<ul style="list-style-type: none"> • Sourcing of borrow area earth is a concern in Bangladesh • Needs adequate Baseline Environment Quality Determination for construction and borrow areas. • Effective Measures must be developed for construction and operation stage both. • Sourcing borrow earth from agriculture area is acceptable provided top soil is preserved. 	<ul style="list-style-type: none"> • Obtain prior environmental clearance being it a red category Project. • Collect Soil from Multiple sources such as Char area or from riverbed, which will increase water depth in river and improve navigability of the river.
	Sayed Nazmul Ahsan Deputy Director (Environmental Clearance)		
	Md. Monirul Islam Assistant Director		
	Md. Samsuzzaman Sarker Assistant Director		
Department of Agriculture Extension (DAE)	Dr. Salma Laizu Upazila Agriculture Officer Sirajganj Sadar, Sirajganj	<ul style="list-style-type: none"> • Agricultural land will be affected due to the project implementation • Livelihoods of the families will be affected severely due to acquiring agricultural land. • Noise pollution & Air pollution will be increased during bringing heavy machinery at the stage of construction. 	<ul style="list-style-type: none"> • Avoid agricultural land as much as possible. • Take proper measure to avoid pollution of water reservoirs as these are sources of irrigation. • Tree plantation programme should be according to the government rule and must be in 1:2 ratio. • Ensure the proper sprinkling of water during construction stage to control dust pollution.
	Gowro Gobindo Das Upazila Agriculture Officer Kalihati Upazila, Tangail		
	Banani Karmakar Agricultural Extension Officer Kalihati Upazila, Tangai		
Department of Fisheries (DoF)	Alok Kumar Shaha Upazila Fisheries Officer	<ul style="list-style-type: none"> • Small water channels/ watercourses may be 	<ul style="list-style-type: none"> • Adopt measures to minimise dust, smoke,

Department	Name and Designation of the Government Official	Comments	Suggestions
	Sirajganj Sadar, Sirajganj Habibur Rahman Talukdar Upazila Fisheries Officer Kalihati Upazila, Tangail	abandoned due to non-availability of passages across the road.	and noise pollution, and to control spillages from construction machinery <ul style="list-style-type: none"> • Drainage system will be provided to control surface runoff • Do not wash the construction materials in ponds and ditches. Try to use a fixed place. • Ensure the proper sprinkling of water during construction stage to control dust pollution.
Local Government Engineering Department (LGED)	Moinul Islam Khan Sub Assistant Engineer Sirajganj Sadar, Sirajganj Shahiduzzaman Khan Upazila Engineer Kalihati Upazila, Tangail	<ul style="list-style-type: none"> • This project will reduce some agricultural land because of land acquisition. • Construction activities will cause noise and air pollution. • Tree cutting will create imbalance to local environment. 	<ul style="list-style-type: none"> • Improve general standards of construction • Plant trees along the highway that could reduce air and noise pollution. • To prevent impacts due to noise all the noisy construction activities will be carried out in day time. • Drainage system will be provided to control surface runoff.



Photograph 11: Consultation with Government Officials

436. The summary of the stakeholder consultations conducted with some government officials during the preparation of Environmental Impact Assessment (EIA) and their opinions and suggestions are detailed in the following paragraphs.

437. Department of Environment, Ministry of Environment and Forests has highlighted that sourcing borrow earth is a concern in Bangladesh. Preference must be given to source borrow earth from char area or riverbed. They also highlight the need of establishing adequate Baseline Environment Quality conditions around borrow areas and road construction areas. They also emphasized that adequate mitigation measures must be planned incorporated in the road design. RHD must also obtain prior environmental clearance before start of construction.

438. Department of Agriculture Extension advised to avoid the agricultural land. They also emphasized that though there is enough land under RHD but it would require additional land which will affect farmers' livelihood. They also indicated twice number of trees should be planted against the number of trees cut.

439. Fisheries officers indicated that most of the ponds in this area are seasonal in nature and road development may not have direct impact on fisheries. However there are some reserved ponds, beels and rivers area for fish breeding and culture in the project location but those are far from the ROW. The project activity will not impact on the fisheries practices directly.

2. Focus Group Discussions

440. A focus group is a group of individuals selected and assembled by the environmental specialists to discuss and comment on, from personal experience. Central to successful group discussion was capturing a wide range of opinions about the impact and mitigation because of the road project. The groups consisted of more than five people and they were discussed for approximately half an hour to gather information and opinion they have. Altogether 8 FGDs were held on 10 to 11 May 2013 and 22 March 2017. Approximately 96 participants, including several women, from different locations have taken part in those consultations. The schedules, venues and the participant's lists are given in Appendix K.

441. During the consultation, the participants spontaneously expressed their feelings about the importance of developing the road. They told that the project will remove current stress on road

traffic and will ease their turmoil and reduce their commuting time. Moreover, business sectors will be greatly benefitted due to the improvement of communication system.

442. Most of them told that the local air quality has been degraded from the emission of vehicles and local small industries and other man made sources. The participants expressed that the dredging materials should not be collected from the agricultural land since people are cultivating there. They believe that there will be no major environmental impacts due to the project except a temporary impact of noise and dust from the engine of the construction transport and materials. Most of the people argued that they are willing to endure the temporary negative impact for the sake of the improvement of communication system which will improve their livelihood.

443. During the focus group discussion, people said that there will be no impacts on ground water and surface water. In accordance with people's information there are some wild life found in the area and rarely cross the road or die because of run over by the transport. People also confirmed that there is no Environmental Protected Area in the project area. Finally, all of them were in favour of the project.



Photograph 12: Photos of Focus Group Discussion at Various Locations

444. **Suggestions.** The following suggestions received from the consultation:

- The dredging materials should be properly managed as though local inhabitants face no troubles.
- Dredging materials should be deposited in a proper place that does not harm the local people and agricultural land.
- There should be effective mitigation measures in order to reduce noise pollution and emission from construction vehicles engine and materials.
- Initiatives need to be taken to stop surface water pollution.
- Water should be sprayed 2-3 times in a day to reduce the dust pollution.
- Tree should be planted in 1:2 ratio.
- The road should be straight or dangerous curve should be minimised.
- Keep provision of foot over bridges and flyovers at busy locations.

3. Local People's Comments

445. A number of informal public consultations were held along the priority roads. In all the places, respondents mostly welcomed the project. However, they pointed out few issues of concern like, noise & air pollution, accident hazard along with loss of land and compensation. In the time of field survey 16 local people were interviewed.

Table 48: Details of Consultation with Public in Elenga-Hatikamrul Road Sections

Location	Person Name, Occupation and Contact	Comments	Suggestions
Kalihati, Tangail	Md. Abdus Salam, Cleaner, 01747322624	<ul style="list-style-type: none"> • It is good news and we welcome the project. • Construction stage will create some inconvenience to people but that is tolerable. • Increased traffic may cause air and noise pollution. • Local people will be benefited economically due to more employment opportunities. • Traveling will be fast which will help improve business environment 	<ul style="list-style-type: none"> • Footpath and over-bridge should be constructed in appropriate and convenient (heavily used) locations so that people may use it to avoid accident during road crossing. • Speed-breakers should be constructed near schools, hospitals and religious places. • Tree shall be planted wherever there is space available. • Water should be sprayed 2-3 times in a day to reduce the dust pollution.
	Md. Rohis Uddin, Labour, 01755084699		
	Md. Abdur Sabur, Cleaner, 01727322434		
Sirajganj Sadar, Sirajganj	Md. Shoriful Islam, Business, 01735671741	<ul style="list-style-type: none"> • Accident prone area • Improved road is essential and we welcome the road. 	<ul style="list-style-type: none"> • Road should be straight as it is sharply turning at this place or road ROW should be reduced. • Require safe passage being a growth centre. • Provide underpass at this location to facilitate easy
	Md. Nidan Ali Shak, Business, 01915914416		
	Md. Shafiqul Islam, Business, 01765021257		

Location	Person Name, Occupation and Contact	Comments	Suggestions
	Md. Abu Shama, Labour, 01734381832		movement of people who are moving in large number currently.
	Md. Obaydul Islam, Business, 01760429673		
	Monowarul Islam, Business, 01718929979		
	Md. Abdul Motaleb, Van Puller		
	Md. Ismail Hossain, Driver, 01710133032		
Kamarkh and, Sirajganj	Md. Nurnobi Sarkar, Farmer, 01745081266	<ul style="list-style-type: none"> • Very welcome step from Govt. • Local people will be benefited economically due to more employment opportunities. • Commuting will be fast which will help improve business environment 	<ul style="list-style-type: none"> • Provision shall be made for safe passage of kids. • A foot over bridge may be provided near school. • Water should be sprayed 2-3 times in a day to reduce the dust pollution. • Tree should be planted in 1:2 ratio.
	Md. Jakir Hossain, Student, 01717423571		
	Md. Jahadul Islam, Business, 01719617522		
	Munjur Rahman, Employee, 01713731581		
Royganj, Sirajganj	Md. Alauddin, Student, 01735660100	<ul style="list-style-type: none"> • Difficult to cross the road due to heavy traffic, accident prone • Road development is welcome 	<ul style="list-style-type: none"> • Make appropriate measures in road design for safe passage. • Water should be sprayed 2-3 times in a day to reduce the dust pollution. • Tree should be planted in 1:2 ratio.

446. A brief summary of comments of local people is presented in the following sections:

- Most of the people who were interviewed in the project area welcome the road expansion project as this is expected to improve the connectivity. Farmers have positively reacted to the development considering that better communication facility will fetch them better farm price. However, roadside shopkeepers and farmers have concern of loss of business due to widening of road and loss of livelihood.
- The people in the project areas were less concerned about the environmental problems, such as, air and noise pollution, top soil removal problem that may arise due to pre and post operation of road construction. However, they have raised concern regarding dust pollution and noise pollution near religious places and

schools and suggested for adoption of appropriate mitigation measures for the control of it.

- The local people also mentioned that the environmental impact due to the proposed project is minor and short term. However, some mitigation measures should be taken during construction of the road, such as water spray to reduce dust pollution, tree plantation, and working hour should be only in day time and particularly if it will near the residential area.
- People have raised concern of accident during road crossing near village due to increasing traffic. They have strongly demanded provision of foot over bridge and speed breaker. They also demanded for traffic management near big junctions like Elenga, Kodda Moor and Hatikamrul.
- Local people are of strong opinion for the early implementation of the project.

4. Findings of Public Consultation

447. Public consultation is one of the key components of the environmental assessment. A number of informal public consultations were held along the priority road. Two consultation meetings were arranged at Kodda Moor and Pachlia Bazar Sirajganj to inform the potential affected people about goals and objective of the project, probable timeline of starting civil construction, roles and responsibilities of the project authority and affected people/stakeholders, probable impacts and mitigation measures. The local people including representative of the Bazar Committee, local residence, businessmen and potential affected people were present in the meeting. Attendance sheet, consultation outcome are briefly described in Appendix G.

448. In consultation meeting both environmental and social issues were examined. The main focus was to dig out information on how does indiscriminate use of natural resources cause poverty and environmental degradation by declining the homestead forests, depleting biodiversity and decreasing livelihood of people. The issue on potential impact of construction works has also been raised.

449. **Suggestions.** The following suggestions received from the public consultations:

- As most of the people engaged in business at the roadsides so rehabilitation program should consider appropriate measure with decent compensation.
- Local employment need to be created during the construction phases which can be a good option for livelihood development.
- There should be acceptable and effective mitigation measures in order to reduce noise and dust pollution. Tree plantation and construction of noise protection walls is suggested.
- Improved technology can be used to mitigate noise pollution.
- Drainage system should be developed to prevent water logging in that urban area.
- Water could be sprayed at the construction site in order to reduce dust, particularly during the construction phase.



Photograph 13: Photos of Public Consultation

5. Integration of comments

450. As observed from their responses, almost everyone interviewed was supportive of the project and believes that it will help to provide the much-needed connectivity and development to the region.

451. During discussions, notes were taken for any issue raised and suggestions made. These were collated for a comprehensive analysis of the concerns raised. References have been taken from public opinion where no official data were available, while the officially available data have been extensively used for understanding of the project area characteristics. Each of the issues was then analysed on practical and scientific basis and accorded a likewise importance in terms of their magnitude in impacts and mitigation. For any significant concern, preventive or mitigation measures have been suggested drawing points from all the suggested measures.

X. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

452. The conclusions are, in fact, summary of findings of the EIA study, which provide valuable input to the decision-makers to take informed decisions. This environmental impact assessment (EIA) concludes that the environmental impacts will be manageable if the mitigation measures are implemented thoroughly. The EMP is based on the type, extent, and duration of the identified environmental impacts. The EMP has been prepared with close reference to best practices and in line with the ADB's Safeguards Policy Statement (SPS) and DoE environmental guidelines.

453. The project is classified 'B' in accordance with ADB's Safeguard Policy Statement 2009 requiring preparation of an Initial Environmental Examination Report. As per the Environmental Conservation Act, 1995 of Bangladesh, the project falls under Red category and requires preparation of an EIA. This report is prepared following the ADB and GOB environmental requirements.

454. This EIA study was carried out when the Elenga-Hatikamrul road project was at the detailed design stage of ADB Loan 2688-BAN. Essentially primary data was used to assess the environmental impacts in a comprehensive manner. Site survey for environmental data collection, public consultation and specific studies (flora, fauna, land use, hydrology) were carried out to complete the environmental impact assessments and recommend suitable mitigation measures. The potential environmental impacts were assessed in a comprehensive manner. The EIA report assesses the potential environmental impacts associated with the Elenga-Hatikamrul road project, and suitable mitigation measures have been recommended. In case any design details of the Elenga-Hatikamrul are changed, the EIA and EMP shall be reviewed and revised accordingly and submitted to DOE & ADB for acceptance.

1. Environmental Gains Due to Proposed Work Justifying Implementation

455. The project entails various impacts on the project setting. There are many impacts bearing benefits to the area against the limited number and magnitude of negative impacts. These include the following: (i) the project will substantially improve the transport efficiency on the road linking the North and North-west region of Bangladesh to Dhaka and the southeast road corridor (to Chittagong). (ii) This will also contribute in integrating the southwest region into the national economy. (iii) The project once implemented will improve the overall environmental conditions with better roads and environmental protection measures (iv) will reduce traffic congestion and related air pollution due to idling of the vehicles and widening as well as provision of flyover and underpasses.

2. Potential Impacts, Mitigation, Management and Monitoring

456. The Elenga-Hatikamrul Road offers a robust option for the enhancement of the existing road-based transportation network. Several actions are required during the detailed design stage to minimize impacts to acceptable levels. The negative environmental impacts from the project will mostly take place during the construction stage since there are no significant cumulative adverse impacts during operation that are identifiable at this stage. The construction impacts should be very predictable and manageable, and with appropriate mitigation, few residual impacts are likely. Additional human and financial resources will be required to improve environmental capability, and to progress and achieve necessary statutory compliance and environmental clearance certification for the Elenga-Hatikamrul road project or associated activities that also

require environmental assessment and environmental permits under the environmental laws of Bangladesh.

457. The finding of EIA indicates that the project is unlikely to cause any significant adverse environmental impacts. The proposed project road expansion does not pass through or located nearby any national park, wildlife sanctuary, reserved forests, or any other ecologically sensitive or areas. No archaeological/protected monument is located in the project vicinity. The land use pattern around the alignment is predominantly agricultural.

458. However, there are some negative impacts but many bearing benefits to the area. Most of the negative impacts are likely to occur during construction stage and are temporary in nature. Some impacts require design consideration and are suitably addressed. The land use pattern around the road alignment primarily includes fallow land, agriculture land, rural settlement, and perennial or non-perennial water bodies. Urban settlement is also there but most of the populated locations either provision of flyover has been made or best engineering measures like RCC wall are taken to minimize the social impact. The impact is primarily caused due to land clearing for widening the carriageway, cutting of roadside full grown trees, borrowing of earth, transportation of construction material, loss of water bodies/fish ponds, and construction of bridge. The impacts are with regard to loss of terrestrial flora, impact on aquatic fauna, soil compaction, water contamination, and change in ambient air quality, water quality, and increase in ambient noise levels. During the operation, direct local impacts are mostly related to noise levels, air quality and road accidents. Some sections of the entire road are threatened by floods of average flood return period of 2.33 years. Provisions have been recommended for the road elevation keeping the HFL level keeping this threat in view. Implementation of the prescribed mitigation measures will minimize the adverse impacts. Moreover, the impacts shall be monitored continually by implementing and updating the Environmental Management Plan and Environmental Monitoring Plan.

459. During the construction stage, some trees along the road are likely to be cut but if the proposed compensatory afforestation plans are effectively implemented and survival rate is monitored and sustained, the positive benefits are likely to be accrued. Some old trees are located along the project road. These trees play vital role for the environmental conditions of the area. Efforts are proposed to minimize cutting of these trees with suitable modifications in the road alignment/widening options. However, there are no legislative restrictions in cutting these trees. There are no other environmental sensitive resources found in the project area, which is likely to be affected due to the project.

460. The project is welcomed by all the stakeholders and received immense support from local people. The local people appreciated that besides providing an all-weather efficient connectivity to large rural populations and improving the traffic scenario in the region, it will bear out several other socio-economic positive benefits. The suggestions received from the public/stakeholders have been integrated while developing the mitigation measures and Environmental Management and Monitoring Plan.

3. Post EIA Surveillance and Monitoring

461. While an EIA is meant to provide a comprehensive understanding of the environment status of the area under the study, post EIA surveillance is the means to ensure that the significant impacts identified are adequately mitigated as per the proposed mitigation plan. A detailed monitoring plan has been provided as part of the Environmental Management Plan.

462. Environmental impact and compliance monitoring activities will focus on compliance with conditions of licenses from DOE and EMP provisions, recording implementation of mitigation measures, recording environmental parameters, reviewing contractor environmental performance, and proposing remedial actions to address unexpected impacts and complaints.

463. The EMP prepared for the project (Chapter 6) will be used as basis for an environmental compliance program in a regular program of environmental monitoring and auditing. In addition, any conditions included as part of the environmental compliance certificate from the government (MOEF/DOE) will also be included as a basis for environmental monitoring and compliance. Therefore, monitoring of (i) the implementation of mitigation measures and (ii) the implementation of the conditions of environmental compliance will be carried out regularly as scheduled in the EMP, and results will be reported semi-annually to ADB and DOE.

4. Public Consultations

464. The project received support and consent from most of local people including those who will be rehabilitated, provided adequate compensation is paid. The local people did not perceive any adverse impact due to the proposed project. Environmental awareness and likewise concern were found generally low. Nevertheless, local stakeholders did raise concern regarding cutting of old trees of the area.

B. Recommendations

465. The EMP, its mitigation and monitoring programs, contained herewith shall be included within the Bidding documents for project works. The Bid documents state that the contractor shall be responsible for the implementation of the requirements of the EMP through his own Site Specific Environmental Management Plan which will adopt all the conditions of the EMP and add site specific elements that are not currently known, such as the Contractors borrow pit locations. This ensures that all potential bidders are aware of the environmental requirements of the project and its associated environmental costs.

466. The EMP and all its requirements shall then be added to the contractor's contract, thereby making implementation of the EMP a legal requirement according to the contract. He shall then prepare his CEMP which will be approved and monitored by the Engineer/Environmental Specialist. To ensure compliance with the CEMP the contractor should employ a national environmental specialist to monitor and report project activities throughout the project construction phase.

467. RHD has Social and Environmental Circle but they need capacity building and practical exposure. Adequate training shall be imparted as proposed under environmental management plan to enhance the capability of concerned EA officials. It is recommended to update environmental guidelines focused on effective implementation of mitigation measures. Performance indicators may also be developed as part of these guidelines to monitor and assess the effectiveness of the mitigation measures.

468. The Initial Environmental Examinations and Environmental Management Plans for the establishment of Research and Training Centre (RRTC) and Road Operations Unit (ROU) will be prepared by the Project Implementation Consultant (Supervision Consultant) after the detailed designs are prepared.

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APPENDIX A: TERMS OF REFERENCE FOR THE IEE STUDY

TERMS OF REFERENCE FOR ENVIRONMENTAL IMPACT ASSESSMENT OF ROAD DEVELOPMENT PROJECTS UNDER SUBREGIONAL TRANSPORT PROJECT (SRTP)

A. Background

1. The Government of Bangladesh (GoB) has received a loan from Asian Development Bank (ADB) for the Subregional Transport Project Preparatory Facility under Technical Assistance for Subregional Road Transport Project Preparatory Facility (ADB Loan 2688-BAN). GoB has resolved to apply a portion of the loan to meet the expenditure for consultancy services to be rendered by international consultants to prepare (a) feasibility studies and (b) detailed engineering designs for upgrading selected national highways and zilla roads from 2-lanes to 4-lanes to promote subregional development. The Ministry of Communications (MOC) is the Executing Agency and Roads and Highways Department (RHD) is the Implementation Agency.

2. The environmental impact assessment (EIA) process will be based on current information, including an accurate project description, and appropriate environmental and social baseline data. In the environmental assessment, Roads and Highways Department (RHD) as the project proponent will consider all potential impacts and risks of the road development works on physical, biological, socioeconomic (occupational health and safety, community health and safety, vulnerable groups and gender issues, and impacts on livelihoods and physical cultural resources) in an integrated way. This TOR is prepared to carry out detailed EIA study for the 'Subregional Transport Project Preparatory Facility' in accordance with the relevant laws and regulations in Bangladesh and the Asian Development Bank's Safeguard Policy Statement, 2009. The study will be carried out by the design consultant during 2012-2014 and the EIA report will be submitted along with the EMP to DOE and ADB for approval.

3. As part of the EIA the project proponent will prepare an environmental management plan (EMP) that addresses the potential impacts and risks identified by the environmental assessment. The EMP will include the proposed mitigation measures, environmental monitoring and reporting requirements, emergency response procedures, related institutional or organizational arrangements, capacity development and training measures, implementation schedule, cost estimates, and performance indicators. Where impacts and risks cannot be avoided or prevented, mitigation measures and actions will be identified so that the project is designed, constructed, and operated in compliance with applicable laws and regulations and meets the requirements specified in this document.

B. Project Location

4. The road development project under SRTP covers a vast area of Bangladesh. The length of the roads of this project is 961km and located in South-central to Southern, South-Western, North-Western, and Northern parts of Bangladesh. The road alignment crosses a total of 21 districts and 2 major rivers, Jamuna and Padma. The districts it will cross are Khulna, Bagerhat, Borguna, Patuakhali, Jhalokathi, Barisal, Madaripur, Gopalganj, Faridpur, Munshiganj, Dhaka, Gazipur, Tangail, Sirajganj, Natore, Rajshahi, Nawabganj, Bogra, Gaibandha, Rangpur and Lalmonirhat. The project location Map with priority details is shown in Figure A-1 .

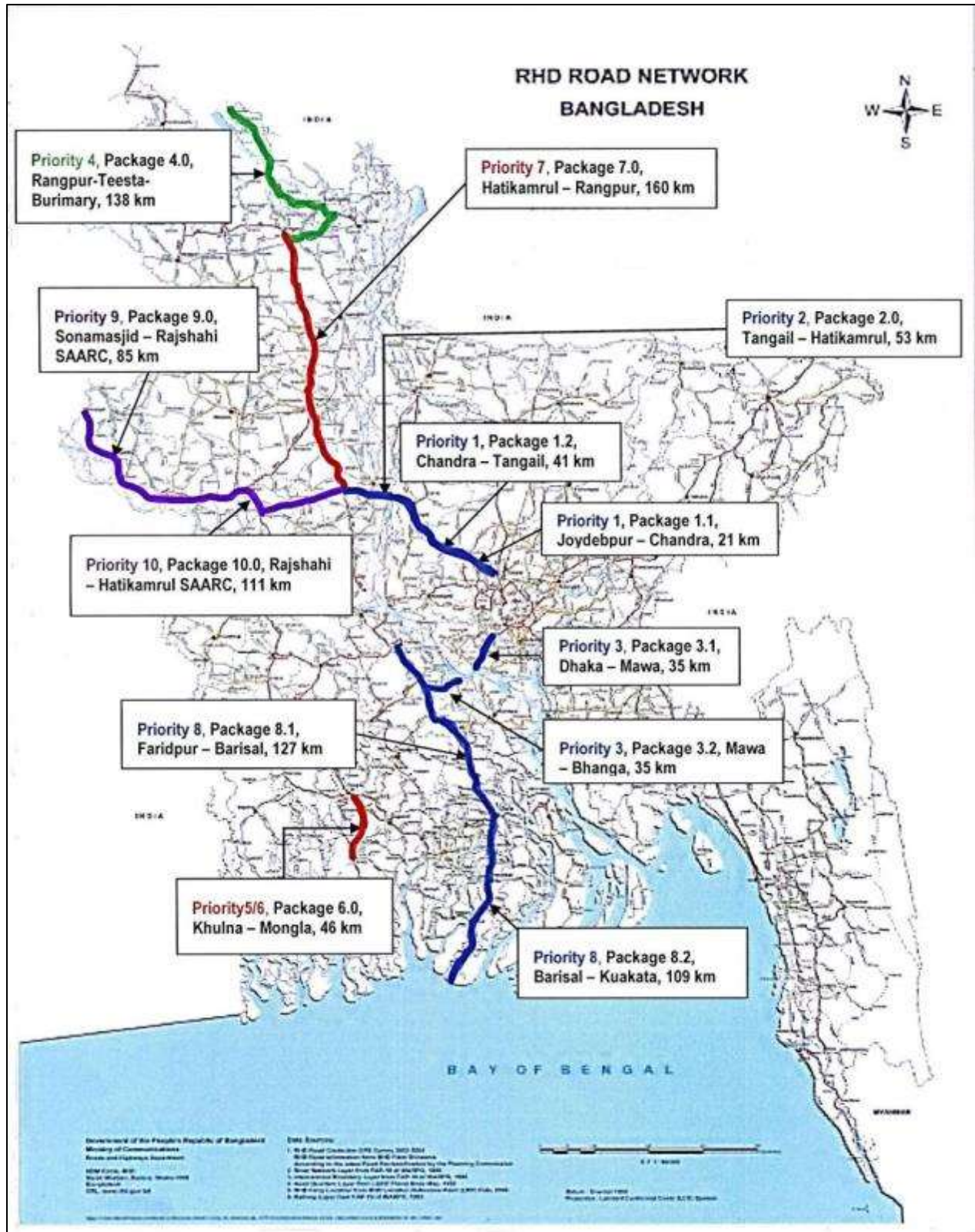


Figure A-1: Location Map of Road with Priority Details

B. Project Components

5. The SRTP consists of the following roads are being considered for upgrading:
- Design Package No. 1 – Joydevpur-Chandra-Tangail road section in N4 and N405 (70km)
 - Design Package No. 2 – Tangail-Hatikamrul (40km)
 - Design Package No. 3 – Dhaka-Mawa-Bhanga road section in N8 (70km)
 - Design Package No. 4 – Upgrading of Rangpur-Teesta-Burimari Road into 4-lane highway (138km)
 - Design Package No. 5 – Construction of a bridge over the river Mongla at Mongla on Khulna-Mongla Road
 - Design Package No. 6 – Upgrading of Khulna-Mongla Road into 4-lane highway with link to Dhigraj to Mongla Ferry Ghat (46km)
 - Design Package No. 7 – Upgrading of Hatikamrul-Rangpur National Highway into 4-lane highway (160km)
 - Design Package No. 8 – Faridpur-Barisal-Kuakata road section in N8 (236km)
 - Design Package No. 9 – Upgrading of Sonamasjid-Rajshahi Road into 4 lane highway (Asian Highway, SAARC Corridor: Regional Corridors identified in SAARC Regional Multimodal Transport Study) (85km)
 - Design Package No. 10 – Rajshahi-Hatikamrul Road into 4 lane highway (Asian Highway, SAARC Corridor: Regional Corridors identified in SAARC Regional Multimodal Transport Study) (111km)
6. As some of the packages consist of upgrading different sections of the same road, these sections would be considered together in a single EIA but with separate Environmental Management Plans for each package.

C. Objectives

7. The main objective of the EIA study is to assess both positive and negative environmental impacts due to each project activities. Assess the impacts and recommend appropriate mitigation measures during preconstruction, construction, and operation phases to minimize negative impacts of the project to acceptable levels. Prepare ten (10) EIA including EMP for SRTP in compliance with the Government and ADB requirements and obtain Environmental Clearance Certificate (ECC) from the Department of Environment, Bangladesh.

D. Scope of Work

1. Baseline Studies

a. Legal and Administrative Procedure

- Collection and review of relevant information regarding environmental legislation, statutory orders, by-laws, etc. connected to preparation and approval of the EIA report by the Department of Environment, and draft the memo. The memo will also consider the requirements of ADB Guidelines.
- Conduction of meetings with the Department of Environment, the Ministry of Environment and Forest (MoEF), and the Roads and Highways Department (RHD). During these meetings appropriate legal and administrative procedures

has been discussed. Review of other relevant environmental laws, regulations, Norms, and Standards on Air, Noise, Vibration, Water, Waste, and Wildlife.

- Conduction of discussion meeting with the Department of Environment particularly for “Environmental Clearance Certificate” in accordance with the Environment Conservation Act, 1995 and Bangladesh Environment Conservation Rules, 1997.

2. Stakeholder Consultation

8. Conduction of Stakeholder Group meetings to ensure relevance of the project to the interests of the people of the project area and hence sustainability of the project; and to seek views and suggestions toward identifying important environmental components (IECs) for environmental assessment and ascertain their degree and ranking. The proposed Stakeholder Group meeting will also help determine potential social, economic and cultural impacts due to the project. Targeted Stakeholder Group is to comprise members of the civil society, professional groups, etc. To provide local communities and socio-economic interest groups with the foundation for their role in detailed design project interventions and, hence, participation in project planning, implementation, operation and maintenance.

3. Preparation of Baseline Assessment

9. Review of reports and secondary data collected from the project’s feasibility study. Feasibility study and the study conducted by the RHD as well as the studies on similar projects carried out under ADB funding.

Collection of general baseline information on existing environmental condition in the project influence area and environmental quality baseline monitoring along the project corridor and identification of the environmental components that need detailed study. Baseline assessment will be done based on the available secondary information, field visits, sampling and environmental monitoring including but not limited to the following:

- (i) Physical Resources:
 - Topography, climate, soils, geology, land use, aquatic resources, and surface and groundwater resources.
- (ii) Environmental Risks:
 - Cyclones, tornadoes, droughts, floods, earthquakes, road accidents, etc.
- (iii) Ecological Resources:
 - Landscape and natural ecosystem, flora and fauna, wildlife and wetland habitats, and protected areas.
- (iv) Environmental Quality:
 - Air (SPM, PM₁₀, CO, CO₂, NO_x, SO_x, O₃ etc.): Air samples should be collected from the existing road alignment to identify the baseline and air quality in the project area.
 - Noise quality: Noise level should be measured along the highway roads during day and night times to identify the baseline and present noise level in the project area.
 - Groundwater quality (pH, Mn, Fe, As, Total hardness as CaCO₃, Coliforms, Chlorine as Cl⁻): Samples should be tested for baseline setup and identifying the present status of groundwater for drinking purpose.
 - Surface Water Quality (pH, BOD, Chlorine as Cl⁻, COD, TDS, TSS, DO, EC, Fe): Samples should be tested for baseline setup and identifying the quality of the surface water.
 - River-bed dredged materials: (Zn, Cu, Hg, Pb, Cd, and As): Samples should be collected from the dredged sites at a reasonable depth. Samples should be tested

for identifying the baseline chemical properties of the dredged materials and the suitability of the material to be used for road embankment, and service area, etc.

(v) Cultural Resources Sites:

- Structures or sites those are of historical, religious, or architectural significance.

C. Detailed Field Investigation to Screen Environmental Impacts

1. Field Investigation and Analysis of Results

10. Collection of cadastral maps showing the project locations and descriptions of the surrounding activities. This is to ensure that the project is compatible with the national regulation specified for construction sites.

11. Initiation of necessary investigations and fieldwork for gathering of additional information on ecological and environmental baseline parameters of the Important Environmental Components (IECs) selected during the previous studies in the project area.

- (i) Physical Environment
 - Regional Hydrology and Flood Pattern,
 - Drainage Congestion,
 - River Erosion and Siltation, and
 - Landuse
- (ii) Ecological Environment
 - Agriculture,
 - Tree Plantation/Felling,
 - Water bodies and Fisheries, and
 - Wildlife
- (iii) Environmental Pollution
 - Surface and Ground Water Quality,
 - Air Pollution,
 - Noise and Vibration,
 - Soil Contamination including dredged spoil, and
 - Pollution due to Waste
- (iv) Social Environment
 - Land Acquisition,
 - Homestead,
 - Irrigation and Agricultural Production,
 - Cultural Resources Loss,
 - Navigation/Water Transport,
 - Health and Safety,
 - Employment Opportunities,
 - Women Empowerment,
 - Infrastructure and Industry,
 - Split of Communities,
 - Road Transport,
 - Road Accident, and
 - Tourism

2. Anticipated Environmental Impacts and Mitigation Measures

12. This section will predict and assess the project's likely positive and negative direct and indirect impacts on physical, biological, socioeconomic (including occupational health and safety,

community health and safety, vulnerable groups and gender issues, and impacts on livelihoods, and physical cultural resources) environment in the project's area of influence, in quantitative terms as far as possible; identify mitigation measures and any residual negative impacts that cannot be mitigated; explore opportunities for enhancement; identify and estimate the extent and quality of available data, key data gaps, and uncertainties associated with predictions and specifies topics; and examine transboundary, and cumulative impacts as appropriate.

D. Environmental Management Plan

13. In this section RHD will incorporate the set of mitigation and management measures to be adopted during project implementation to avoid, reduce, mitigate, or compensate for adverse environmental impacts (in that order of priority). It may include multiple management plans, sub plans and actions. It will include the following key components:

- (i) Mitigation: Under mitigation the EMP will:
 - (a) identify and summarize anticipated significant adverse environmental impacts and risks;
 - (b) describe each mitigation measure with technical details, including the type of impact to which it relates and the conditions under which it is required (for instance, continuously or in the event of contingencies), together with designs, equipment descriptions, and operating procedures, as appropriate; and
 - (c) provide links to any other mitigation plans (for example, for involuntary resettlement) required for the project.
- (ii) Monitoring: Under monitoring the EMP will:
 - (a) describe monitoring measures with technical details, including parameters to be measured, methods to be used, sampling locations frequency of measurements, detection limits and definition of thresholds that will signal the need for corrective actions; and
 - (b) describe monitoring and reporting procedures to ensure early detection of conditions that necessitate particular mitigation measures and document the progress and results of mitigation.
- (iii) Implementation arrangements: Under the implementation arrangements the EMP will:
 - (a) specify the implementation schedule showing phasing and coordination with overall project implementation;
 - (b) describe institutional or organizational arrangements, namely, who is responsible for carrying out the mitigation and monitoring measures, which may include one or more of the following additional topics to strengthen environmental management capability: technical assistance programs, training programs, procurement of equipment and supplies related to environmental management and monitoring, and organizational changes; and
 - (c) estimate capital and recurrent costs and describe sources of funds for implementing the environmental management plan.
- (iv) Performance indicators: Here the desired outcomes as measurable events will be described to the extent possible, such as performance indicators, targets, or acceptance criteria that can be tracked over defined time periods.

E. Institutional Arrangement, Capacity building and Grievance Redress Mechanism

14. Assessment of institutional capacity of the implementing agencies for effective implementation of environmental management and monitoring plan. Identification of responsible

institutes for implementation and supervision of the Environmental management and monitoring plan (EMMP). Assess training needs of these agencies and propose capacity building measures and institutional arrangements to strengthen these agencies along with the cost estimates.

15. In this section RHD will describe the grievance redress framework (both informal and formal channels), prepared for the road development projects, setting out the time frame and mechanisms for resolving complaints about environmental performance.

F. Information Disclosure, Consultation, and Participation

15. This section will:

- (i) describe the process undertaken during project design and preparation for engaging stakeholders, including information disclosure and consultation with affected people and other stakeholders;
- (ii) summarize comments and concerns received from affected people and other stakeholders and how these comments have been addressed in project design and mitigation measures, with special attention paid to the needs and concerns of vulnerable groups, including women, the poor, and Indigenous Peoples; and
- (iii) describe the planned information disclosure measures (including the type of information to be disseminated and the method of dissemination) and the process for carrying out consultation with affected people and facilitating their participation during project implementation.

G. Conclusion and Recommendation

16. This section will provide the conclusions drawn from the assessment and present the recommendations.

H. EIA Study Team

17. The EIA team has been included in the following team:

1. National Environmental Specialist-1	08 months
2. National Environmental Specialist-2	12 months
3. Junior Environmental Specialist-1	17 months
4. Junior Environmental Specialist-2	07 months

18. RHD will be responsible to coordinate with the Consultant to carry out the EIA study along with EMP in accordance with environmental guidelines of ADB and GOB within the project stipulated time schedule. The Environment and Social Circle of RHD will monitor the EIA and EMP activities on a regular basis and review all environmental reports prepared by the Environmental Team of the Consultant.

I. Work Program and Personal Schedule

19. The duration of the preparation of the 10 EIA including EMP will be about 18 months. The work program and personnel schedule is provided in Annex-1.

J. EIA Report Structure

20. The EIA report will be prepared following the DOE guidelines and ADB safeguard policy statement 2009. The EIA reports prepared by RHD will contain the following Chapters:

Executive Summary

1. Introduction
2. Policy, Legal and Administrative Framework
3. Description of the Project
4. Description of the Environment (Baseline Data)
5. Anticipated Environmental Impacts and Mitigation Measures
6. Environmental Management Plan
7. Institutional Arrangement, Capacity Building and Grievance Redress Mechanism
8. Information Disclosure, Consultation and Participation
9. Conclusions and Recommendations

APPENDIX B: DOE APPROVAL OF THE TOR

Government of the People's Republic of Bangladesh
 Department of Environment
 www.doc-bd.org
 Head Office, Paribesh Bhaban
 E-16 Agargaon, Dhaka-1207

Memo No: DoE/Clearance/5195/2013/ 117

Date: 20 May, 2013

Subject: Approval of Terms of Reference for Environmental Impact Assessment (EIA) in favour of Sub-Regional Road Transport Project (Road Component Package-1).

Ref: Your application received on 04 March 2013.

With reference to your letter dated 04.03.2012 for the subject mentioned above, the Department of Environment hereby gives approval of TOR for Environmental Impact Assessment (EIA) in favour of Sub-Regional Road Transport Project (Road Component Package-1) subject to fulfilling the following terms and conditions.

1. Roads and Highways Department (RHD) shall conduct a comprehensive Environmental Impact Assessment (EIA) study considering the overall activity of each component under package-1 of the said Project in accordance with the TOR submitted to the DOE and additional suggestions provided herein.
2. The EIA report should be prepared in accordance with following-indicative outlines:
 1. Executive summary
 2. Introduction: (Background, brief description, scope of study, methodology, limitation, EIA team, references)
 3. Legislative, regulation and policy consideration (covering the potential legal, administrative, planning and policy framework within which the EIA will be prepared)
 - 4a. Project activities: A list of the main project activities to be undertaken during site clearing, construction as well as operation.
 - 4b. Project schedule: The phase and timing for development of the PMBP
 - 4c. Resources and utilities demand: Resources required to develop the project, such as soil and construction material and demand for utilities (water, electricity, sewerage, waste disposal and others), as well as infrastructure (road, drains, and others) to support the project.
 - 4d. Map and survey information
Location map, Cadastral map showing land plots (project and adjacent area), Geological map showing geological units, fault zone, and other natural features.
 5. Baseline Environmental Condition should include, inter alia, following:
 - Physical Environment : Geology, Topology, Geomorphology, Soils, Meteorology, and Hydrology.
 - Biological Environment : Habitats, Aquatic life and fisheries, Terrestrial Habitats and Flora and Fauna
 - Environment Quality : Air, Water, Soil and Sediment Quality.
 6. Soio-economic environment should include, inter alia, following:
 - Population: Demographic profile and ethnic composition
 - Settlement and housing
 - Traffic and transport
 - Public utilities: water supply, sanitation and solid waste
 - Economy and employment: employment structure and cultural issues in employment
 - Fisheries: fishing activities, fishing communities, commercial important species, fishing resources, commercial factors.

9A.

7. Identification, Prediction and Evaluation of Potential Impacts (identification, prediction and assessment of positive and negative impacts likely to result from the proposed project).

In identification and analysis of potential impacts'-the 'Analysis' part shall include the analysis of relevant spatial and non-spatial data. The outcome of the analysis shall be presented with the scenarios, maps, graphics etc. for the cases of anticipated impacts on baseline. Description of the impacts of the project on air, water, land, hydrology, vegetation-man made or natural, wildlife, socio-economic aspect shall be incorporated in detail.

8. Management Plan/Procedures:

For each significant major impact, proposed mitigation measures will be set out for incorporation into project design or procedures, impacts, which are not capable of mitigation, will be identified as residual impacts Both technical and financial plans shall be incorporated for proposed mitigation measures..

An outline of the Environmental Management Plan shall be developed for the project.

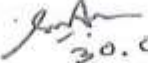
In Environmental Monitoring Plan, a detail technical and financial proposal shall be included for developing an in-house environmental monitoring system to be operated by the proponent's own resources (equipments and expertise).

9. Consultation with Stakeholders/Public Consultation (ensures that consultation with interested parties and the general public will take place and their views taken into account in the planning and execution of the project)

Beneficial Impacts (summarize the benefits of the project to the Bangladesh nation, people and local community and the enhancement potentials)

10. Conclusion and Recommendations

3. Without approval of EIA report by the Department of Environment, Roads and Highways Department (RHD) shall not be able to open L/C in favor of importable machineries.
4. Without obtaining Environmental Clearance, Roads and Highways Department (RHD) shall not start operation of each component under package-1 of this project.
5. Roads and Highways Department (RHD) shall submit the EIA along with a filled-in application for Environmental Clearance in prescribed form, the applicable fee in a treasury chalan, the no objection certificates (NOCs) from the local authority, NOC from forest department (if it is required in case of cutting any forested plant/trees-private or public), NOC in favor of Cutting/Dressing (if it is required) of Hill/Hillock from the concerned authority and NOC from other relevant agencies for operational activity etc. for each component under package-1 of this project to the concerned Divisional office of DOE with a copy to the Head office of DOE in Dhaka.
- 6.


30.05.2013

(Syed Nazmul Ahsan)
Deputy Director (Environmental Clearance)
and
Member Secretary
Environmental Clearance Committee

Mr. Dilip Kumar Guha

Project Director & Additional Chief Engineer
Roads & Highways Department (RHD)

Technical Assistance for Subregional Road Transportation Project Preparatory Facility
132/4, New Baily Road, Dhaka.

Copy Forwarded to :

- 1) PS to Secretary, Ministry of Environment and Forest, Bangladesh Secretariat, Dhaka.
- 2) Director, Department of Environment, Khulna/Barisal Divisional Office, Khulna/Barisal.
- 3) Assistant Director, Office of the Director General, Department of Environment, Head Office, Dhaka.

APPENDIX C: RAPID ENVIRONMENTAL ASSESSMENT CHECKLIST

Rapid Environmental Assessment (REA) Checklist

Instructions:

- (i) The project team completes this checklist to support the environmental classification of a project. It is to be attached to the environmental categorization form and submitted to the Environment and Safeguards Division (RSES), for endorsement by Director, RSES and for approval by the Chief Compliance Officer.
- (ii) This checklist focuses on environmental issues and concerns. To ensure that social dimensions are adequately considered, refer also to ADB's (a) checklists on involuntary resettlement and Indigenous Peoples; (b) poverty reduction handbook; (c) staff guide to consultation and participation; and (d) gender checklists.
- (iii) Answer the questions assuming the "without mitigation" case. The purpose is to identify potential impacts. Use the "remarks" section to discuss any anticipated mitigation measures.

Country/Project Title: Bangladesh:SASEC-Dhaka Northwest Corridor Road Project, Phase 2 (Elenga-Hatikamrul (EH) Road)

Sector Division: South Asia Transport and Communication Division

Screening Questions	Yes	No	Remarks
A. Project Siting			
Is the project area adjacent to or within any of the following environmentally sensitive areas?			
▪ Cultural heritage site		✓	The road passes through some villages and bazars and few community resources like school, and mosque are located near the roads. Some of these cultural sites will be directly affected because of the widening of the existing road.
▪ Protected Area		✓	There are no protected areas in or within 5km of the project area that might be directly affected because of the project.
▪ Wetland	✓		There are small ponds linked to certain rivers. However, none of them are protected or rich in biodiversity.
▪ Mangrove		✓	None
▪ Estuarine		✓	None
▪ Buffer zone of protected area		✓	The road does not pass through any buffer zone of protected area.
▪ Special area for protecting biodiversity		✓	None
B. Potential Environmental Impacts			
Will the Project cause...			
▪ Encroachment on historical/cultural areas; disfiguration of landscape by road embankments, cuts, fills, and quarries?	✓		No encroachment on historical but some religious areas are envisaged. The topography of project road is mainly flat. However, minor impacts on landscape are unavoidable due to increase in elevation and widening of road embankment and side roads for slow moving vehicles.

Screening Questions	Yes	No	Remarks
<ul style="list-style-type: none"> ▪ Encroachment on precious ecology (e.g. sensitive or protected areas)? 		✓	The project road does not pass through any National Park/Wildlife Sanctuary.
<ul style="list-style-type: none"> ▪ Alteration of surface water hydrology of waterways crossed by roads, resulting in increased sediment in streams affected by increased soil erosion at construction site? 	✓		<p>There is a bridge with the existing road and this bridge will be reconstructed. The bridge construction may temporarily increase the sedimentation level in the river around bridge construction site. However, this would only be temporary and short term in nature.</p> <p>All measures shall be taken during construction stage so that watercourses are not affected and temporary soil and rock stockpiles will be designed so that runoff will not induce sedimentation of waterways.</p>
<ul style="list-style-type: none"> ▪ Deterioration of surface water quality due to silt runoff and sanitary wastes from worker-based camps and chemicals used in construction? 	✓		<p>Suitable siltation prevention measures such as silt fencing is included in the EMP.</p> <p>Adequate measures for sanitary and construction related waste such as chemicals shall be taken to prevent contaminating local water resources.</p>
<ul style="list-style-type: none"> ▪ Increased local air pollution due to rock crushing, cutting and filling works, and chemicals from asphalt processing? 	✓		Local air pollution level will likely increase for short duration during construction period particularly due to earth work. Appropriate distance from settlement area and wind direction will be considered to locate air polluting facility like stone crushing unit etc. if required.
<ul style="list-style-type: none"> ▪ Risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during project construction and operation during project construction and operation? 	✓		Construction activities could cause accidents and health risks to workers. Occupational health and safety measures will be mandatory for the contractor.
<ul style="list-style-type: none"> ▪ Noise and vibration due to blasting and other civil works? 	✓		<p>Ambient noise level is expected to increase in the range of 80-90 dB(A) due to various construction activities, maintenance workshops, and earthmoving equipment for short durations. The impact due to noise during construction activities will be minimal to inhabitants since most of the built-up areas are located at safe distances from the road. However, there is little noise sensitive locations especially schools, mosque, etc. close to the alignment that will be affected adversely.</p> <p>Impact due to noise to the workers and local community will be avoided/minimized through mitigation measures such as occupation health and safety gear, restriction of construction timing and others.</p>
<ul style="list-style-type: none"> ▪ Dislocation or involuntary resettlement of people? 		✓	There will be minimal resettlement impacts. Further details are provided in the Resettlement Plan.
<ul style="list-style-type: none"> ▪ Dislocation and compulsory resettlement of people living in right-of-way? 		✓	

Screening Questions	Yes	No	Remarks
<ul style="list-style-type: none"> ▪ Disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups? 		✓	
<ul style="list-style-type: none"> ▪ Other social concerns relating to inconveniences in living conditions in the project areas that may trigger cases of upper respiratory problems and stress? 		✓	No major impacts anticipated. However, efforts will be made to minimize air pollution through appropriate measures such as wet spraying, covering of trucks, location of hot mix plants and other stationary equipment away from settlement areas and others.
<ul style="list-style-type: none"> ▪ Hazardous driving conditions where construction interferes with pre-existing roads? 	✓		Proper safety measures such as barricades, flagman, sign boards etc. will be placed to prevent accidents.
<ul style="list-style-type: none"> ▪ Poor sanitation and solid waste disposal in construction camps and work sites, and possible transmission of communicable diseases (such as STI's and HIV/AIDS) from workers to local populations? 	✓		Appropriate waste management shall be adopted in construction camps. Worker health checks and awareness rising will be implemented to educate workers on communicable diseases.
<ul style="list-style-type: none"> ▪ Creation of temporary breeding habitats for diseases such as those transmitted by mosquitoes and rodents? 	✓		Breeding habitats maybe created in labour camps, garbage disposal sites borrow pits and material storage yards. Appropriate sanitation requirements in labour camps and avoidance of stagnant water included in the EMP.
<ul style="list-style-type: none"> ▪ Accident risks associated with increased vehicular traffic, leading to accidental spills of toxic materials? 	✓		Temporarily during construction Stage. Adequate measures will be provided to prevent them such as speed reduction, provision of crash barrier & proper traffic signage system at sensitive places will ensure smooth traffic flow which will reduce accidental risk
<ul style="list-style-type: none"> ▪ Increased noise and air pollution resulting from traffic volume? 	✓		Due to improvement in road riding conditions the net effect on noise and air pollution will be negligible. However, the number of traffic will increase and the pollution will also increase consistently.
<ul style="list-style-type: none"> ▪ Increased risk of water pollution from oil, grease and fuel spills, and other materials from vehicles using the road? 		✓	EMP recommendations are designed to mitigate water pollution due to construction related activities.
<ul style="list-style-type: none"> ▪ Social conflicts if workers from other regions or countries are hired? 		✓	EMP suggests to hire most workers from the local area and to ensure gender equality.
<ul style="list-style-type: none"> ▪ Large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)? 		✓	Most workers will be hired locally, hence this is not anticipated.
<ul style="list-style-type: none"> ▪ Risks to community health and safety due to the transport, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during construction and operation? 	✓		Transport, storage, use and disposal of fuel and chemicals will be required. Appropriate safety, storage and disposal measures recommended in the EMP.

Screening Questions	Yes	No	Remarks
<ul style="list-style-type: none"> ▪ Community safety risks due to both accidental and natural causes, especially where the structural elements or components of the project are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning. 	✓		Safety and injury related risks will arise from the presence of equipment's and construction activities. Clear demarcation of restricted areas and prevention of open access to construction areas is included in the EMP.

Climate Change and Disaster Risk Questions The following questions are not for environmental categorization. They are included in this checklist to help identify potential climate and disaster risks.	Yes	No	REMARKS
<ul style="list-style-type: none"> • Is the Project area subject to hazards such as earthquakes, floods, landslides, tropical cyclone winds, storm surges, tsunami or volcanic eruptions and climate changes 	✓		As in most parts of Bangladesh, parts of the project road face problems of flooding. A separate climate change impact study has been conducted during IEE. Required design measures for adapting to future flooding events the result of climate change study from IEE have been recommended to this EIA as well.
<ul style="list-style-type: none"> ▪ Could changes in temperature, precipitation, or extreme events patterns over the Project lifespan affect technical or financial sustainability (e.g., increased erosion or landslides could increase maintenance costs, permafrost melting or increased soil moisture content could affect sub-grade). 		✓	With the incorporation of recommendations from the climate change study of IEE, it is expected that the road will be able to withstand with future changes of various climatic parameters.
<ul style="list-style-type: none"> ▪ Are there any demographic or socio-economic aspects of the Project area that are already vulnerable (e.g., high incidence of marginalized populations, rural-urban migrants, illegal settlements, ethnic minorities, women or children)? 		✓	There is no potential impact identified in the project area yet.
<ul style="list-style-type: none"> ▪ Could the Project potentially increase the climate or disaster vulnerability of the surrounding area (e.g., by encouraging settlement in areas that will be more affected by floods in the future, or encouraging settlement in earthquake zones)? 		✓	A separate climate change study in IEE showed that the project will significantly reduce the GHG emissions.

Note: Hazards are potentially damaging physical events.

APPENDIX D: SURFACE WATER QUALITY TEST RESULTS

Form No. QSF-22
ISO/IEC 17025:2005 Certified

Revision No. 08

Revision Date: 24 June, 2016

জীবনের জন্য বিজ্ঞান



Certificate No: T-1676

Institute of National Analytical Research and Service (INARS)

ইনস্টিটিউট অব ন্যাশনাল এনালিটিক্যাল রিসার্চ এন্ড সার্ভিস

BCSIR LABORATORIES, DHAKA

BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

ANALYSIS REPORT

Ref. No. : i) 401 of BCSIR Lab, Dhaka dt. 09/05/2016
: ii) D-401 of Analytical Service Cell, BCSIR. 08/05/2016

Lab ID : A-385 to A-388

Name and address of Customer : Md. Saiful Islam
Environmental Specialist
Environment and Resource Analysis Center Ltd.
464/C (Ground Floor), Khilgaon, Dhaka-1219, Bangladesh.

Work order details : Application for testing of materials (Surface water and Ground water), Date: 08/05/2016

Type of sample* : Water

Quantity of sample : 1 Litre/bottle (7 bottles)

Packing and marking : Glass & Plastic bottle

Date of receipt : 09/05/2016

Period of analysis : 09/05/2016 to 25/05/2016

Visual observation/Remarks : Colourless

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-385	Surface water (SW 01)	Total Organic Carbon (TOC)	4.01 mg/L	5310.B
		Total Phosphate (PO ₄)	0.26 mg/L	4500-P C
		Total Suspended Solids (TSS)	Less than 5 mg/L	2540.D
		Oil and Grease	8.80 mg/L	5220.B
A-386	Surface water (SW 02)	Total Organic Carbon (TOC)	3.65 mg/L	5310.B
		Total Phosphate (PO ₄)	0.71 mg/L	4500-P C
		Total Suspended Solids (TSS)	Less than 5 mg/L	2540.D
		Oil and Grease	Less than 5 mg/L	5220.B
A-387	Surface water (SW 03)	Total Organic Carbon (TOC)	2.42 mg/L	5310.B
		Total Phosphate (PO ₄)	Less than 0.2 mg/L	4500-P C
		Total Suspended Solids (TSS)	Less than 5 mg/L	2540.D
		Oil and Grease	Less than 5 mg/L	5220.B

Page 1 of 2

*The results relate only to the items tested.

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PABX: 8611057-61, 8625038-9, 8626034-5, 8626032, Ext/325; E-mail: directorid@yahoo.com, bcsir@banqla.net

জীবনের জন্য বিজ্ঞান

"শেখ হাসিনার দর্শন, সব মানুষের উন্নয়ন"



বাংলাদেশ বিজ্ঞান ও শিল্প গবেষণা পরিষদ (বিসিএসআইআর)

BANGLADESH COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH (BCSIR)

Laboratories / Institute / Center: BCSIR Laboratories, Dhaka.

ANALYSIS REPORT

ASC Ref No. : D-112, Date : 20-03-2017 Unit (Lab/Inst.) Ref. No. : 112, Date : 21-03-2017
 Lab / Sample ID : SE - 535 Number of Sample : 17
 Sample Description: Test of different parameters in supplied surface water samples (as supplied). Test Commencement Date : 21/03/2017
 Client's Details : Md. Shafiqul Islam, Jr. Environmental Specialist, Environment and Resource Analysis Center Ltd., 464/C (Ground Floor), Khilgaon, Dhaka-1219. Test Completion Date : 05/04/2017

Details:

Lab Id	Sample ID (as mentioned)	Result				
		pH	Total Organic Content	Total Phosphate	Total Suspended Solids (TSS)	Dissolved Oxygen (DO)
SE 535-01	SW 01	7.22	3.16 ppm	4.95 ppm	58.21 mg/L	6.24 mg/L
SE 535-02	SW 02	6.88	6.42 ppm	7.35 ppm	141.53 mg/L	6.05 mg/L
SE 535-03	SW 03	6.93	6.35 ppm	4.58 ppm	148.50 mg/L	7.46 mg/L
SE 535-04	SW 04	6.86	3.16 ppm	4.52 ppm	50.21 mg/L	7.70 mg/L
SE 535-05	SW 05	7.45	6.29 ppm	3.48 ppm	62.34 mg/L	7.72 mg/L
SE 535-06	SW 06	7.30	6.39 ppm	4.22 ppm	195.21 mg/L	6.86 mg/L
SE 535-07	SW 07(50m Up Stream)	7.64	6.41 ppm	4.65 ppm	102.35 mg/L	7.73 mg/L
SE 535-08	SW 07(50m Down Stream)	6.92	6.28 ppm	6.06 ppm	130.63 mg/L	5.23 mg/L
SE 535-09	SW 08	7.21	12.63 ppm	5.81 ppm	183.02 mg/L	5.26 mg/L
SE 535-10	SW 09	6.84	6.37 ppm	7.83 ppm	198.51 mg/L	5.31 mg/L
SE 535-11	SW 10(50m Up Stream)	7.28	9.52 ppm	3.87 ppm	135.21 mg/L	7.64 mg/L
SE 535-12	SW 10(50m Down Stream)	7.72	9.48 ppm	4.03 ppm	112.41 mg/L	7.02 mg/L
SE 535-13	SW 11	7.22	15.84 ppm	6.79 ppm	212.59 mg/L	5.10 mg/L
SE 535-14	SW 12	7.32	32.12 ppm	63.50 ppm	316.35 mg/L	1.01 mg/L
SE 535-15	SW 13(50m Up Stream)	7.37	18.94 ppm	4.22 ppm	253.81 mg/L	1.47 mg/L
SE 535-16	SW 13(50m Down Stream)	7.22	12.61 ppm	5.26 ppm	222.79 mg/L	2.96 mg/L
SE 535-17	SW 16	7.49	12.69 ppm	6.12 ppm	192.70 mg/L	4.63 mg/L

Methodology / Instrument:

1. pH: pH measuring meter
2. TSS: Gravimetric method
3. Phosphate: Vanadomolybdophosphoric Yellow Color Method
4. DO: DO measuring meter
5. TOC: Wet Oxidation Method followed by Potentiometric Titration.

[Signature]
 Dr. Md. Kamal Hossain
 Senior Scientific Officer
 Soil and Environment Section
 Biological Research Division
 BCSIR Laboratories, Dhaka
 Dhaka-1205, Bangladesh

[Signature]
 09.04.2017
 Supervisor
 MOHAMMAD MONIRUZZAMAN
 Senior Scientific Officer
 Soil and Environment Section
 Biological Research Division
 BCSIR Laboratories, Dhaka
 BCSIR, Dhanmondi, Dhaka-1205

[Signature]
 09.04.2017
 Director / Officer-In-Charge
 Dr. Md. Sarwar Jahan
 Director (Add-Charge)
 BCSIR Laboratories, Dhaka
 Dr. Qudus-e-Khuda Road
 Dhaka-1205

Notes:

1. The results reported here are based only on the supplied samples in this laboratory.
2. Any complain about the test result will not be acceptable after one month from the date of issuing of the said report.
3. This report/result shall not be reproduced / published without prior approval of the authority.

Analytical Service Cell (ASC)
 Dr. Qudus-e-Khuda Road, Dhanmondi, Dhaka-1205, Bangladesh

"শেখ হাসিনার দর্পন, সব মানুষের উন্নয়ন"

জীবনের জন্য বিজ্ঞান



BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH (BCSIR)
বাংলাদেশ বিজ্ঞান ও শিল্প গবেষণা পরিষদ (বিসিএসআইআর)

Laboratories/Institute/Center: Institute of National Analytical Research & Service (INARS)

ANALYSIS REPORT

ASC Ref No : Mar2017001209 Unit (Lab/Inst.) Ref No : INS-470
Lab/Sample ID : A-233 Number of Sample : 1
Sample Description : Test of Surface water (Oil and Grease)-SW 16 Test Commencement date : 21/03/2017
Client's Details : Tahsin-Uz-Zaman
ENRAC
House#464/C (Ground Floor), Khilgaon, Dhaka-1219

Details:

Lab ID	Particulars of supplied Sample	Parameters	Concentration	Test Method (APHA)
A-233	Surface water (SW-16)	Oil and Grease	2.40 mg/L	5520.B

Mohammed
06/04/2017
Analyst
Mohammed Majedul Haque
Scientific Officer
Institute of National Analytical
Research & Service (INARS)
BCSIR, Dhanmondi, Dhaka.

Shamim
06/04/17
Supervisor
Shamim Ahmed
Senior Scientific Officer
Institute of National Analytical
Research & Service (INARS)
BCSIR Dhaka

Shamim 6.4.17
Director/Officer in-Charge
ড. শামিমা আছমেদ
শ্রীমানক (সিনিয়র)
ইনস্টিটিউট অফ ন্যাশনাল এনালিটিক্যাল
রিসার্চ এন্ড সার্ভিস (বিসিএসআইআর)
বিসিএসআইআর, ঢাকা।

Note:

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- This report/result shall not be reproduced/published without prior approval of the authority.

Analytical Service Cell (ASC)

Dr. Qudrat-i-Khuda Road, Dhanmondi, Dhaka-1205, Bangladesh
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APPENDIX E: GROUNDWATER QUALITY TEST RESULTS



Centre for Food and Waterborne Diseases
 Mohakhali, Dhaka-1212
 Phone : +880-2-9827001-10/2405
 Fax : +880-2-9827062
 Web : <http://www.icddr.org>

Environmental Microbiology
 Laboratory

Test Report

Lab. ID No.2017031007

Receipt No: MAR1708297

Date of Reporting: 20.03.2017

Particular of Sample: Drinking Water

Date of Sample Tested: 15.03.2017

Date of Sample Received: 15.03.2017

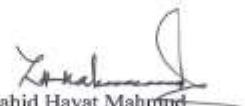
Client Address: ENRAC GW 01, Elenga.

Sl. No.	Water Quality Parameters	Unit	Results	Bangladesh Standard for Drinking Water (ECR'97)	WHO Guideline for Drinking Water, 2004	Method
1	Total coliforms	CFU /100mL	0	0	0	Membrane Filtration
2	Faecal coliforms	CFU /100mL	0	0	0	Membrane Filtration

N.B: This report is valid only for particular sample tested and cannot be used for publicity.

Tested By (Code No.): 7, 8
 EM.FM.007.01 Effective Date 30/03/2016

Checked By (Code No.): 2
 End of the Report


 Dr. Zahid Hayat Mahmud
 Associate Scientist and Head
 Environmental Microbiology Lab, LSSD, icddr,b

Page 1 of 1



Centre for Food and Waterborne Diseases
 Mohakhali, Dhaka-1212
 Phone : +880-2-9827001-10/2405
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 Web : <http://www.icddr.org>

**Environmental Microbiology
 Laboratory**

Test Report

Lab. ID No.2017031011

Receipt No: MAR1708298

Date of Reporting: 20.03.2017

Particular of Sample: Drinking Water

Date of Sample Tested: 15.03.2017

Date of Sample Received: 15.03.2017

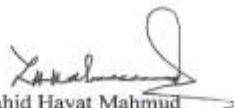
Client Address: ENRAC GW 02, Hatikumurul.

Sl. No.	Water Quality Parameters	Unit	Results	Bangladesh Standard for Drinking Water (ECR'97)	WHO Guideline for Drinking Water, 2004	Method
1	Total coliforms	CFU /100mL	0	0	0	Membrane Filtration
2	Faecal coliforms	CFU /100mL	0	0	0	Membrane Filtration

N.B: This report is valid only for particular sample tested and cannot be used for publicity.

Tested By (Code No.): 7, 8
 EM.FM.007.01 Effective Date 30/03/2016

Checked By (Code No.): 2
 End of the Report


 Dr. Zahid Hayat Mahmud
 Associate Scientist and Head
 Environmental Microbiology Lab, LSSD, icddr,b

Form No. QSF-22
ISO/IEC 17025:2005 Certified

Revision No. 08

Revision Date: 24 June, 2016
জীবনের জন্য বিজ্ঞান



Certificate No: T-1676

Institute of National Analytical Research and Service (INARS)
ইনস্টিটিউট অব ন্যাশনাল এনালাইটিক্যাল রিসার্চ এন্ড সার্ভিস
BCSIR LABORATORIES, DHAKA
BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-388	Ground water (GW 01)	Manganese (Mn)	0.67 mg/L	3110.B
		Arsenic (As)	0.022 mg/L	3114.C
		Iron (Fe)	12.7 mg/L	3111.B
		Chloride (Cl)	2.66 mg/L	4110.B
		Total Hardness as CaCO ₃	172 mg/L	2340.C

Signature
25-05-2016

Sig and Name of the Validator
Md. Aminul Ahsan
Principal Scientific Officer
Institute of National Analytical
Research & Service (INARS)
BCSIR Laboratories, Dhaka

Page 2 of 2

*The results relate only to the items tested.

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FAX: 8611057-61, 8625038-9, 8626034-5, 8626032, Ext/325; E-mail: director@vahoo.com, bcsir@bangla.net

জীবনের জন্য বিজ্ঞান

"শেখ হাসিনার মর্পন, সব মানুষের উন্নয়ন"



বাংলাদেশ বিজ্ঞান ও শিল্প গবেষণা পরিষদ (বিসিএসআইআর)

BANGLADESH COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH (BCSIR)

Laboratories / Institute / Center: BCSIR Laboratories, Dhaka.

ANALYSIS REPORT

ASC Ref No. : D-113, Date : 20-03-2017 Unit (Lab/Inst.) Ref. No. : 113, Date : 21-03-2017
 Lab / Sample ID : SE - 536 Number of Sample : 08
 Sample Description: Test of different parameters in supplied samples (as supplied). Test Commencement Date : 21/03/2017
 Client's Details : Md. Shafiqul Islam, Jr. Environmental Specialist, Environment and Resource Analysis Center Ltd., 484/C (Ground Floor), Khilgaon, Dhaka-1219. Test Completion Date : 05/04/2017

Details:


Lab Id	Sample ID (as mentioned)	Result					
		pH	Manganese (Mn)	Arsenic (As)	Iron (Fe)	Chloride (Cl)	Total Hardness (as CaCO ₃)
SE 536-01	GW 01	7.32	0.056 ppm	5.11 ppb	0.027 ppm	20.83 ppm	83.9 ppm
SE 536-02	GW 03	6.02	0.144 ppm	4.64 ppb	0.025 ppm	40.05 ppm	85.2 ppm
SE 536-03	GW 04	6.84	0.017 ppm	6.28 ppb	0.026 ppm	27.41 ppm	68.5 ppm
SE 536-04	GW 05	6.95	0.363 ppm	6.64 ppb	0.059 ppm	26.79 ppm	86.8 ppm
SE 536-05	GW 06	6.66	0.584 ppm	2.93 ppb	0.021 ppm	81.19 ppm	152 ppm
SE 536-06	GW 07	6.56	0.522 ppm	3.09 ppb	0.022 ppm	73.43 ppm	133.2 ppm
SE 536-07	GW 08	5.99	0.031 ppm	4.83 ppb	0.020 ppm	50.38 ppm	75.9 ppm
SE 536-08	GW 09	6.47	0.191 ppm	5.05 ppb	0.022 ppm	47.43 ppm	137.3 ppm
SE 536-09	GW 10	6.76	0.026 ppm	4.10 ppb	0.040 ppm	10.73 ppm	38.3 ppm

Methodology / Instrument:

1. pH: pH measuring meter
2. Iron & Manganese: Atomic Absorption Spectrophotometer.
3. Chloride: Ion Chromatography
4. Hardness: Potentiometric Titration
5. Arsenic: Atomic Absorption Spectrophotometer with Hydride Vapor Generator (HVG) Unit.


 6.4.17
 Analyst
BADHAN SAHA
 Scientific Officer
 Soil and Environment Section
 Biological Research Division
 BCSIR Laboratories, Dhaka
 BCSIR, Dhanmondi, Dhaka-1205


 6.4.17
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APPENDIX F: AIR QUALITY IMPACTS ASSESSMENT OF PROPOSED HIGHWAY CORRIDOR OF ELENGA-HATIKAMRUL

A. Introduction

1. The major impact on the air quality during the operation stage will be due to plying of vehicles on the proposed Highway corridor. The impact on air quality depends upon traffic volume, traffic fleet including fuel type and prevailing atmospheric conditions. An unstable atmospheric condition disperses pollutants more and results in to low pollutant concentrations while stable atmospheric conditions buildup the pollution level. To assess the likely impacts on the ambient air quality due to the proposed highway corridor project, the prediction of the carbon monoxide (CO) and particulate matter (PM) concentrations have been carried out using line source dispersion modelling approach, based on Gaussian equation. CO is an indicator pollutant for vehicular exhaust pollution. So, prediction of CO concentration is representative of the impacts of air pollution due to traffic movement on the road. Both PM_{2.5} and PM₁₀ concentration emitted from vehicles exhaust and re-suspension of road dust are predicted along the high corridor. The modeling for this project has been carried out using CALINE-4, line source model developed by the California Transport Department. The model has been setup and run by using CO emission factors (Department of Environment, Bangladesh Govt., 2012), for PM_{2.5} (ARAI, 2007, Indian standards) and for PM₁₀ due to re-suspension of road dust (AP-42, USEPA) and hourly traffic volumes as predicted for the project. Only CO emission factor are available in full-fledged for all vehicles categories in Bangladesh. The study is conducted to predict hourly increment in CO, PM_{2.5} and PM₁₀.

B. Model descriptions

2. CALINE-4 is the fourth generation simple line source Gaussian plume dispersion model (Benson, 1984). It employs a mixing zone concept to characterize pollutant dispersion over the roadway. The main purpose of the model is to assess air quality impacts near transportation facilities. The input parameters are emission source strength, meteorology and road geometry. It can predict the pollutant concentrations at selected receptors locations for 1 hour and 8-hour average up to 500 meters of the roadway. For most applications, optional inputs can be bypassed and many other inputs can be assigned assuming worst-case values. More complex approaches to dispersion modeling are unnecessary for most of the applications because of the uncertainties in the estimation of emission factors and traffic volumes for the future years. CALINE- 4's accuracy is well balanced with the accuracy of state-of-art predictive models for vehicular pollution.

C. Source information

1. Traffic data

3. The fleet wise traffic volumes for the present study have been taken from the detailed project report of the project. The annual average daily traffic (AADT) data is available for the proposed highway corridor through traffic survey for year 2016 (Base year) and future years (2020, 2025, 2030, 2035 and 2040). CALINE 4 model needs hourly average traffic volume. However, model has been setup for peak traffic hours assuming 2 times of average hourly traffic volume. The total hourly traffic volume is further categorized in to two wheeler, three wheeler, four wheeler, light commercial vehicles (LCVs), high commercial vehicles (HCVs) and Bus based on the traffic survey at existing highway corridor (Figure 1). It is found that heavy duty vehicles are the dominating vehicles category (45% of total traffic) along the road corridor.

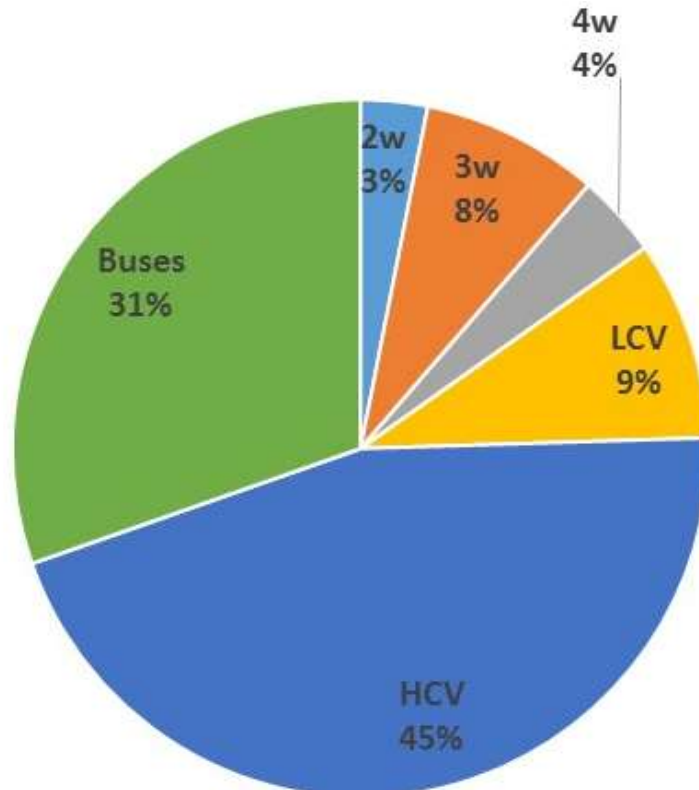


Figure F-1: Traffic Fleet on the proposed Highway Corridor

4. The annual average daily motorized traffic data are given in table 1 of proposed highway

Table F-1: Annual average daily motorized traffic data

Years	Motor Cycles (2W)	Auto Rickshaw (3W)	Car (4W)	Light Commercial Vehicles (LCV)	HCV	Bus	Total
2016	48	128	60	144	700	471	48
2020	63	168	79	192	1209	617	63
2025	85	225	105	257	1618	883	85
2030	113	301	141	344	2165	1182	113
2035	151	403	189	461	2897	1582	151
2040	202	539	252	617	3877	2117	202

2. Road geometry

5 In the CALINE-4 model the entire length of the selected road section is divided into various road links. The division of sections into links has been done in such way, so that the link can be fairly considered as straight stretch of road having homogenous geometry with uniform road width, height and alignment. The coordinates of end points of links specify the location of the links in the model. The maximum numbers of link in each road section can be 20. The mixing zone width calculated for selected highway corridor is 14.2 m (1.2 m + 3 m + 3 m + 7 m) as per guideline provided in CALINE4 model.

3. Emission factors

6. Emission factor is one of the important input parameter in Caline-4 model. In the present study, the emission factors specified by Department of Environment, Bangladesh Govt., 2012 (for CO), ARAI, 2007, Indian standards (for PM_{2.5}) and AP-42 for PM₁₀ due to re-suspension of road dust are used. Only CO emission factor are available in full-fledged for all vehicles categories in Bangladesh. The weighted emission factors (WEF in g/mile) have been calculated using these emission factors (g/km) for CO, PM_{2.5} and PM₁₀ for corresponding year. The emission factor for CO and PM_{2.5} used in the present study for different vehicles type are given in table 2. These emission factors have been expressed in terms of type of vehicles and type of fuel used (for petrol and diesel driven passenger cars). Since, there is only one input requirement for total no. of vehicles in the CALINE 4 model, whereas, there are different categories of vehicles (viz., Two wheelers, Cars, Bus and trucks) with different fuel used, it is essential that a single value representing the equivalent or weighted emission factors for all the vehicles is input into the model. The emission factor used to estimate WEF are given below in table 3. The traffic data are not available for fuel types, therefore average emission factor for different fuels vehicle are used in this study. Thus, WEF expressed in g/mile (converted from gm/km) has been calculated for the present study using methodology given by Sharma et al., 2013. For PM₁₀, emission from re-suspension of road dust of paved road have been estimated using following empirical equation

(USEPA 2011).

$$E = k (sL)^{0.91} \times (W)^{1.02}$$

Where:

E= particulate emission factor (g/VKT)

K =particle size multiplier (g/VKT), default value of “k” for PM₁₀ is 0.3 g/VKT

sL = road surface silt loading (g/m²) = 0.531 g/m² (Sahu et al., 2011)

W = Average weight of vehicles (in tons) on road = 1.41 Ton (Sahu et al., 2011)

7. The calculated WEF for CO, PM_{2.5} and PM₁₀ for peak traffic hours is given in table 3. It is estimated that WEF is almost same for all future years for all three pollutants. This is because of similar traffic fleet characteristics in all years. The WEF is representative of dominated vehicles types.

Table F-2: Emission factors for different types of Vehicle

Vehicle type	CO Emission factor (gm/km)*	PM _{2.5} Emission factor (gm/km)#
Two wheeler	5.5	0.20
Three Wheeler	4.5	0.24
Cars/Jeep	2.68	0.06
LCV	6.5	0.49
BUS [§]	4.5	1.08
HCV	4.5	1.60

*Department of Environment, Bangladesh Govt., 2012 (CASE Project); #ARAI, 2007; § Emission factor for bus is not available, so HCV is used

Table F-3: Weighted Emission Factor for proposed traffic

Year	Weighted Emission factor for CO (g/mile)	Weighted Emission factor for PM _{2.5} (g/mile)	Weighted Emission factor for PM ₁₀ (g/mile)
2016	7.49	1.81	2.03
2020	7.47	1.91	2.13
2025	7.47	1.90	2.12
2030	7.47	1.90	2.12
2035	7.47	1.90	2.12
2040	7.47	1.90	2.12

4. Meteorological data

8. The study was conducted to predict pollutant concentration for given meteorological conditions. The meteorological parameters such as wind speed, wind direction, temperature, mixing height and stability condition are used in model as given in table 4. It is found that dominated wind direction is South East in the study area with average wind speed of 0.24 km/hr. The minimum threshold wind speed essential for the model run is 0.5 m/s. The same has been used in the present study. The model has been run with standard case, in which models predicted maximum pollutant concentration w.r.t down wind direction.

Table F-4: Meteorological Parameters in the study area

Parameter	Unit	Location of Sampling Point								
		Koddar Mor	Hatikamrul	Chandaikona Bazar	Nandigram - Sherpur	Noymail Bus Stand	Bir Shrestho Square	Elenga – Gaibandha Rangpur	Pirganj Bus Stand	Rangpur Parker Mor
Temp	°C	25	26.15	23.55	25.95	28.39	25.83	25.47	22.76	23.82
Humidity	%	79.97	79.84	81.87	82.64	76.10	85.43	86.72	92.01	88.36
Wind Speed	Km/hr	0.43	0.14	0.09	0.34	0.62	0.11	0.09	0.20	0.17
Wind Direction	Degree	238.37 ⁰ South-West	194.57 ⁰ South-West	148.58 ⁰ South-East	95.98 ⁰ South-East	183.61 ⁰ South-West	237.53 ⁰ South-West	229.23 ⁰ South-West	280.40 ⁰ North-West	165.06 ⁰ South-East

5. Receptors

9. A set of link receptors were taken at various receptor locations within each section at a distance of 5 m, 10 m, 20 m, 40 m, 70 m, 100m and 200 m both sides (in perpendicular direction along the road alignment) from edge of the carriageway to know the dispersion of pollutant from the road. The monitoring station are marked as receptor points to compare the monitoring and predicted pollutant concentrations. Further, model also run for grid receptor locations to evaluate the spatial dispersion of the pollutant along whole road section (Figure 2).

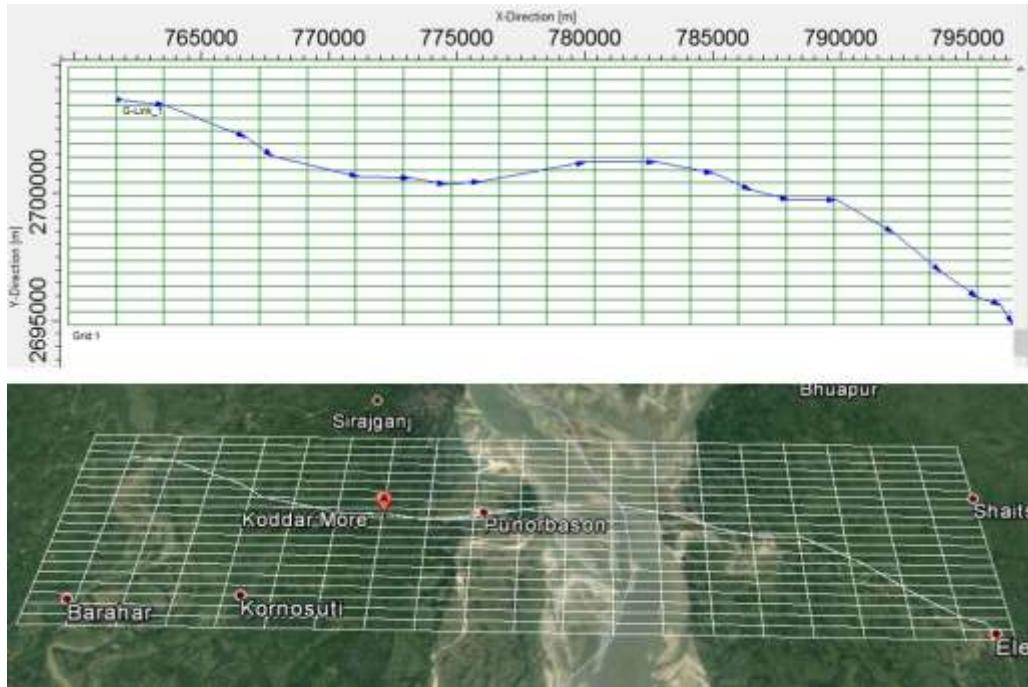


Figure F- 2: Road alignment and receptor grid representation in Model and Google Earth view

D. Results

10. The model has been setup and run to predict hourly average CO, PM_{2.5} and PM₁₀ concentrations generated from traffic movement on proposed highway. The kerb side locations are selected to compare the model prediction with monitored locations and same has been described in table 5. It seems the monitored concentration are higher than predicted concentrations of each pollutant which might be due contribution of other sources such as natural dust, other fossil fuels etc. The contribution of vehicles movement is almost 60-70% of total concentration at receptor location. The high movement of heavy duty diesel trucks (45%) along the road generates high amount of CO and particulates in the downwind side of the road.

Table F-5: Monitored and Predicted Concentration at Koddar More

S.N	Parameter	Unit	Concentration at Koddar More	
			Monitored	Predicted
1	PM _{2.5}	µg/m	99.85	70
2	PM ₁₀	µg/m	148.8	85
6	CO	ppm	0.4	0.3

11. The predicted hourly average concentration of CO, PM_{2.5} and PM₁₀ during peak traffic hour are shown in table 6. The graphical representation of hourly average pollutant concentrations on both side of the road section shown in figures 3 – 5.

Table F- 6: Pollutant predicted concentrations along the proposed highway corridor for peak traffic hour

Pollutant	Distance from the edge of the road, m. (Left side)							Distance from the edge of the road, m. (Right side)						
	200	100	-70	-40	-20	-10	-5	5	10	20	40	70	100	200
CO (ppm)	0	0	0	0	0.1	0.1	0.2	0.4	0	0	0	0	0	0
PM _{2.5} (µg/m ³)	0.00	3.50	7.00	14.00	24.50	32.20	35.00	70.00	49.00	42.00	21.00	14.00	0.00	0.00
PM ₁₀ (µg/m ³)	0.00	4.00	8.00	16.00	28.00	36.80	40.00	85.00	59.50	55.25	25.50	25.50	8.50	1.12

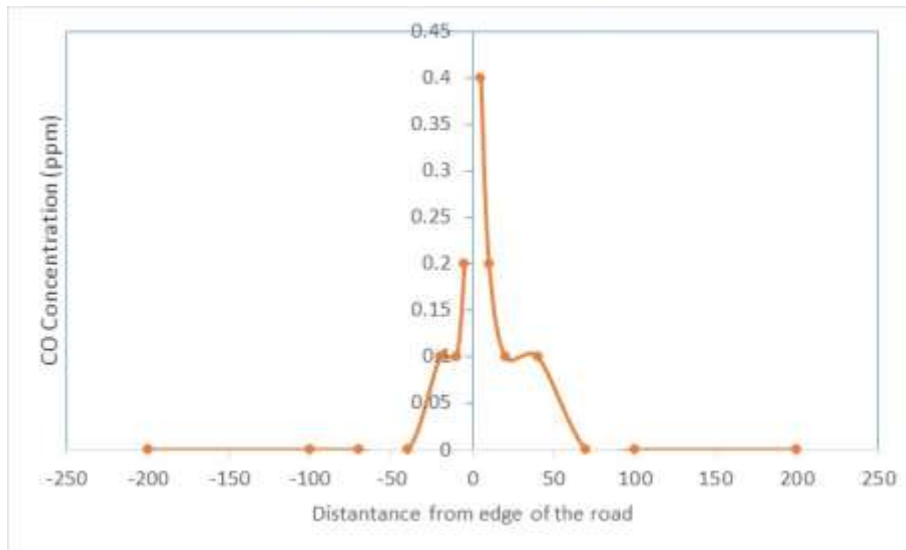


Figure F-3: CO predicted concentrations (ppm) along the proposed highway corridor (Right side is of graph represent downwind side)

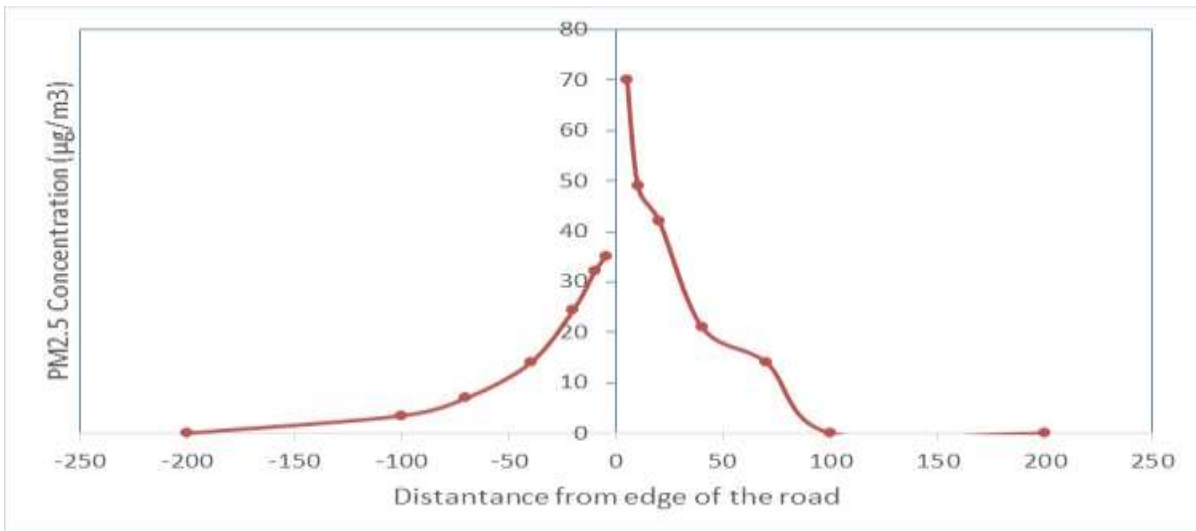


Figure F-4: PM_{2.5} predicted concentrations (µg/m³) along the proposed highway corridor (Right side is of graph represent downwind side)

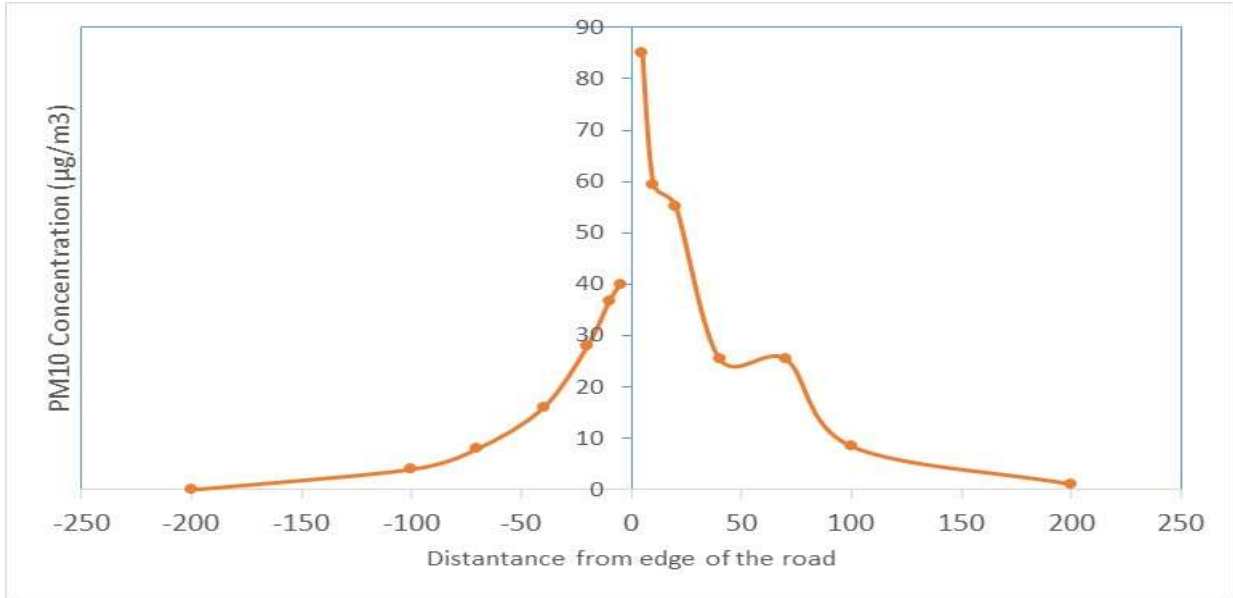


Figure F-5: PM₁₀ predicted concentrations (µg/m³) along the proposed highway corridor (Right side is of graph represent downwind side)

12. In addition, the spatial distribution of hourly average predicted CO, PM_{2.5} and PM₁₀, concentrations have been plotted in figures 6-9, respectively for peak traffic hour which shows that pollutant concentrations is decreasing when goes away from the highway corridor. Therefore, the impacts of traffic movement at proposed highway project will not impact the surrounding atmosphere.



Year 2016



Year 2020



Year 2025



Year 2030



Year 2035



Year 2040

Figure F-6: Spatial distribution of CO concentrations



Year 2016



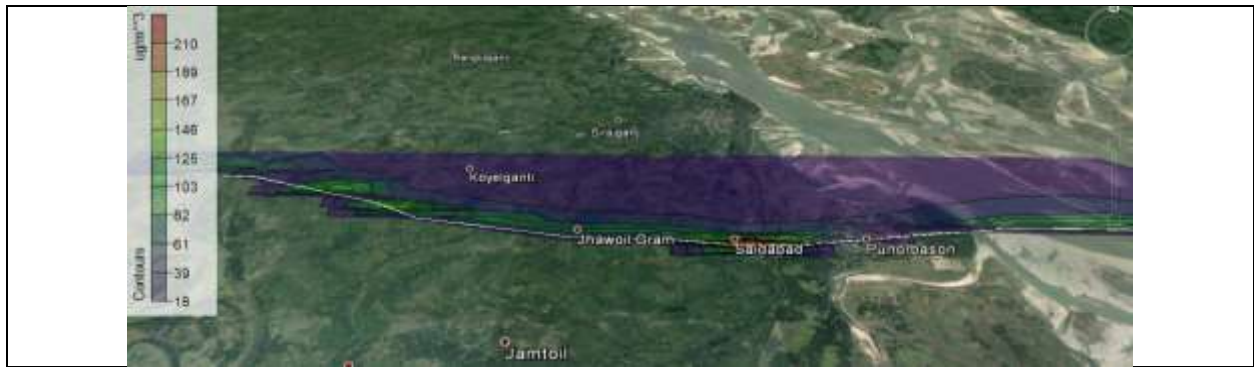
Year 2020



Year 2025



Year 2030



Year 2035

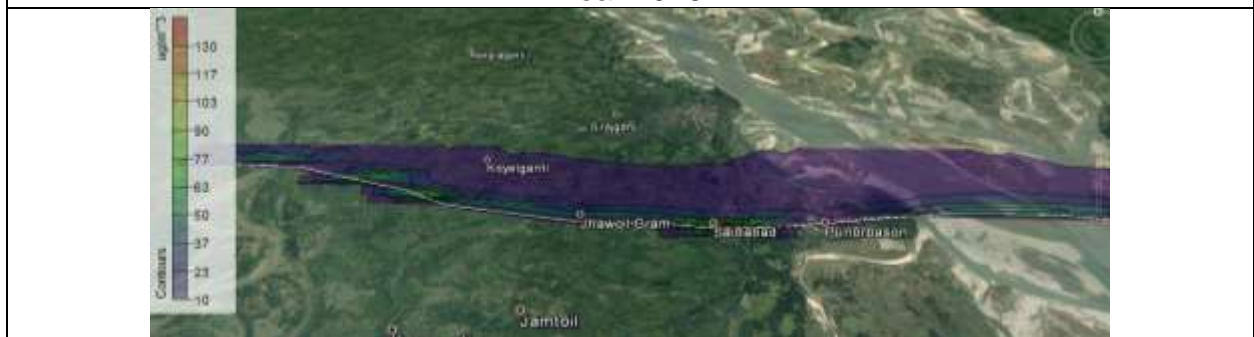


Year 2040

Figure F-7: Spatial distribution of PM_{2.5} concentrations



Year 2016



Year 2020

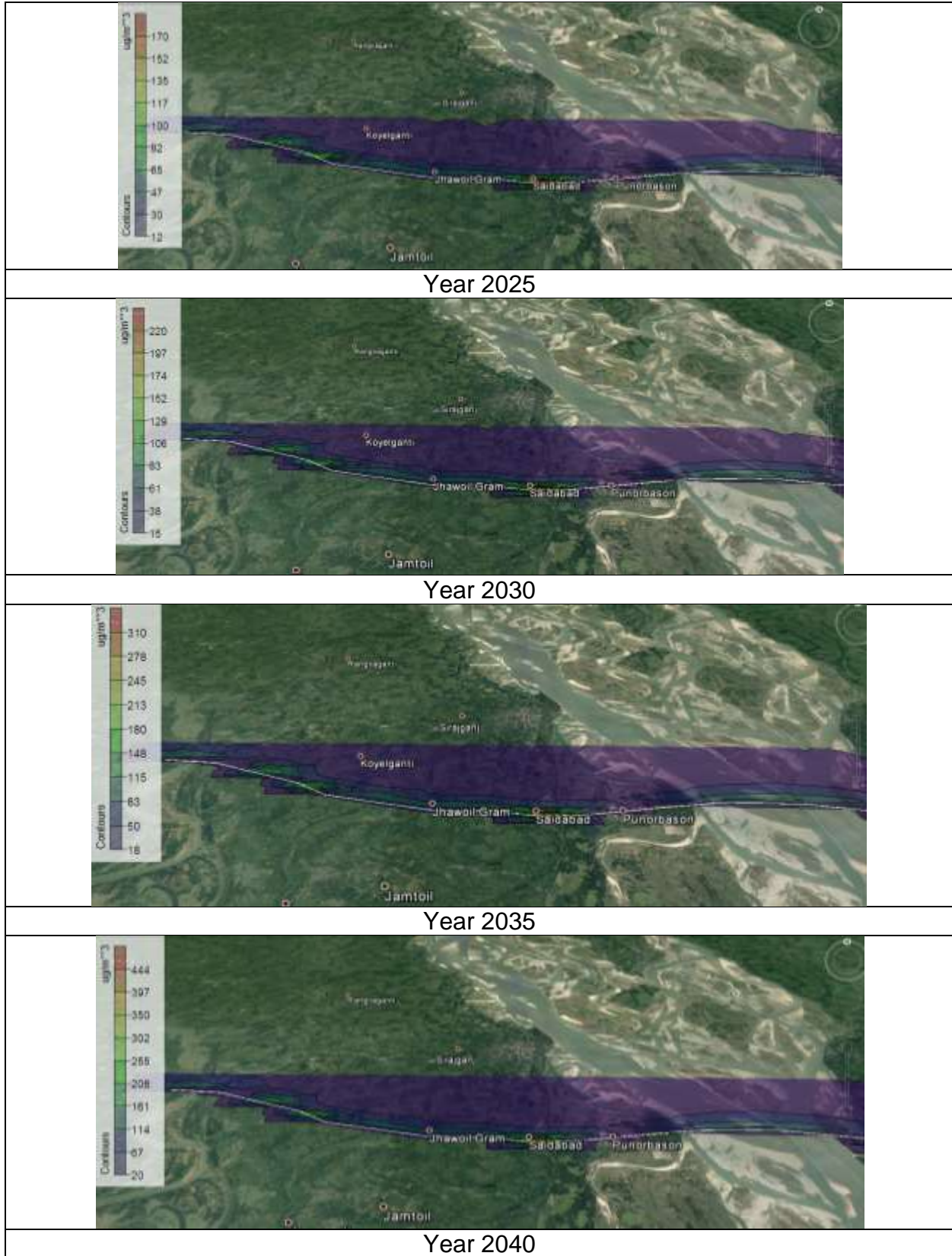


Figure F-8: Spatial distribution of PM₁₀ concentrations

13. The summary of maximum GLC of CO, PM_{2.5} and PM₁₀ at kerb side of road in downwind side are described in Table 7. With the present traffic growth and traffic composition, the PM_{2.5} and PM₁₀ concentration are going to be exceeded the specified standards in future which needs to be take care. The high concentration at kerb side of the road are only due to high diesel trucks movement on the road.

Table F-7: Maximum GLC of CO, PM_{2.5} and PM₁₀ at kerb side of road in downwind side

Year	CO	PM _{2.5}	PM ₁₀
2016	0.3	70	85
2020	0.5	95	130
2025	0.6	120	170
2030	0.8	160	220
2035	1	210	310
2040	1.4	320	444

References:

- Department of Environment (2012). Revisions of Vehicular Emission Standards For Bangladesh (Bdesh-2 And Bdesh-3) Draft Final Report - Part 1, Clean Air and Sustainable Environment (CASE) Project, Department of Environment, Government of The People's Republic of Bangladesh.
- ARAI (Automotive Research Association of India), 2007. Emission factor development for Indian vehicles. Project report no. AEF/2006-07/IOCL/Emission Factor Project. Automotive Research Association of India, Pune, India, 94 pages.
- USEPA (U.S. Environment Protection Agency), 2011d. Compilation of air pollutant EFs: miscellaneous sources: paved roads final section. AP 42, Fifth Ed. 1.

APPENDIX G: NOISE MODELING FOR THE PROJECT ROAD

A. Noise Emission Modeling of the proposed Elenga-Hatikamrul-Rangpur Roadway traffic

1. Under the proposed project the existing 2-lane roadways will be upgraded to a four lane road with safety features that include the addition of a separate SMVT lane, flyovers at the busiest junctions, overpasses, Bus stops, pedestrian bridges and additional lanes at intersections. This will generate additional traffic and consequently alter the noise environment along the route of the roadway. We used Canarina CUSTIC 3.2 software for noise pollution modeling for the assessment of the noise pollution propagation generated from traffic. The CUSTIC Software allows us to create robust and useful numeric simulations that fully makes use of the graphical user interface. The methodology and governing equations for noise modelling under the graphic user interface of CUSTIC 3.2 is described in Annex A.

B. Basic Data and Assumptions for Noise Impact Modeling

2. Noise emission from vehicles along the route is modelled as steady-state line source. We use the traffic projections (primarily motorized traffic) from the “STPPF (Road Component - Package 1) –Traffic Forecast Report – Feb 2014” to estimate the source emissions according to different scenarios. In the report, traffic projections are made considering 2011 RHD traffic data as the baseline traffic and increasing it by the annual growth rates. For the Rangpur-Hatikamrul route, there is no diverted traffic from any internal road but affected by SAARC traffic. More specifically, for 2011-16, traffic on all seven sections is increased annually by the normal traffic growth rates. In 2016 the additional traffic on all seven sections generated from the SAARC traffic (367 veh./day from Nepal and Bhutan) is added. In 2018 additional SAARC traffic of 1259 veh./day is added up to Gobindaganj and 856 veh./day from Gobindaganj to end point which will be diverted from India. During the period 2018-2040, traffic on all seven sections is increased annually by the normal traffic growth rates.

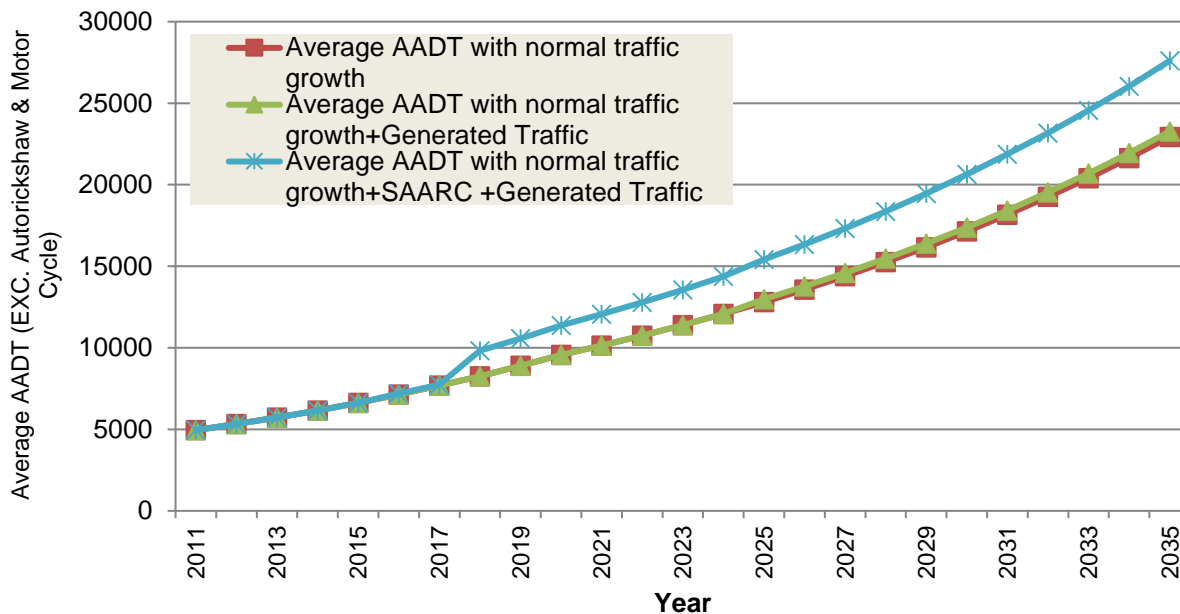


Figure G- 1: Traffic Forecast of Rangpur-Hatikamrul Road

(Source: STPPF (Road Component - Package 1) –Traffic Forecast Report – Feb 2014)

3. For noise emission modeling, we considered three scenarios: (i) baseline emission for the current year (i.e. projected estimate of 2016); (ii) projected noise emission for the design year 2033 and (ii) projected noise emission for the year 2040. Estimations of Motorized traffic of different sections of the road for these scenarios (as stated in the STPPF report) are used as input which is summarized in Table 1. Figure 2 shows the different road sections in which noise emission modeling has been performed. The design speed has been assumed to be 80 km/hr for noise emission modeling. The posted speed is 70 km/hr, therefore 80 km/hr will give a conservative estimate of noise emissions.

Table G-1: Baseline traffic data of different sections which were used for noise modeling

Segment name	Box Designation in Figure 2	Baseline traffic for year 2016 (veh/hr)	Projected traffic for 2033 (veh/hr)	Projected traffic for 2040 (veh/hr)
N5-51, between Mithapukur-Rangpur Modern More, Pairabond, km 316.022	1	486	1553	2336
N5-50, between Pirganj-Mithapukur, km 292.502	2	252	871	1309
N5-48, between Palashbari-Pirganj, Ekberpur, km 275.511	3	269	917	1378
N5-45, between Kashipur (Mokamtola)-Gabindaganj, Pakurtala, km 243.512	4	530	1754	2638
N5-33, between Int. with Bogra2nd By pass-Sultanganj, Banani, km 203.568	5	1134	3511	5279
N5-31, Sherpur(Int. with Z-5049)-Sherpur(Int. with Z-5401)	6	854	2717	4085
N5-28, Hatikamrul-Bhuyangati	7	583	1977	2972
N405-1, between Elenga-Jamuna Bridge, 11km west of Elenga	8,9,10	775	2123	3802

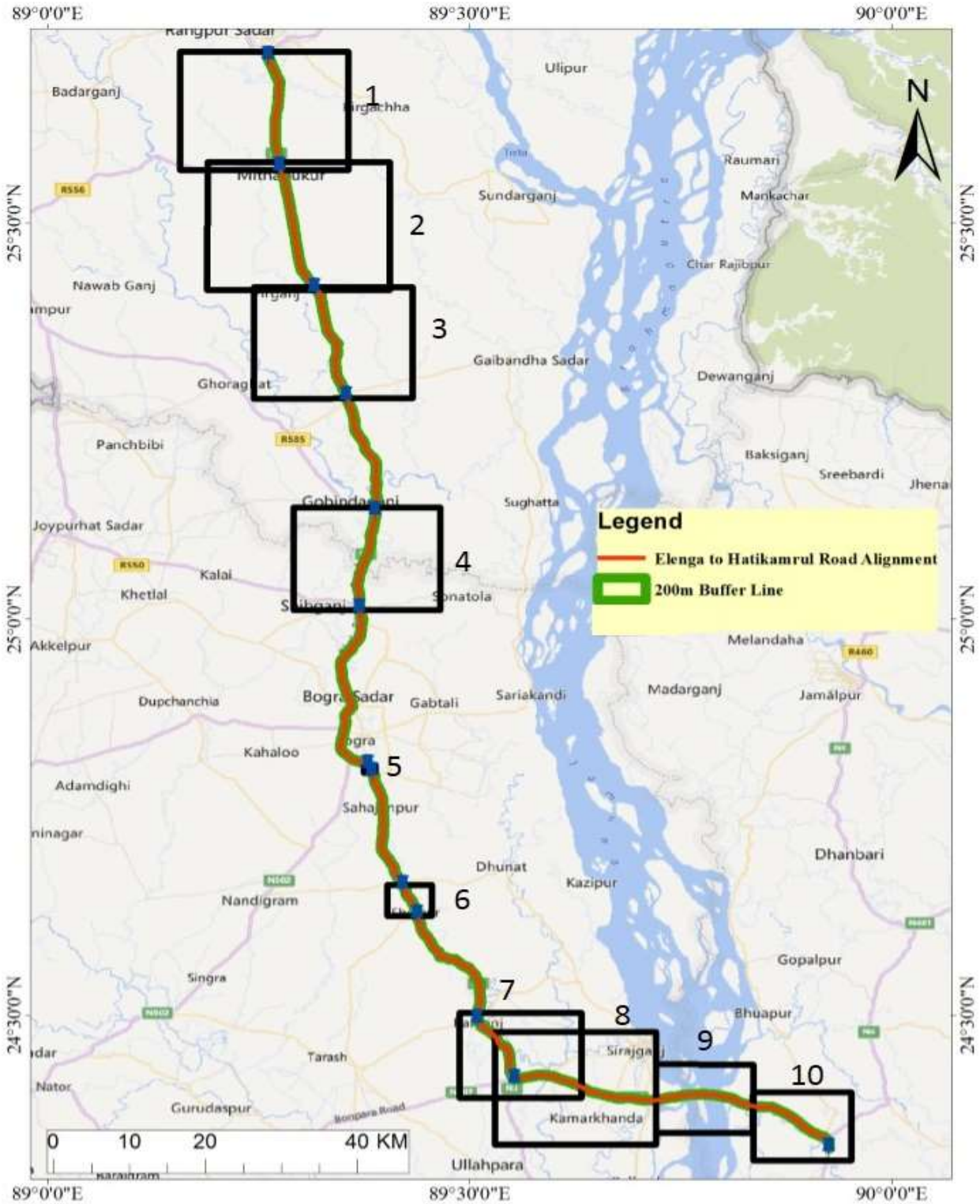


Figure G-2: The different road sections in which noise emission modeling has been performed. Boxes 1 – 10 are delineated in the figure to highlight the road sections (see Table 1 for details) in which noise simulations were made.

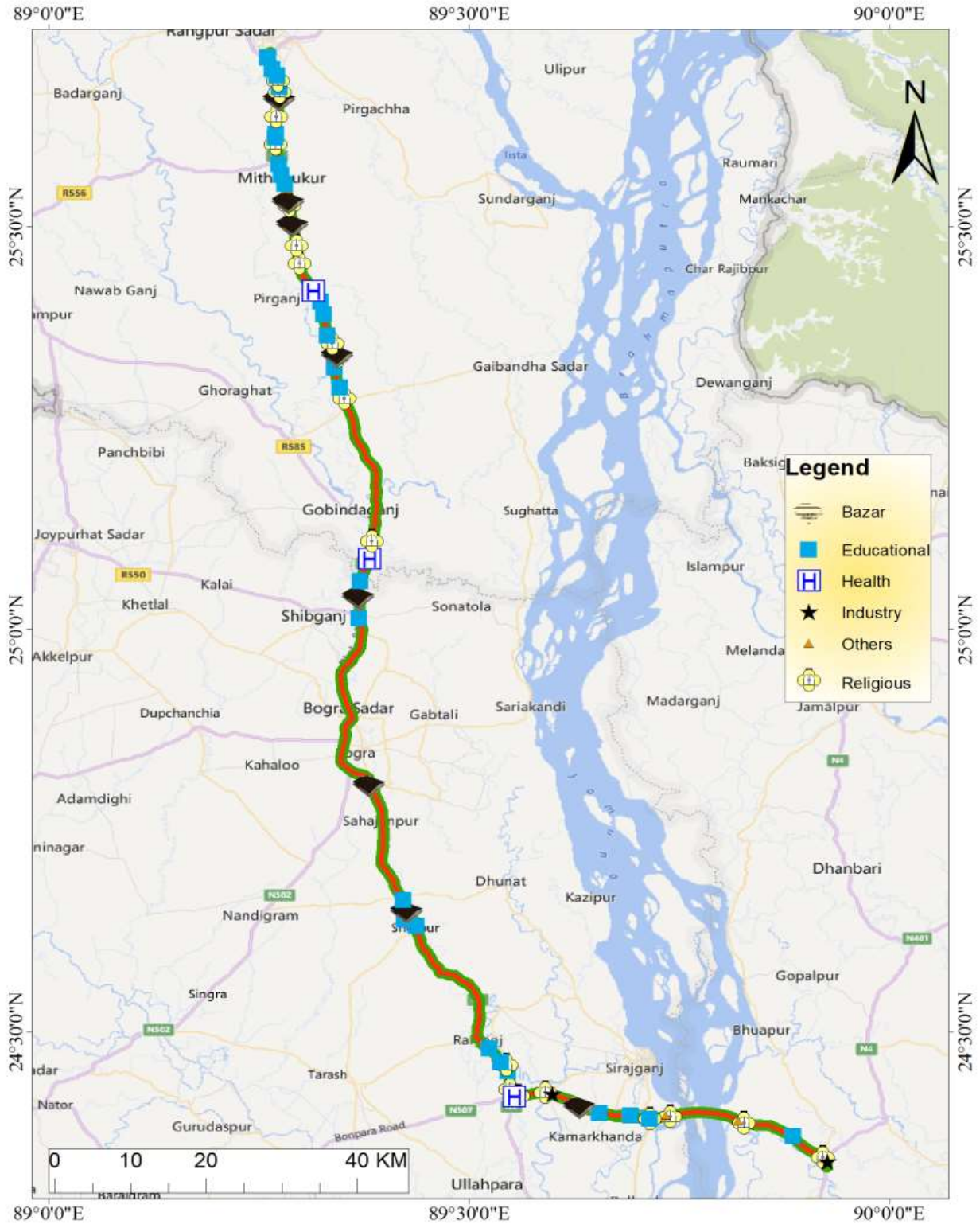


Figure G-3: Location of sensitive noise receptors where baseline noise measurements were carried out along the Elenga- Hatikamrul-Rangpur route

C. Identification of Sensitive Noise Receptors in the Road Network

3. As a part of the baseline study, noise level measurements were made at different locations along the Rangpur-Hatikamrul route. These noise receptors are chosen based on the assumption that these locations may be sensitive to noise increase due to traffic because of the specific nature of the establishment: educational institution, health complexes or religious centres. Baseline noise measurements were performed during daytime with a calibrated noise level meter. 5-minute continuous noise level measurements were carried out at the selected locations in 'A' Weighting and slow Response mode, and the equivalent noise levels (L_{eq})³¹ was determined. Figure 3 shows the locations of these receptors. The noise prediction from CUSTIC 3.2 is compared to the baseline noise to assess the impact of the proposed road development project. Applicable Noise guidelines and standards are provided in Annex B.

D. Noise Impact on Roadside Environment

4. As mentioned earlier, noise impact on roadside environment has been assessed on several sensitive receptors (educational, religious institutions, health facilities) located beside the road. The Hatikamrul-Rangpur route has been divided into 8 road segments, the predicted noise under different scenarios and impact on the receptors are described below:

1. N5-28, Hatikamrul-Bhuyangati

5. The noise simulation under different scenarios for the Hatikamrul-Bhuyangati segment (Box 7 in figure 2) is shown in Figure 4(a). Figure 4(b) provides a spatial noise intensity map of the segment. Table 2 provides the baseline and predicted noise (for the year 2040) at different sensitive receptors identified along the route. It can be seen that

- The baseline noise at these receptors exceed standards for residential areas and are comparable to standards of mixed/commercial/industrial areas.
- There will be slight increment of ambient noise at the educational institutions probably because of their close proximity to the main road.

³¹The equivalent level is the level (L_{eq}) of a hypothetical steady sound that would have the same energy (i.e., the same time-averaged mean square sound pressure) as the actual fluctuating sound observed. The equivalent level represents the time average of the fluctuating sound pressure and is close to the maximum level observed during the measurement period. For the fluctuating noise scenario the equivalent noise level (L_{eq}) is generally used for more complete noise sample and is calculated as follows: $L_{eq} = 10 \log_{10} \left[\sum_{i=1}^n P_i 10^{L_i/10} \right]$

where P_i is the probability of the noise level lying in the i -th measurement interval and L_i is the mid-point of that interval

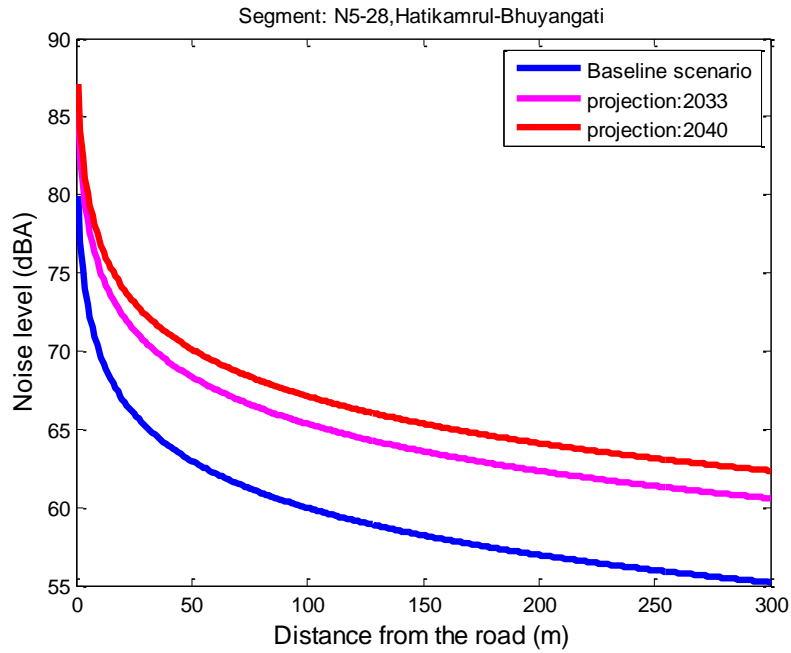


Figure 4(a): Noise Prediction under different scenarios as a function of the distance from the road in the Hatikamrul-Bhuyangati segment

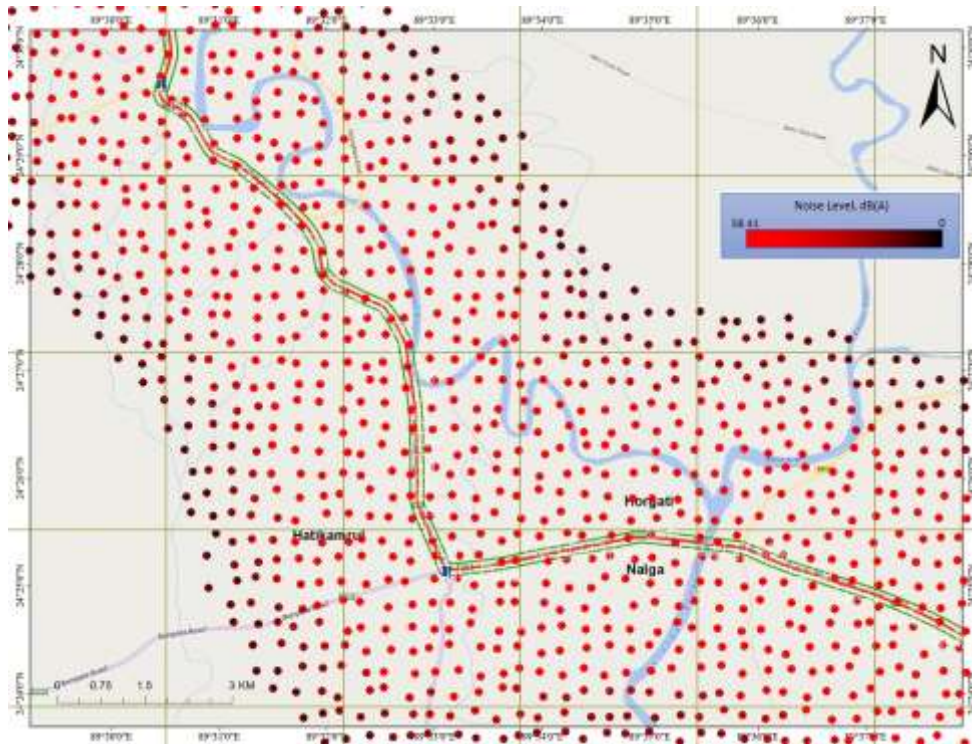


Figure 4(b): Spatial noise intensity map of the Hatikamrul-Bhuyangati segment (Box 7)

Table 2: Baseline and predicted noise (for the year 2040) at different sensitive receptors identified along the Hatikamrul-Bhuyangati route segment

Segment name	Name of sensitive receptor	Type of establishment	Latitude	Longitude	Baseline noise (Leq) under current traffic conditions	Predicted noise (Leq) for the year 2040	Comments (No change/ net increase in noise)
N5-28, Hatikamrul-Bhuyangati	Hatikamrul Puraton Mosque	Religious	24.42852	89.54746	82.5	74.2	No change
	Dadupur Sahebgonj Govt. High School	Educational	24.45099	89.5454	68.6	69.9	Marginal increase
	Daudpur Raypara Mosque	Religious	24.45828	89.54364	74.2	72.5	No change
	National Skill Development Institute	Educational	24.46188	89.5375	71.0	73.7	Net increase
	Royhati Madrasa Mor	Educational	24.47895	89.52355	70.1	73.4	Net increase

2. N5-31, Sherpur Int. with Z-5049)-Sherpur (Int. with Z-5401)

6 The noise simulation under different scenarios for the N5-31, Sherpur (Int. with Z-5049)-Sherpur (Int. with Z-5401) segment (Box 6 in figure 2) is shown in Figure 5(a). Figure 5(b) provides a spatial noise intensity map of the segment. Table 3 provides the baseline and predicted noise (for the year 2040) at different sensitive receptors identified along the route. It can be seen that

- The baseline noise at some of these receptors (except the educational institutions) exceed standards for residential areas
- There will be an increase in ambient noise at the educational institutions probably because of their close proximity to the main road. It may be suggested in the mitigation plan that regular noise monitoring should be conducted in these locations in future and proper mitigation measures should be devised (green-belt development) if required.

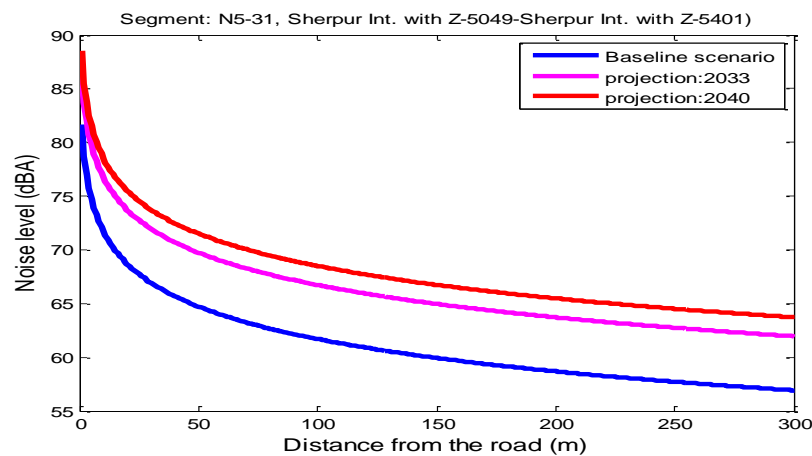


Figure 5(a): Noise Prediction under different scenarios as a function of the distance from the road in the N5-31, Sherpur Int. with Z-5049)-Sherpur (Int. with Z-5401)

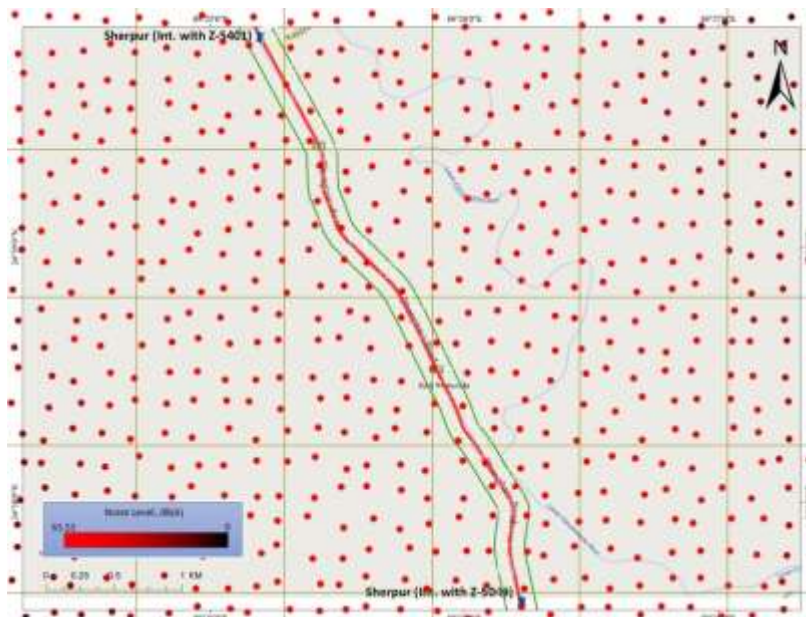


Figure 6(b): Spatial noise intensity map of the N5-31, Sherpur Int. with Z-5049)-Sherpur (Int. with Z-5401) (Box 6)

Table 3: Baseline and predicted noise (for the year 2040) at different sensitive receptors identified along the N5-31 route segment

Segment name	Name of sensitive receptor	Type of establishment	Latitude	Longitude	Baseline noise (Leq) under current traffic conditions	Predicted noise (Leq) for the year 2040	Comments (No change/ net increase in noise)
N5-31, Sherpur Int. with Z-5049)-Sherpur (Int. with Z-5401)	Holi Child School	Educational	24.63166	89.43683	73.2	72.4	No change
	Krishnapur Govt. Primart School	Educational	24.63901	89.43226	57.6	70.6	Net increase
	Sherua Bottola Bazar	Bazar	24.65272	89.42429	80.6	75.5	No change
	Jameya Hafizia Madrasha	Educational	24.66334	89.42091	61.8	70.4	Net increase

1. N5-33, between Int. with Bogra 2nd By pass-Sultanganj, Banani

7. The noise simulation under different scenarios for the N5-31, Sherpur (Int. with Z-5049)-Sherpur (Int. with Z-5401) segment (Box 5 in figure 2) is shown in Figure 6(a). Figure 6(b) provides a spatial noise intensity map of the segment. Table 4 provides the baseline and predicted noise (for the year 2040) the sensitive receptor identified along the route. It can be seen that the baseline noise at some of the receptors exceed standards for residential areas and there will be no net change of noise due to added traffic in the route.

Table G-4: Baseline and predicted noise (for the year 2040) at different sensitive receptors identified along the N5-33 route segment

Segment name	Name of sensitive receptor	Type of establishment	Latitude	Longitude	Baseline noise (Leq) under current traffic conditions	Predicted noise (Leq) for the year 2040	Comments (No change/ net increase in noise)
N5-33, between Int. with Bogra 2nd By pass-Sultanganj, Banani, km 203.568	Banani Bazar	Bazar	24.81253	89.3807	82.5	74.2	No change

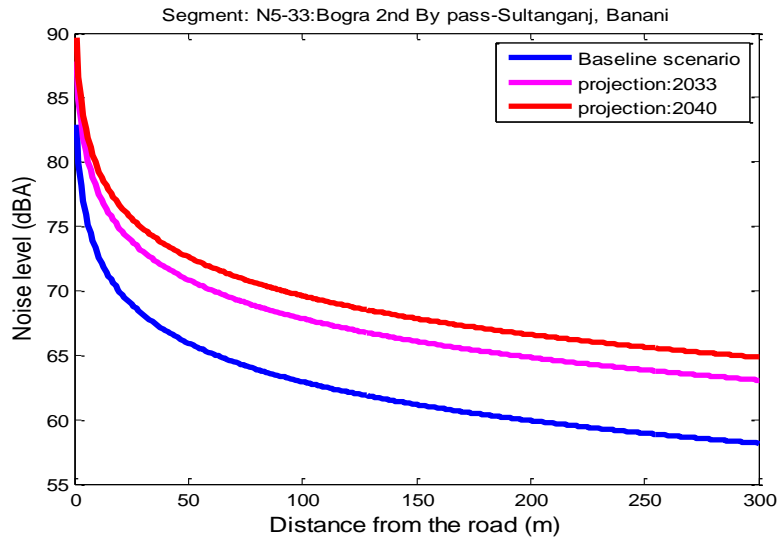


Figure G-6(a): Noise Prediction under different scenarios as a function of the distance from the road in the N5-33, between Int. with Bogra 2nd By pass-Sultanganj, Banani

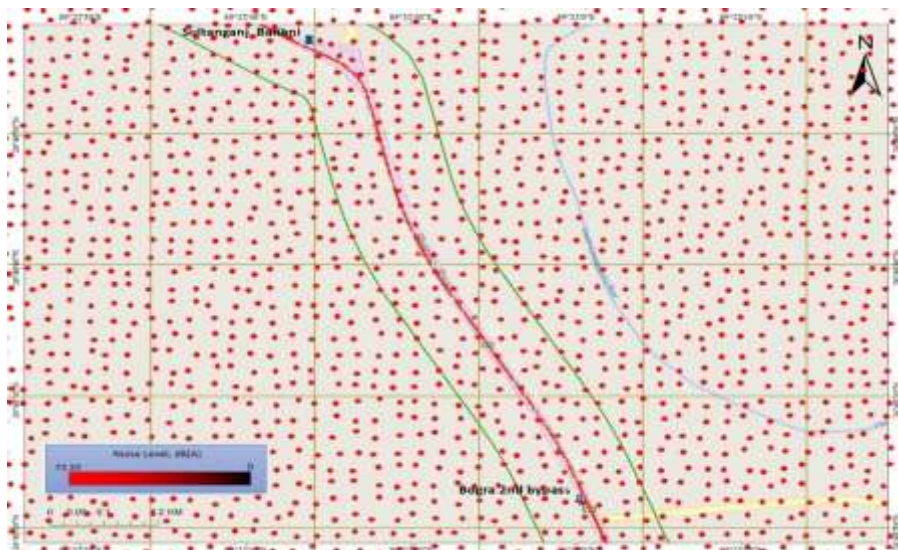


Figure G-6(b): Spatial noise intensity map of the N5-33, between Int. with Bogra 2nd Bypass-Sultanganj, Banani (Box 5)

3. N5-45, between Kashipur (Mokamtola)-Gabindaganj, Pakurtala

8. The noise simulation under different scenarios for the N5-45, between Kashipur (Mokamtola)-Gabindaganj, Pakurtala (Box 4 in figure 2) is shown in Figure 7(a). Figure 7(b) provides a spatial noise intensity map of the segment. Table 5 provides the baseline and predicted noise (for the year 2040) at different sensitive receptors identified along the route. It can be seen that

- The baseline noise at some of these receptors exceed standards for residential areas
- There will be an increase in ambient noise at the educational institution and health facility probably because of their close proximity to the main road. It may be suggested in the mitigation plan that regular noise monitoring should be conducted in these locations in future and proper mitigation measures should be devised (green-belt development) if required.

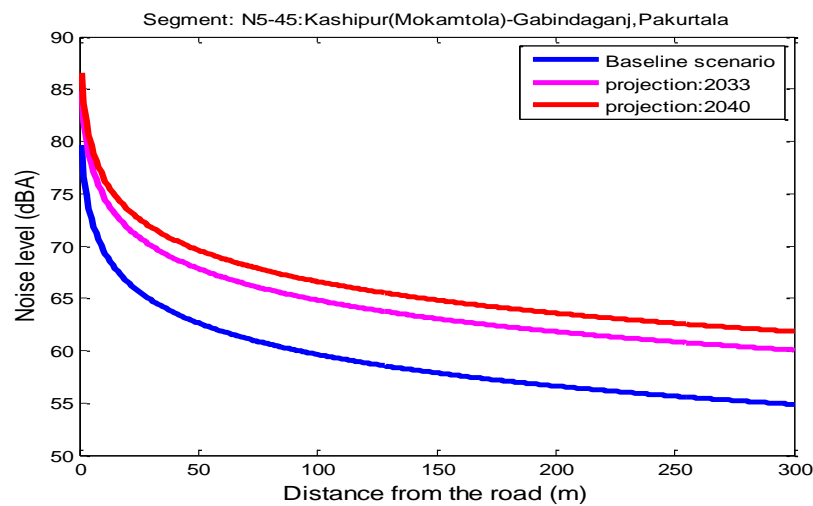


Figure G-7(a): Noise Prediction under different scenarios as a function of the distance from the road in the N5-45, between Kashipur (Mokamtola)-Gabindaganj, Pakurtala

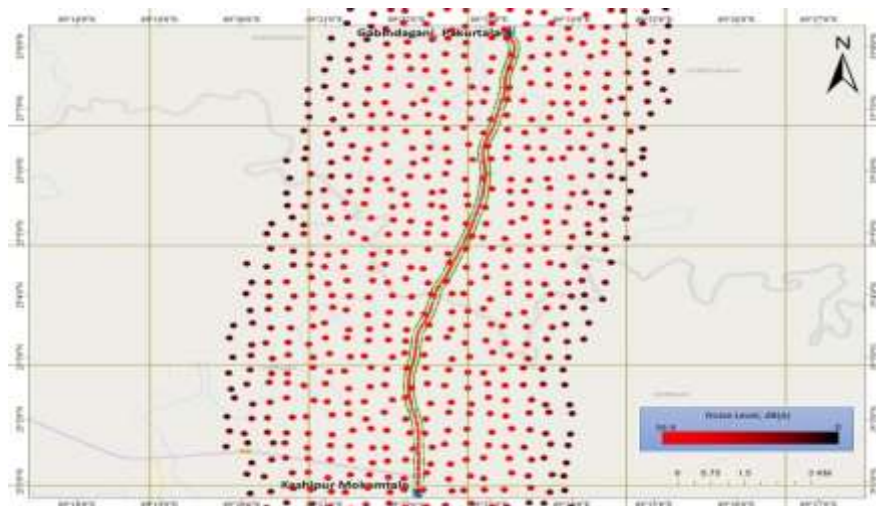


Figure G-7(b): Spatial noise intensity map of the N5-45, between Kashipur (Mokamtola)-Gabindaganj, Pakurtala (Box 4)

Table G-5: baseline and predicted noise (for the year 2040) at different sensitive receptors identified along the N5-45 route segment

Segment name	Name of sensitive receptor	Type of establishment	Latitude	Longitude	Baseline noise (Leq) under current traffic conditions	Predicted noise (Leq) for the year 2040	Comments (No change/net increase in noise)
N5-45, between Kashipur (Mokamtola) - Gabindaganj, Pakurtala, km 243.512	Makamtola Mohila Degree College	Educational	25.01357	89.36747	63.8	65.0	Marginal increase
	Pakurtola Bazar	Bazar	25.04359	89.36677	75.1	72.1	No change
	Rahbol Girls High School	Educational	25.05966	89.36947	63.4	68.3	Increase
	TMSS Health Complex	Health	25.08785	89.3807	61.8	73.3	Increase
	Boxer Mondolpara Jame Mosque	Religious	25.10972	89.38301	73.8	71.6	No change

4. N5-48, between Palashbari-Pirganj, Ekberpur

9. The noise simulation under different scenarios for the N5-48, between Palashbari-Pirganj, Ekberpur (Box 3 in figure 2) is shown in Figure 8(a). Figure 8(b) provides a spatial noise intensity map of the segment. Table 6 provides the baseline and predicted noise (for the year 2040) at different sensitive receptors identified along the route. It can be seen that

- The baseline noise at most of these receptors exceed standards for residential areas mainly due to high level of human activities during daytime
- There will be a marginal increase in ambient noise at few of these receptors and overall the generated noise will not alter the existing noise environment significantly.

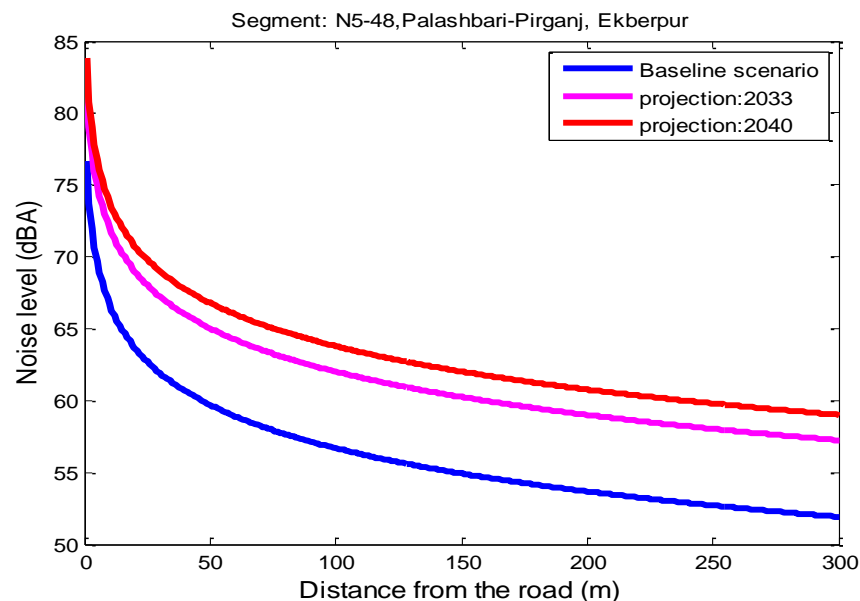


Figure G-8(a): Noise Prediction under different scenarios as a function of the distance from the road in the N5-48, between Palashbari-Pirganj, Ekberpur

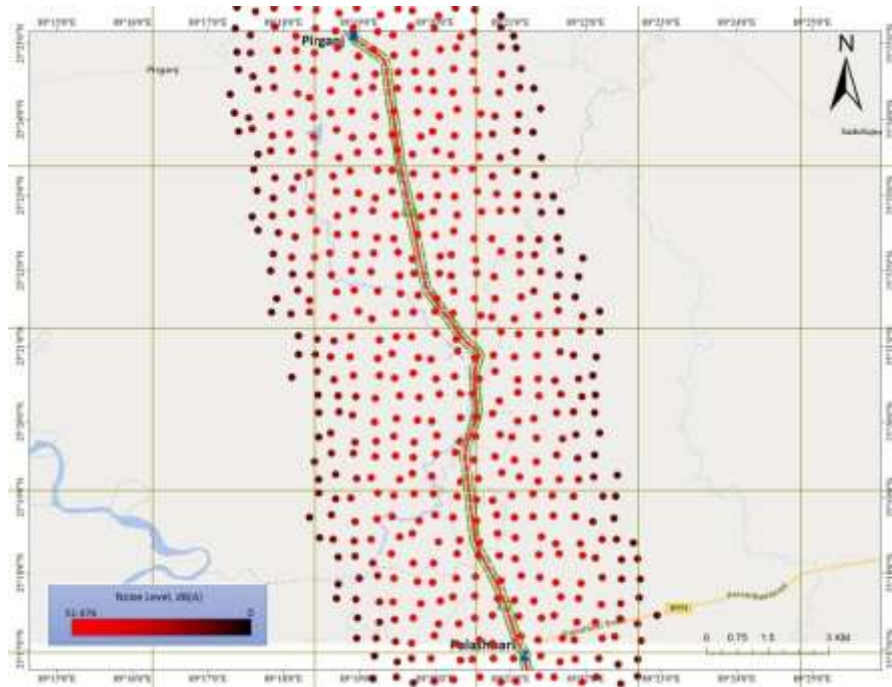


Figure G-8(b): Spatial noise intensity map of the N5-48, between Palashbari-Pirganj, Ekberpur (Box 3)

Table G-6: baseline and predicted noise (for the year 2040) at different sensitive receptors identified along the N5-48 route segment

Segment name	Name of sensitive receptor	Type of establishment	Latitude	Longitude	Baseline noise (Leq) under current traffic conditions	Predicted noise (Leq) for the year 2040	Comments (No change/net increase in noise)
N5-48, between Palashbari-Pirganj, Ekberpur, km 275.511	Mosque	Religious	25.28686	89.35039	74.7	66.7	No change
	Mosheshpur Govt. Primary School	Educational	25.30028	89.34622	73.7	66.3	No change
	Akbarpur Govt. Primary School	Educational	25.32521	89.33933	65.3	65.2	No change
	R. V. Cold Storage Mosque	Religious	25.33883	89.34263	66.8	69.3	Increase
	Dhaperhat Bazar	Bazar	25.3441	89.3419	70.6	72.9	Increase
	Mosque	Religious	25.35539	89.33632	71.3	66.9	No change
	Madarpur Govt. Primary School	Educational	25.36537	89.33066	73.9	70.8	No change
	Lillah Boarding Madrasha	Educational	25.39123	89.32641	61.5	64.4	Increase
	PirganjMohila Technical and BM College	Educational	25.40738	89.32244	69.3	65.3	No change

5. N5-48, between Pirganj, Ekberpur -Mithapukur

10. The noise simulation under different scenarios for the N5-50, between Pirganj-Mithapukur (Box 2 in figure 2) is shown in Figure 9(a). Figure 9(b) provides a spatial noise intensity map of the segment. Table 7 provides the baseline and predicted noise (for the year 2040) at different sensitive receptors identified along the route. It can be seen that

- The baseline noise at most of these receptors exceed standards for residential areas mainly due to high level of human activities during daytime.
- There will be a marginal increase in ambient noise at only one of the receptors (a mosque) and overall the generated noise will not alter the existing noise environment significantly.

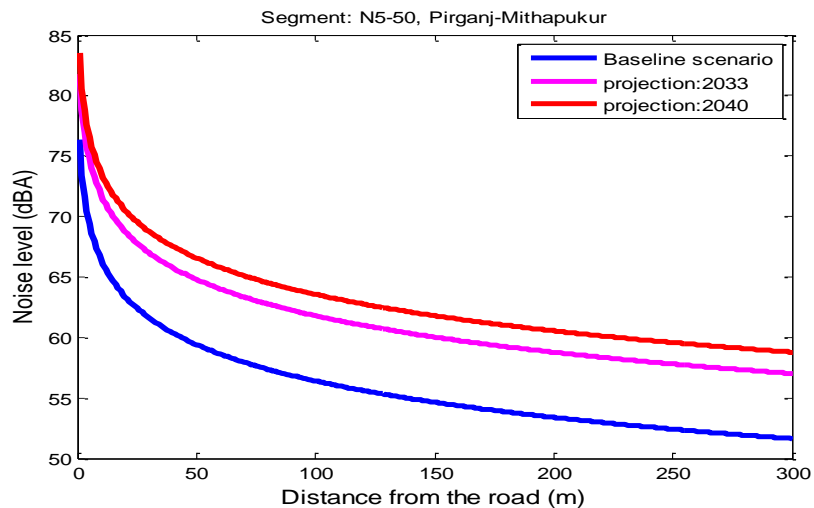


Figure G-9(a): Noise Prediction under different scenarios as a function of the distance from the road in the N5-50, between Pirganj-Mithapukur

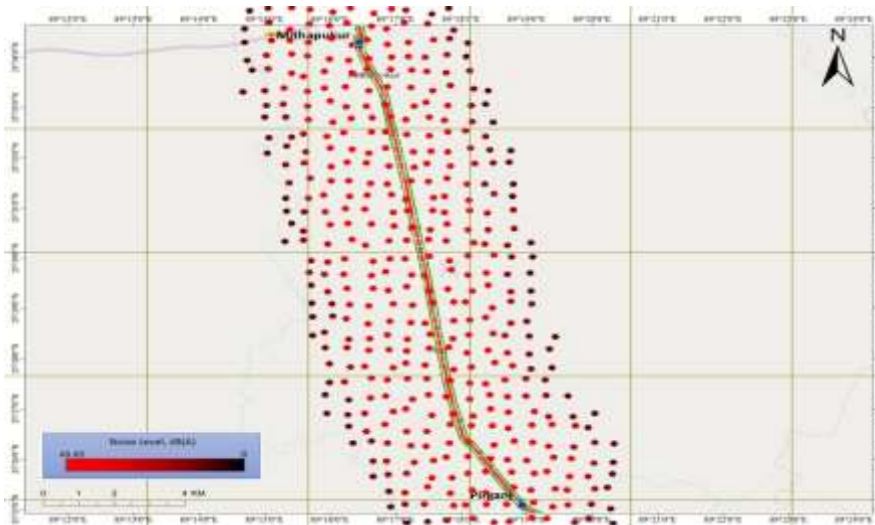


Figure 9(b): Spatial noise intensity map of the N5-50, between Pirganj-Mithapukur (Box 2)

Table G-7: baseline and predicted noise (for the year 2040) at different sensitive receptors identified along the N5-50 route segment

Segment name	Name of sensitive receptor	Type of establishment	Latitude	Longitude	Baseline noise (Leq) under current traffic conditions	Predicted noise (Leq) for the year 2040	Comments (No change/ net increase in noise)
N5-50, between Pirganj-Mithapukur, km 292.502	Pirganj Community Eye Hospital	Health	25.42076	89.31395	69.3	70.5	No change
	Mosque	Religious	25.45452	89.29762	65.4	69.9	Increase
	Bishmail Jame Mosque	Religious	25.47706	89.29352	69.5	69.7	No change
	Borodorga Bazar	Bazar	25.50597	89.2894	71.9	69.4	No change
	ShotibariJame Mosque	Religious	25.52649	89.28544	74.2	70.9	No change
	Sathibari Bazar	Bazar	25.53495	89.28418	79.7	72.0	No change
	Al Farukh High School	Educational	25.5536	89.27981	75.2	65.2	No change
	Hera Memorial Mohila Mohabiddaloy	Educational	25.56396	89.27596	72.6	68.0	No change

6. N5-51, between Mithapukur-Rangpur Modern More, Pairabond

12. The noise simulation under different scenarios for the N5-51, between Mithapukur-Rangpur Modern More, Pairabond (Box 1 in figure 2) is shown in Figure 10(a). Figure 10(b) provides a spatial noise intensity map of the segment. Table 8 provides the baseline and predicted noise (for the year 2040) at different sensitive receptors identified along the route. It can be seen that

- The baseline noise at most of these receptors exceeds standards for residential areas mainly due to high level of human activities during daytime.
- There will be an increase in ambient noise at the educational institutions probably because of their close proximity to the main road. It may be suggested in the mitigation plan that regular noise monitoring should be conducted in these locations in future and proper mitigation measures should be devised (green-belt development) if required.

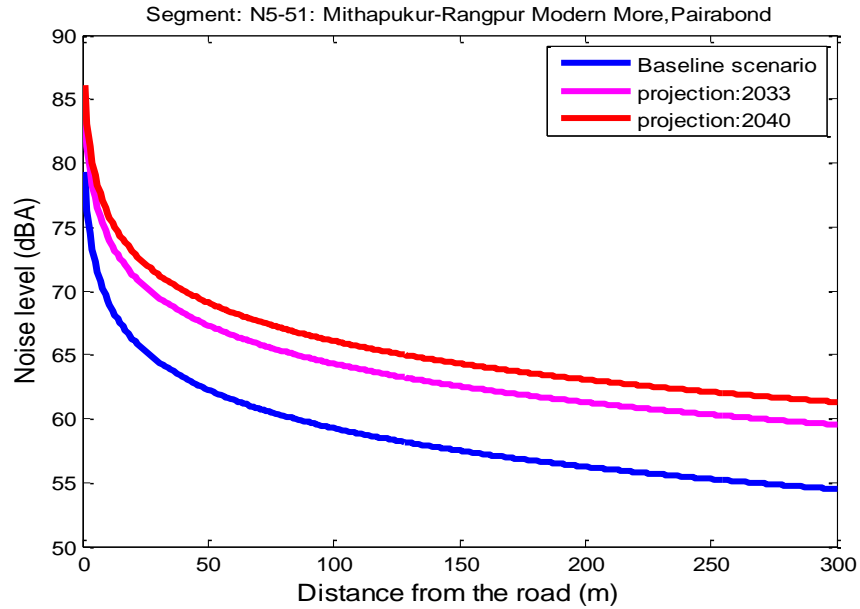


Figure G-10(a): Noise Prediction under different scenarios as a function of the distance from the road in the N5-51, between Mithapukur-Rangpur Modern More, Pairabond

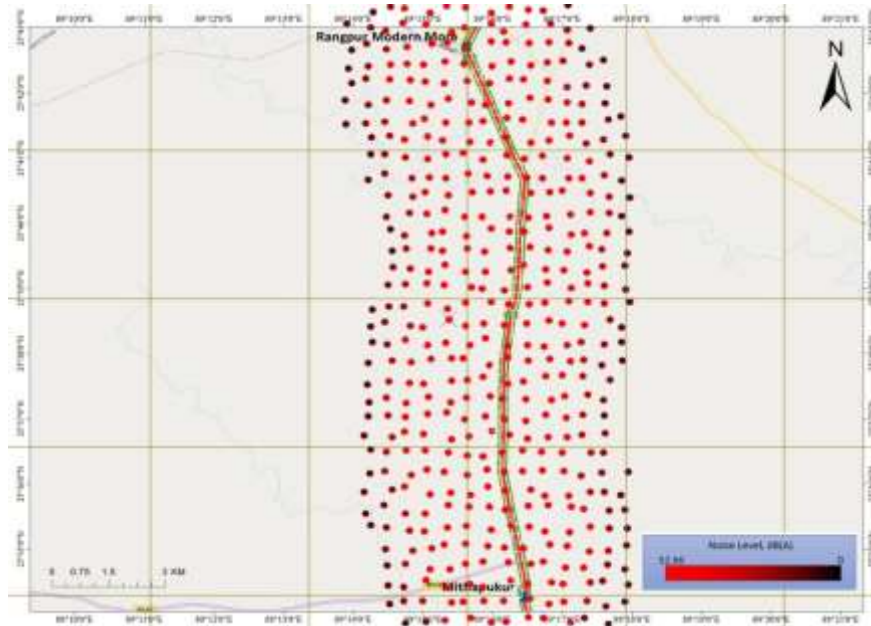


Figure G-10(b): Spatial noise intensity map of the N5-51, between Mithapukur-Rangpur Modern More, Pairabond (Box 1)

Table G-8: baseline and predicted noise (for the year 2040) at different sensitive receptors identified along the N5-50 route segment

Segment name	Name of sensitive receptor	Type of establishment	Latitude	Longitude	Baseline noise (Leq) under current traffic conditions	Predicted noise (Leq) for the year 2040	Comments (No change/net increase in noise)
N5-51, between	Mithapukur Autistic School	Educational	25.57818	89.27351	67.2	70.1	Increase

Segment name	Name of sensitive receptor	Type of establishment	Latitude	Longitude	Baseline noise (Leq) under current traffic conditions	Predicted noise (Leq) for the year 2040	Comments (No change/net increase in noise)
Mithapukur-Rangpur Modern More, Pairabond, km 316.022	Batson Fathehfur Jame Mosque	Religious	25.60268	89.26888	74.4	72.6	No change
	Genbikash Sishukanon	Educational	25.61124	89.26881	73.4	71.7	No change
	Adorsho High School	Educational	25.61546	89.26982	70.8	67.8	No change
	Mosque	Religious	25.63672	89.2699	74.3	71.9	No change
	Boiriganj Bazar	Bazar	25.66192	89.27274	80.6	68.8	No change
	Islampur Mondon Para Mosque	Religious	25.6672	89.27393	67.5	68.9	Increase
	Payrabondo Salehkiya Madrasa	Educational	25.6738	89.27351	61.6	69.1	Increase
	Hazipara Jame Mosque	Religious	25.68171	89.27203	69.0	68.6	No change
	Drishtiprotibondhi School	Educational	25.68816	89.27077	61.2	67.0	Increase
	Popular Model School	Educational	25.69598	89.26561	77.3	66.1	No change
	Muslim Aid Institute of Technology	Educational	25.71022	89.25935	72.5	64.8	No change
	North Bengal University	Educational	25.71091	89.26022	69.7	72.3	Increase

7. Tangail (Elenga)-Hatikamrul Road

13. The noise simulation under different scenarios for the Tangail (Elenga)-Hatikamrul Road (Box 8-10 in figure 2) is shown in Figure 11(a). Figure 11(b) provides a spatial noise intensity map of the segment. Table 9 provides the baseline and predicted noise (for the year 2040) at different sensitive receptors identified along the route. It can be seen that

- The baseline noise at most of these receptors exceeds standards for residential areas mainly due to high level of human activities during daytime.
- There will be an increase in ambient noise at most of the receptors identified along the route. It may be suggested in the mitigation plan that regular noise monitoring should be conducted in these locations in future and proper mitigation measures should be devised (green-belt development) if required.

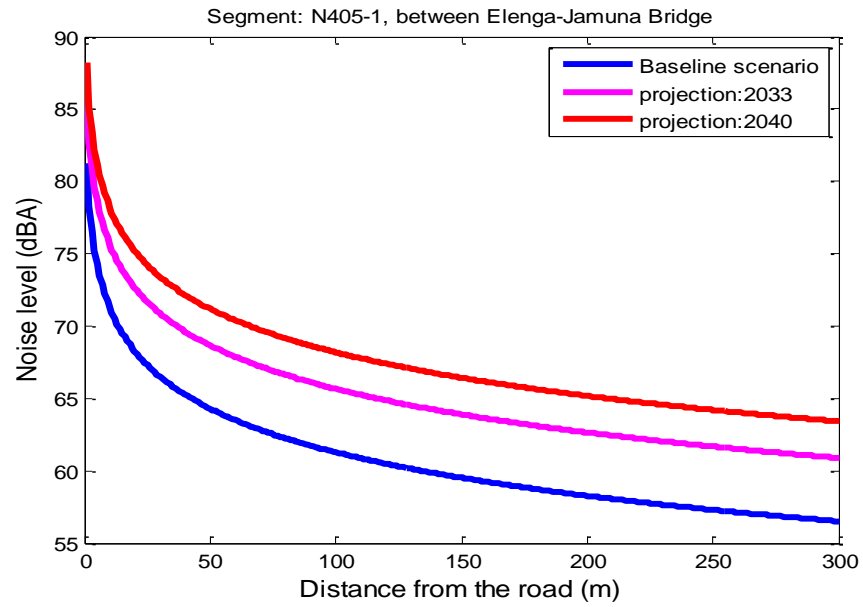


Figure G-11(a): Noise Prediction under different scenarios as a function of the distance from the road in Tangail (Elenga)-Hatikamrul Road segment

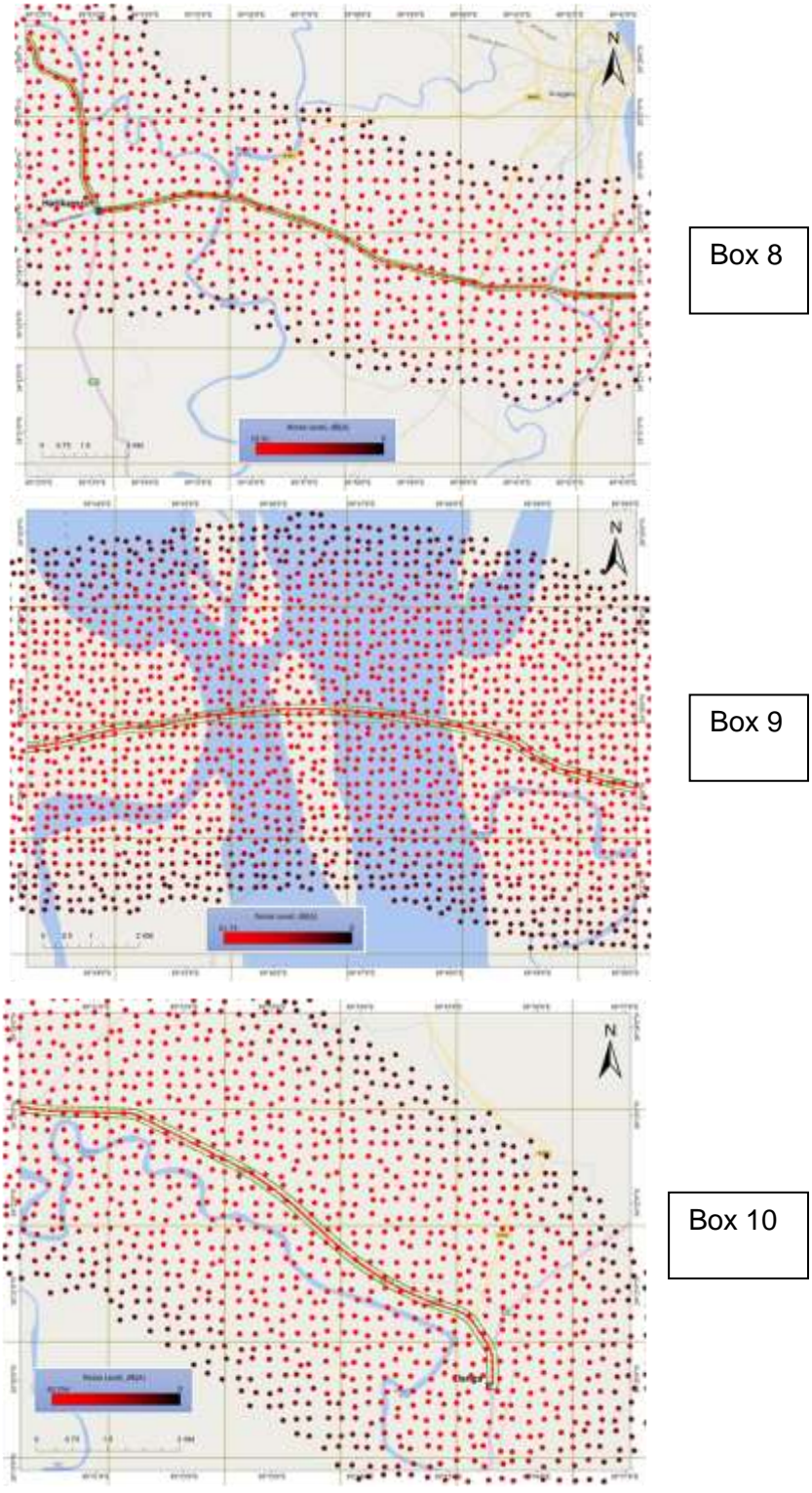


Figure G-11(b): Spatial noise intensity map of the Tangail (Elenga)-Hatikamrul Road (Box 8, 9 and 10)

Table G-9: baseline and predicted noise (for the year 2040) at different sensitive receptors identified along the Tangail (Elenga)-Hatikamrul Road segment

Segment name	Name of sensitive receptor	Type of establishment	Latitude	Longitude	Baseline noise (Leq) under current traffic conditions	Predicted noise (Leq) for the year 2040	Comments (No change/ net increase in noise)
Tangail (Elenga)-Hatikamrul Road	Bytunnur Jame Mosque	Religious	24.34407	89.91985	62.0	67.4	Increase
	An-Noor Mosque	Religious	24.38649	89.8258	62.0	68.5	Increase
	Mosque	Religious	24.39461	89.73837	48.9	65.6	Increase
	Sayadabad Mosque	Religious	24.39177	89.71413	61.0	69.9	Increase
	Dhopakanti Mosque	Religious	24.42	89.5575	72.3	74.8	Increase
	Fuljor Degree College Mosque	Religious	24.42454	89.58956	65.7	68.0	Increase
	Bangabandhu Setu Purbo Station	Others	24.38945	89.81992	66.3	72.4	Increase
	Bangabandhu Setu Poschim Station	Others	24.39579	89.73359	59.7	71.8	Increase
	Hatikomrul Highway Thana	Others	24.41885	89.55367	76.0	70.7	No change
	Gas Transmission Company Ltd	Industry	24.3384	89.92561	73.5	68.9	No change
	Poschimancho I Gas Company Limited	Industry	24.42158	89.59808	74.6	68.6	No change
	Shakhawat Memorial Hospital	Health	24.41961	89.55268	80.0	72.3	No change
	Analiabari High School	Educational	24.37013	89.88501	60.3	66.1	Increase
	Talimul Islam Madrasha	Educational	24.39169	89.7142	66.0	69.3	Increase
	Jamuna Polytechnic Institute	Educational	24.39612	89.69189	64.6	67.6	Increase
	Shohidul Bulbul Karigori College	Educational	24.39864	89.65486	63.4	66.9	Increase
Simanto Bazar	Bazar	24.41015	89.63028	67.0	73.6	Increase	

Annex A: Methodology for Noise Modeling

A. Noise Model

1. Noise emission from the proposed road network will be modeled using CUSTIC 3.2 (Canarina Environmental Software, Spain). CUSTIC 3.2 noise modeling is based on estimates for dispersion of noise in free field by means of numerical simulations which provides approximate values for the noise levels, regardless of source type (point, line or area). The program calculates the noise level discrete points in space considering different kind of sources and the conditions of the atmosphere. Figure 1 presents the input and output data of the CUSTIC 3.2 software. As shown on the Figure 1, input data include: type of source (point, line or area), ambient (climate) data, grid size and scale. Based on data entered the software calculates noise levels and presents those levels in form of iso-lines, numerical grid or color gradient.

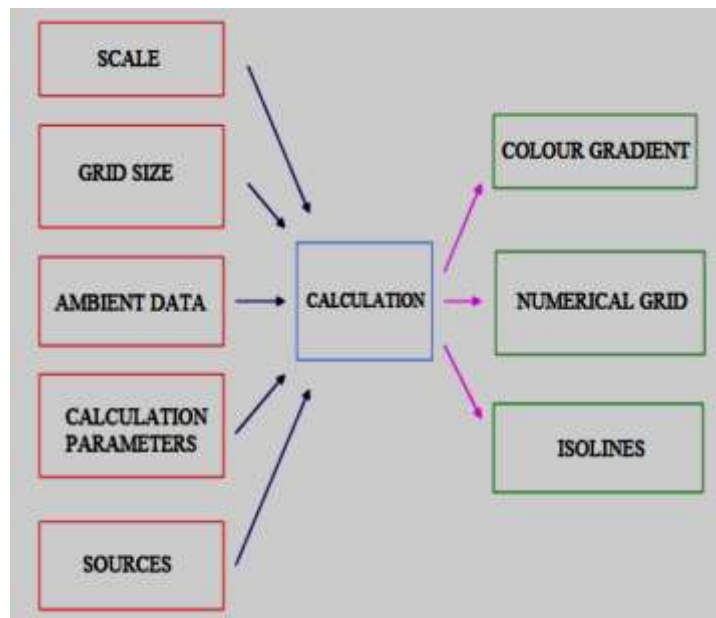


Figure 1: Input and output data arrangements in CUSTIC 3.2



Figure 2: A typical noise intensity output in CUSTIC 3.2 for a typical road using line noise source.

B. *Mathematical Construct of Noise Dispersion Model*

2. The mathematical model that the software uses provides options to model noise emissions from a wide range of sources that might be present at industrial areas and urban areas. The basis of the model is the linear sound propagation equation, which is used to model simple point source emissions from vehicles, industries, aircrafts etc. Emission sources are categorized into two basic types of sources: point sources and line sources. The algorithms used to model each of these source types are described in the following:

3. The CUSTIC software accepts meteorological data records to define the conditions for sound propagation. The model estimates the noise level for each source and receptor combination and calculates user-selected averages. For an external source, the noise level equation is

$$L_{eq} = LW - 20 \times \log(r) - 11 \times dB(A)$$

Where r is the distance and LW the source power.
However, for an industrial complex, the following equation will be used:

$$L_{eq} = L_i + 10 \times \log(S) - 20 \times \log(r) - 14 \times dB(A)$$

Where S is the external surface and L_i is the internal noise power.

4. In a road case, we shall consider several points. We shall consider a minimum number of 1000 vehicles per hour N with a 50km/h minimum velocity (100km/h is the maximum velocity). Then we have a 68 dB(A) noise level at 10m from a lineal road (infinity length). The noise level in the linear (infinite) road case will be,

$$L_{eq} = 68 \times dB(A) + 30 \log(v/50) + 10 \times \log(N/1000) - 10 \times \log(r/10)$$

5. In the curved road case, the program considers a finite element method of calculation. Each small size of road contributes to the total noise level. Each contribution will be given by

$$L_i = 10 \times \log(a/180)$$

Where a is the angle of the small road size (degrees).

6. To obtain the total noise level, we add the different L_i values following the equation

$$L_{eq} = 10 \times \log\left[\sum_i 10^{(L_i/10)}\right]$$

7. This model performs satisfactorily for simple sound propagations with no ground interaction or attachment. The application will not consider sound reflections in the ground surface.

C. *Data and Assumptions in the Noise model*

8. The noise model will consider the following:
- Current noise emissions will be predicted based on current vehicle density in the proposed road sections. The estimated projected traffic will be used to predict the noise in future times.
 - Flat topographic features (no undulations) will be assumed in the noise model. Meteorological information of the respective area will be used as input parameters.
 - Contour diagrams of noise isolines will be generated along the proposed road route
 - Several potential sensitive receptors will be located along the route of the road network (educational institutions, hospitals, religious institutions) and the incremental increase in noise will be calculated based on measured baseline noise in those locations and predicted noise from CUSTIC 3.2

Reference:

CUSTIC 3.2 Noise Pollution Modeling Software, Manuel, 004. Canarina Algorithos Numericos, S.L.

Annex B: Ambient Noise Standards and Guidelines

Table B-1: Bangladesh standards for sound level (GoB, 2006)

Locations	Noise level (dBA) at day	Noise level (dBA) at night
Silent zone	50	40
Residential area	55	45
Mixed area	60	50
Commercial area	70	60
Industrial area	75	70

(Ref: Noise Pollution Control Rules, 2006)

Table B-2: Noise Level Guidelines Measure Out of Doors. (Guidelines for Community Noise, WHO, 1999)

Receptor	One Hour L_{Aeq} (dBA)	
	Daytime 07:00 – 22:00	Night-time 22:00 – 7:00
Residential, institutional, educational	55	45
Industrial, commercial	70	70

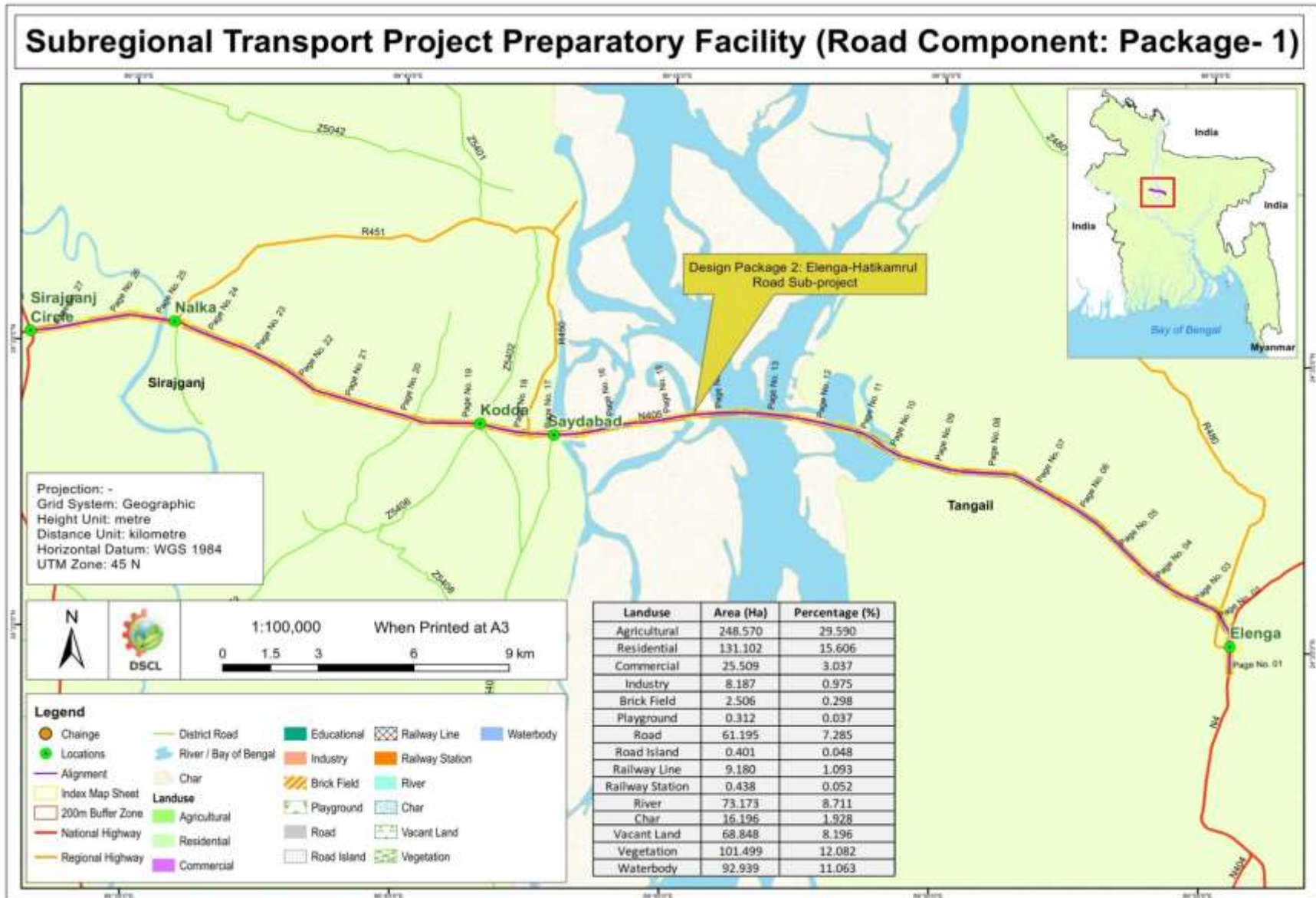
Note: For acceptable indoor noise levels for residential, institutional, and education settings refer to WHO (1999)

Table B-3: Noise Limits for Various Working Environments.

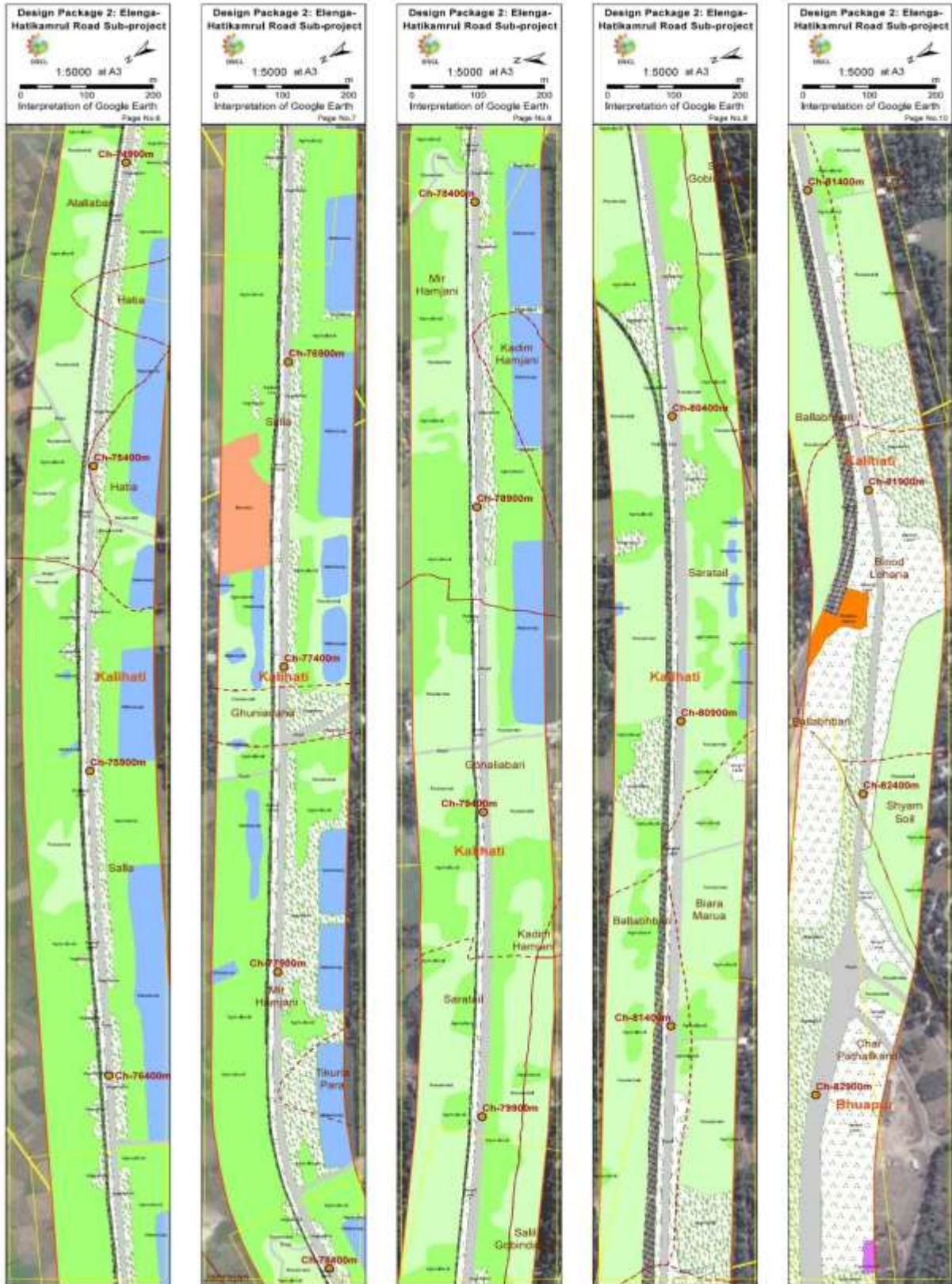
Location/ activity	Equivalent Level $L_{Aeq, 8h}$	Maximum $L_{Amax, fast}$
Heavy Industry (no demand for oral communication)	85 dB(A)	110 dB(A)
Light Industry (decreasing demand for oral communication)	50 – 65 dB(A)	110 dB(A)
Open offices, control rooms, service counters or similar	45 – 50 dB(A)	--
Individual offices (no disturbing noises)	40 – 45 dB(A)	--
Classrooms, lecture halls	35 – 40 dB(A)	--
Hospitals	30 – 35 dB(A)	40 dB(A)

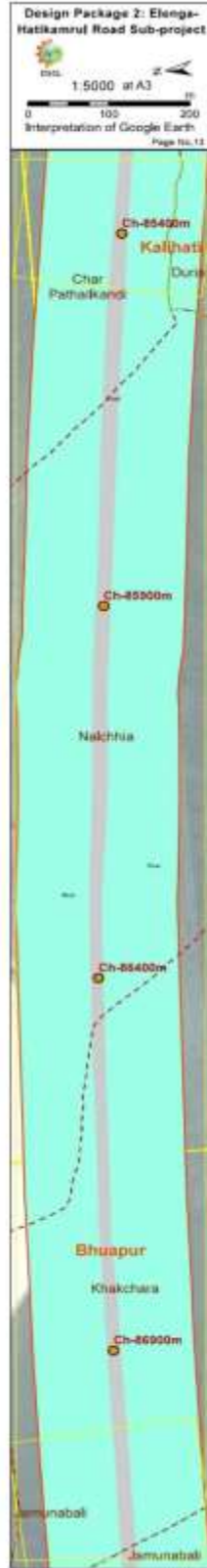
Note: For acceptable indoor noise levels for residential, institutional, and education settings refer to WHO (1999)

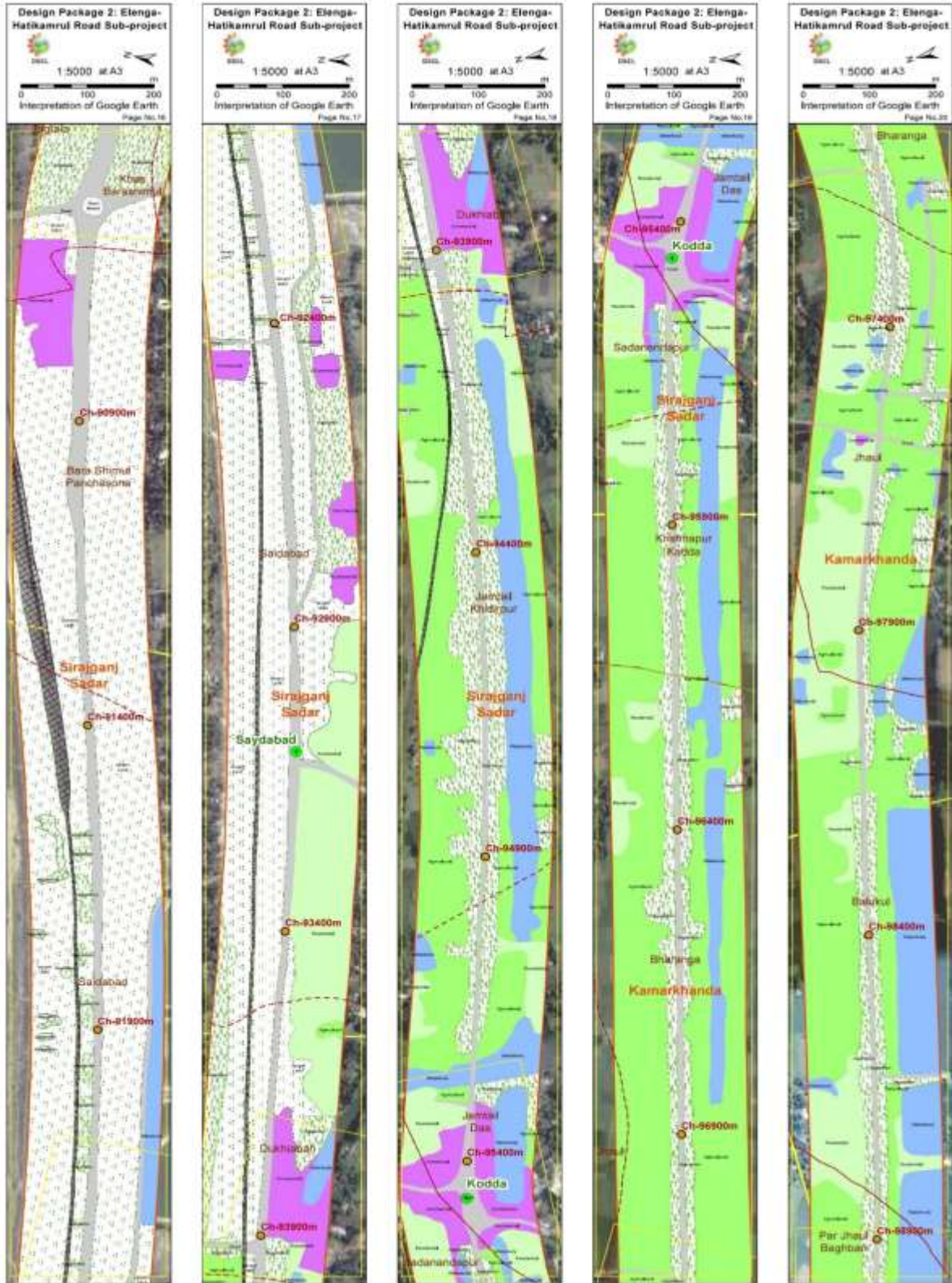
APPENDIX H: LAND USE OF THE PROJECT ROAD AREA

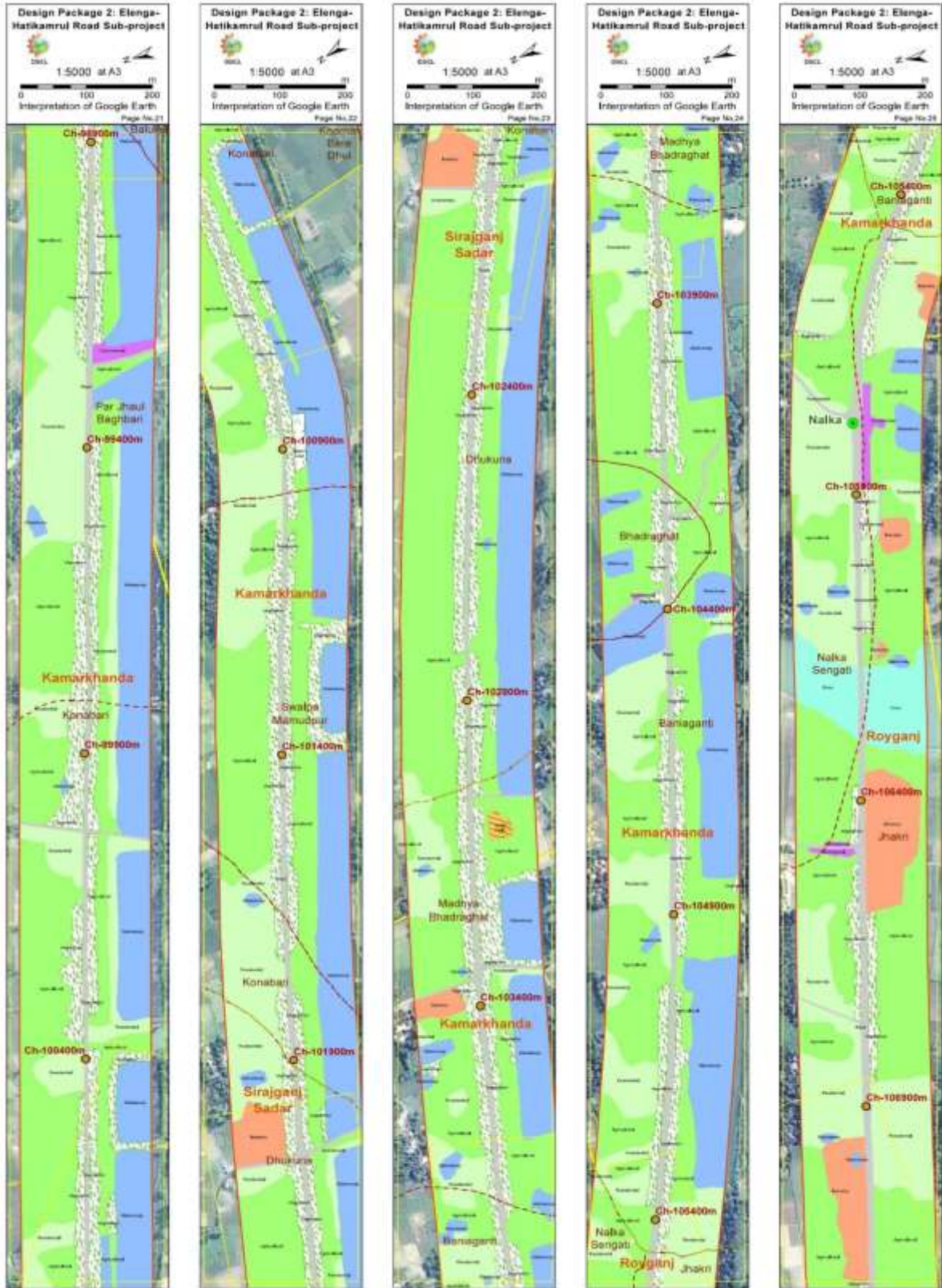














Appendix I: List of Trees Affected in the ROW

1. Tree assessment survey has been done in February-March 2014. According to the survey, total 31450 trees of different species and sizes standing on the private and government lands will be affected.

Table I-1. Number of affected trees remained on private (Non-Government) land

Local Name of the Trees	Type of Tree	Large	Medium	Small	Saplings	Total
Number of Trees Affected on Private Land (Non-Gov. Land)						
Peyara	Fruit	1	6	4	3	14
Narkel		4	5	2		11
Kodbel			1	2		3
Boroi		4	1	3		8
Sajina		2	7	4	2	15
Supari		5	4			9
Ata		1		4		5
Pepe		4				4
Total Fruits Trees			21	24	19	5
Jiga	Timber	2	14	12		28
Total Timber Trees		2	14	12	0	28
Kola		169	72	55	43	339
Bash		100	290	50		440
Grand Total		292	400	136	48	876

Table I-2. Number of affected trees remained on Government land (other than RHD)

Local Name of the Trees	Type of Tree	Large	Medium	Small	Saplings	Total	
Aam	Fruit	6	47	53	26	132	
Kathal		3	30	16	10	59	
Peyara		4	18	5	3	30	
Narkel		4	17	3	2	26	
Kodbel			1	1		2	
Kamrangga					2	2	
Jam				3	8	11	
Jambura					8	8	
Jujube				2	1	3	
Jolpai			1	2	4	7	
Sajina			1	3	3	7	
Supari			2	2	2	6	
Ata					1	1	
Khejur					2	2	
Litchu					6	1	7
Palmyra					1	1	
Tetul				4		4	
Pepe			34	5		39	
Latim					4	4	
Amra			1	1		1	3
Pomegranate					1	1	
Total Fruit Trees			56	135	121	43	355
Bunka		Timber		1	2		3
Mehogoni			3	6	24	425	458
Jiga				5			5

Local Name of the Trees	Type of Tree	Large	Medium	Small	Saplings	Total
Kadom				1		1
Eucalyptus		24	118	95	80	317
Pitahari		1	1			2
Akashmoni			5			5
Pitraj			3			3
Debdaru				4		4
Lombu					5	5
Total Timber Trees			28	139	126	510
Margosa	Medicinal			4		4
Arjun				1		1
Total Medicinal Trees				5		5
Kola		58	38	9		105
Bash			10	10		20
Grand Total		142	322	271	553	1288

Table I.3: List of affected trees standing on RHD Land

Name of the Tree	Large	Medium	Small	Saplings	Total
Mango	2	68	159	82	311
Jackfruit	35	103	166	46	350
Guava		20	30		50
Coconut	7	7			14
Wood Apple (Bel)	4	2	3		9
Blackberry (Kalo Jam)		5	167		172
Grape fruit (Batabilebu)			2		2
Jujube (Boroi)	15	63	49	71	198
Olive	3	4	25		32
Horseradish/ Drumstick (Sajina)	34	46	66		146
Betel nut (Supari)			20	15	35
Custard Apple	2	4	10		16
Date palm	7	9	138	6	160
Litchi		5	3		8
Plum (Tal)		2	549	440	991
Tamarind		2	1		3
Total Fruit Trees	109	340	1388	660	2497
Timber Trees					
Mehuguni	427	1833	4437	239	6936
Koroy	113	53	99	10	275
Shimul	2	10	27		39
Kadom			23		23
Eukaliptash	84	143	327	480	1034
Pitahara	40	63	2		105
Akashmoni	1343	2154	7457	1074	12028
Rain Tree	244	1140	1716	150	3250
Shisu	204	186	235		625
Paikor	16	12	9		37
Banyan Tree	11	15	24	1	51
Babla	6	41	233	24	304
Krisnachura	2				2
Pitraj			5		5
Devdaru		10		10	20
Lombu			4		4

Name of the Tree	Large	Medium	Small	Saplings	Total
Gamari			78		78
Total Timber Trees	2492	5660	14676	1988	24816
Medicinal trees					
Margosa (Nim)Tree	11	58	380	8	457
Arjun	15	128	392	15	550
Total	26	186	772	23	1007
Banana and Bamboo Trees					
Banana	121	48	20	25	214
Bamboo	250	362	120	20	752
Total	371	410	140	45	966

Table I-4: Summary of affected trees in terms of ownership and types of trees

Ownership	Large	Medium	Small	Saplings	Total
On Private land	292	400	136	48	876
On Gov. land (Other than RHD land)	142	322	271	553	1288
On RHD land	2998	6596	16976	2716	29286
Grand Total	3432	7318	17383	3317	31450
Timber= 25647, Fruit= 2921, Medicinal= 1012, Banana= 658, and Bamboo= 1212					

APPENDIX J: TREE PLANTATION PLAN

A. Objectives

1. The objective of the tree plantation program is to compensate for the loss of trees due to the implementation of the Elenga-Hatikamrul road subproject. Other major objectives of the program are to protect the affected cultural/sensitive areas (<25m from the ROW boundary) and to enhance the health of the existing ecosystem.

2. Approximately 31,450 nos. of various trees of different sizes will be cut down due to preparing of project sites. The proposed Tree Plantation Plan (TPP) will plant a total number of **71,500** tree saplings.

3. The following areas have been identified for development of plantation sites in the project areas. However, the required space for tree plantation will cover from the road embankment but the open space of private land under social forestry category has been taken into consideration for tree plantation in any case. The tree plantation program will be carried out along the road embankment but there are many urban areas and market places. In that case the private land near these places will be considered for tree plantation.

- Both side slopes of the developed Elenga-Hatikamrul road embankment;
- Open places of private land along the Elenga-Hatikamrul road under social forestry; and
- Along the affected cultural/sensitive areas.

B. Selection of Tree Species

4. The species for the proposed tree plantation have been selected based on the statistics of the lost vegetation and suitability for the intended purpose. The main consideration for selection of species for the Elenga-Hatikamrul road has been on protection of the road embankment from erosion and habitat for biotic species, improved aesthetics and ecological conservation as well as commercial benefits. Accordingly, the list of tree species proposed to be planted on the slope of road embankment, but not limited to, are the following:

- Timber Trees: Garjan (*Dipterocarpus turbinatus*), Shal (*Shorea robusta*), Shilkoroi (*Albizia procera*), Akasmoni (*Acacia auriculiformis*), Kat badam (*Terminalia catappa*), mehogani (*Swietenia mahagoni*), Raintree (*Samanea saman*) etc.
- Fruit Trees: Date Tree (*Phoenix sylvestris*), Black berry (*Syzygium cumini*), Olive (*Elaeocarpus floribundus*), Palm tree (*Borassus flabelliformis*), Mango (*Mangifera indica*), Jackfruit (*Artocarpus heterophyllus*) etc.
- Fuel Trees: Epil–epil (*Leucaena leucocephala*), Raintree (*Samanea saman*), Krishnochura (*Delonix regia*) etc.
- Medicinal Trees: Neem (*Azadirachta indica*), Arjun (*Terminalia arjuna*), Bohera (*Terminalia belliricha*), Bel (*Aegle marmelos*) etc.

5. The species of tree under the social forestry will be selected after the consultation with the land owner.

C. Tree Plantation Regime

6. According to the prevailing practice in Bangladesh, the FD has recommended to plant minimum of 2 trees for each tree felled for the implementation of the project. Total available space for the tree plantation on the side slopes of road embankment is 2,86,000 m² (1,90,000 m² on the left side and 96,000 m² on the right side).

7. Under the proposed tree plantation plan:
- fruit tree species will cover 40% of the total area;
 - timber tree species will cover 30% of the total area;
 - medicine tree species will cover 20% of the total area and
 - fuel tree species will cover the rest 10% of the total area.

8. The estimated land area under each category of trees and the number of trees are given in Table J-1.

Table J-1: Number of Trees

Tree species	Spacing of Tree Species (m) (center to center)	No. of Trees	Total Area (m ²)
Fruit (40%)	2.0	28,600	114,400
Timber (30%)	2.0	21,450	85,800
Medicine (20%)	2.0	14,300	57,200
Fuel (10%)	2.0	7,150	28,600
Total		71,500	286,000

D. Institutional Arrangements

9. The Forest Department (FD) is generally responsible for plantation of all government owned sites. It is a common practice in Bangladesh that the Forest Department performs the task by themselves. However, the FD will encourage the involvement of PAPs, especially vulnerable poor and women, in the plantation program. The Forest Department will provide all technical and other supports in planning and developing the plantations.

10. Nurseries of the FD along the Elenga-Hatikamrul road districts can be used for raising the suitable saplings of the tree species for the project areas as mentioned above. There are a number of private sector nurseries in the project districts which may also be contacted for raising saplings. The Forest Department will also assist the PAP in developing the tree plantation surrounding their housing space in all possible ways. The Environmental Officer of Project Implementation Unit (PIU), RHD will be responsible for overall coordination (with the FD, PAPs, and women), implementation and supervision of the program. It is recommended that RHD should start dialogue with the Forest Department for the tree plantation development program in the construction stage, so that setting up of nurseries for trees can be done in the operation stage of the project.

11. The tasks of the FD are as follows:
- Training of the local people particularly the PAPs on tree plantation and maintenance;
 - Preparation of the tree plantation programs in accordance with this plan and get them approved by the Forest Department and PIU under RHD;
 - Development of nurseries for raising seedlings;
 - Procurement of seedlings of approved species and / or FD nurseries;

- Plantation of seedlings after preparation of the land with fertilizers and installing fences for the protection of saplings;
- Maintenance of the saplings by employing adequate number of the trained PAPs;
- Distribution of saplings among the PAPs settled in and outside of the RA;
- Assist Forest Department and PIU-EMU in procurement and distribution of saplings and other inputs to the PAPs and conduct sample trace studies on the effectiveness of the program in plantation.

E. Budget

12. The budget for the proposed tree plantation development plan is given in Table J-2. The budget also includes maintenance for first five years of plantation to ensure that all planted saplings will survive and provision for an additional plantation. The plantation on the slopes of road embankment, and along the affected cultural/sensitive areas will be taken up after completion of construction work. The budget also includes procurement and development of all facilities required to establish a nursery such as, collection of suitable soils, decomposing cow dung, procurement of fertilizers etc. The budget also includes measures required for maintenance of plantation, such as watering, weeding, fertilizer application, replacing of dead saplings (if any) etc. for first five years. Total approx. budget for tree plantation is **BDT 22.16 Million**.

Table J-2: Cost estimates for the tree plantation plan

Tree Plantation Area	Unit	Rate (BDT)	Quantity	Amount (BDT)
Both sides' slope of Elenga-Hatikamrul four lane road	Nos.	100	71,500	71,50,000.00
Maintenance of replanted trees (three years)	Nos.	200	71,500	1,43,00,000.00
Provision of additional 10% tree plantation (in case of dead)	Nos.	100	7150	7,15,000.00
Total in BDT				2,21,65,000.00

APPENDIX K: LIST OF PARTICIPANTS FOR FGDS

TECHNICAL ASSISTANCE FOR SUBREGIONAL ROAD TRANSPORT PROJECT
PREPARATORY FACILITY (Elenga to Hatikamrul and Hatikamrul to Rangpur Road Sections)

Focus Group Discussions (FGDs)List of Participants

Focus Group No. 05 Date 22/03/17 Time 3:00 PM
Location: Hatikamrul, Singrajanj Road, Singrajanj
GPS: N 24.41952° E 89.55310°

Sl No.	Name	Age	Occupation	Telephone No.	Signature
01	Md. Feroz Karim	33	Business	01759176980	Feroz
02	Md. Abdus Razzaq	32	Business	01719985872	Razzaq
03	Md. Abdul Kuddus	40	Agriculture	-	-
04	Md. Abdul Malek	50	-	01938705742	Malek
05	M. Sultana Begum	30	Housewife	-	Begum
06	Sapla Khatun	30	Housewife	01965796431	Sapla
07	Moneasa Khatun	32	Housewife	-	Moneasa
08	Sefalr Khatun	32	Housewife	-	Sefalr
09	Hena Khatun	36	Housewife	-	Hena
10	Selime Hella	30	Member (word-3)	01719753570	Selime
11	Sabuj	19	student	01799658822	Sabuj
12	Nargis Khatun	42	Housewife	-	Nargis
13	Md. Ceidur Mahommed	32	Business	01939795195	Ceidur
14	Md. Abdul Sattar	52	Business	01759110053	Sattar
15	Md. Husim Uddin	45	Business	01779215109	Husim

FGD Completed By: MASFIQ BASHIR

Signature: Masfiq Bashir
22/03/17

**TECHNICAL ASSISTANCE FOR SUBREGIONAL ROAD TRANSPORT PROJECT
PREPARATORY FACILITY (Elenga to Hatikamrul and Hatikamrul to Rangpur Road Sections)
Focus Group Discussions (FGDs)**

List of Participants

Focus Group No. 05 Date 22/03/17 Time 3:00 PM
 Location: Hatikamrul, Sirajganj Road, Sirajganj
 GPS: N 24.41952° E 89.55310°

Sl No.	Name	Age	Occupation	Telephone No.	Signature
16	Alamin Sarkar	35	Business	01726340739	<i>[Signature]</i>
17	Md. Johurul Islam	48	Business	01728029424	<i>[Signature]</i>
18	Ab. Nitai Saha	40	Business	01923473161	<i>[Signature]</i>
19	Md. Jakaria Hossain	39	Service	01773891834	<i>[Signature]</i>
20	Bahar Uddin	45	Doctor	01965981575	<i>[Signature]</i>

FGD Completed By: MASFIQ BASHIR
 Signature: *[Signature]* 22/03/17

TECHNICAL ASSISTANCE FOR SUBREGIONAL ROAD TRANSPORT PROJECT
 PREPARATORY FACILITY (Elenga to Hatikamrul and Hatikamrul to Rangpur Road Sections)
Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 06 Date 22/03/17 Time 09:00 PM
 Location: Keddar Maze, Sidjgang Road, Sidjgang
 GPS: N 24.29526° E 99.69184°

Sl No.	Name	Age	Occupation	Telephone No.	Signature
01.	Md. Nazzul Islam	30	Driver	01770576026	
02.	Md. Aziz Hossain	40	Driver	01782050513	Amir Ho:
03.	Md. Samiul Islam	40	Driver	01866818340	
04.	Md. Junnar	22	Driver	01948972516	
05.	Md. Abdur Razzak	38	Driver	01739765355	
06.	Md. Abdul Haamid	45	Driver	01710901796	
07.	Md. Omor Faruk	23	Driver	01766624889	
08.	Md. Alhan Sahaluddin	44	Driver	01771181151	M. Shohabuddin
09.	Md. Nirzhar Atamed	18	Driver	01967042981	
10.	Md. Abu Hasem	24	Driver	01916535144	
11.	Md. Nur Nobi Sheik	33	Driver	01708733450	
12.	Md. Shahidul Islam	19	Driver	01792360397	
13.	Md. Jakaria	36	Business	01730617087	
14.	Md. Al Aziz	22	Driver	01937036253	
15.	Md. Romjan Ali	28	Driver	01737485515	

FGD Completed By: MASTIQ BASHIR

Signature: Mastiq Bashir
22/03/17

**TECHNICAL ASSISTANCE FOR SUBREGIONAL ROAD TRANSPORT PROJECT
PREPARATORY FACILITY (Elenga to Hatikamrul and Hatikamrul to Rangpur Road Sections)
Focus Group Discussions (FGDs)**

List of Participants

Focus Group No. 06 Date 22/09/17 Time 09:00 PM
 Location: Koddaix Mera, Sizaipani Road, Sizaipani
 GPS: N 24.39526° E 87.62184°

Sl No.	Name	Age	Occupation	Telephone No.	Signature
16.	Md. Hossain Talukder	29	Driver	01945108124	(Signature)
17.	Md. Abul Kalam Azad	27	Driver	01755391817	(Signature)

FGD Completed By: MAGFID BASHIR
 Signature: (Signature)

TECHNICAL ASSISTANCE FOR SUBREGIONAL ROAD TRANSPORT PROJECT
PREPARATORY FACILITY (Elenga to Hatikamrul and Hatikamrul to Rangpur Road Sections)
Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 07 Date 22/03/2017 Time 05:00 PM
Location: Elenga By-pass Area, Tangail
GPS: N 24.33969° E 89.92486°

Sl No.	Name	Age	Occupation	Telephone No.	Signature
01.	Md. Shafiqul Islam Mollah	30	Business	01715245334	
02.	Md. Rahim	32	Driver	01747757714	
03.	Md. Haris Masud	37	Business	01764266299	
04.	Md. Kasim Uddin	32	Driver	01728011751	
05.	Md. Sultan Mia	42	Labour	01767593266	
06.	Md. Husul Islam	58	Business	01716445791	
07.	Md. Eliash Khan	37	Driver	01924153584	
08.	Md. Adnan Ali Mollah	58	Doctor	01745424670	
09.	Md. Delwar	23	Driver	01944427710	
10.	Sulhas Chandro Shil	31	Salon	01732102961	
11.	Md. Md. Abdul Kalam	60	-	-	-
12.	Md. Abdul Kader	30	Driver	01786042155	-
13.	Md. Sagor Chowdhury	27	Business	01727189658	
14.	Md. Waheed	45	Labour	-	-
15.	Rasidul Islam Nihad	17	Student	01777486854	

FGD Completed By: MASFIQ BASHIR
Masfiq Bashir
Signature: 22/03/17

**TECHNICAL ASSISTANCE FOR SUBREGIONAL ROAD TRANSPORT PROJECT
PREPARATORY FACILITY (Elenga to Hatikamrul and Hatikamrul to Rangpur Road Sections)
Focus Group Discussions (FGDs)**

List of Participants

Focus Group No. 07 Date 22/03/2017 Time 05:00PM
 Location: Elenga By-pass More, Tangail
 GPS: N 24.33969° E 89.92586°

Sl No.	Name	Age	Occupation	Telephone No.	Signature
16.	Suman Sikdar	17	Driver	-	SUMAN
17.	Md. Uzzal Sikdar	38	-	01786094520	UZZAL
18.	Md. Feroz Mia	35	Driver	01718128682	FIROZ
19.	Md. Azam	48	Driver	01796091822	AZAM

FGD Completed By: MASFIQ BASHIR
 Signature: Masfiq Bashir
22/03/17

EIA of Elenga-Hatikamrul (N4 and N405) 40km Road Project

Focus Group Discussions (FGDs)**List of Participants**

Focused Group 01 Date & Time 10-05-2013, 10:15 AM
 Location 82+650

Sl No.	Name	Address	Occupation	Telephone No.	Signature
1	Md. Mizanur Rahman		Bus	01835-96112	mizan
2	Obaydul Islam Babu		Contractor	01739-534868	BABU
3	Md. Salim Raza		Driver	01837-260993	salim
4	Md. Solaman		Dokani		(signature)
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Focus Group Discussions (FGDs)**List of Participants**

Focused Group 02 Date & Time 10-05-2013, 1:10 PM
 Location 23+300

SI No.	Name	Address	Occupation	Telephone No.	Signature
1	Md. Salman Ali	New Saydabad, Sirajganj	Dokani	01743-904918	
2	Md. Altaf Hosan	Paik Para, Sirajganj		01754-765715	
3	Md. Foridul Islam	Amsona, Saydabad, Sirajganj	Vudvadi Driver	01761-883639	
4	Md. Abu Shama,	Mohonpur, Saydabad Sirajganj.	Motor labor.	01734-381832	
5	Md. Abdul Mannan.	New Saydabad Sirajganj.	Farmer.	01820-512847	
6	Md. Esmail Hossain.	Sayda bad Sirajganj.	C.H.G Driver	01710-133032	
7	Md. Nidan Ali Shak.	Mohonpur, Saydabad Sirajganj.	Dokani	01915-914416	
8	Md. obaydul Islam	New Saydabad, Sirajganj.	Tea Steal	01760-423673	
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Focus Group Discussions (FGDs)**List of Participants**

Focused Group 03 Date & Time 10-05-2013, 3:45 AM
 Location 95+690 (Kadia more)

SI No.	Name	Address	Occupation	Telephone No.	Signature
1	Md. Mohabbot Alam	Kadia More Sirajganj	Business	01913-273609	
2	Md. Moniruzzaman	Ponabari, Sirajganj	service	01949-693023	
3	Md. Anwar Hasan	Sadanandapur Sirajganj	service	01716-575999	
4	Md. Abu Sayed	DO	College teacher	01716-330876	
5	Md. Md. Genur Rahman	DO	Business	01921-217996	
6	Md. Mofaleb Hosain	Kadia More Sirajganj	service	01716-454229	
7	Md. Abdul Kalam AS.	Konagati, Sirajganj	Business	01712-169091	
8	Md. Abdul Momin	Nandana mela Sirajganj	Emmam	01922-001389	
9	Md. Abdul Barik	Chala shabulpur, Sirajganj	Farmer	.	
10	Md. Kholiqul Karim Sarker.	Konagati Sirajganj	P. teacher	01960-167646	
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Focus Group Discussions (FGDs)**List of Participants**

Focused Group 04 Date & Time 11.05.13, 11:45 AM
 Location 100+180 (Konabari)

SI No.	Name	Address	Occupation	Telephone No.	Signature
* 1	Md. Kamrul Islam	Konabari, Kamarakhande, Sir.	Service	01937-971725	
2	Md. Jaymal Abedin	Kamarakhande, Kamarakhande	Bus	01773-581240	
3	Md. Sidul Islam	Konabari, Kamarakhande	tea stall		
4	Md. Badse Shak.	Konabari, Kamarakhande, Sirajganj.	Dokani	01917-237093	
* 5	Md. Jahangir Alam	Konabari, Kamarakhande	Emmam	01753-592097	
6	Md. Miray Hossain	Konabari, Kamarakhande	student	01914-210238	
7	Md. Abu Hasan Malik	Konabari, Kamarakhande	Dokani	01945-810967	
8	Md. Saful Islam	Konabari, Kamarakhande	st. L.E.P.L	01914-210238	
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Focus Group Discussions (FGDs)**List of Participants**

Focused Group 05 Date & Time 11.05.13 (3'30)
 Location 105+900 (Nalka)

SI No.	Name	Address	Occupation	Telephone No.	Signature
1	Md. Jahadeul Islam.	Madde vadroogate Kamar Khando.	Service	01719-617522	Jahad
2	Md. Monjur Rahman.	Nalka, Salanga, Sirajganj	Service	01713-731581	MONJUR
3	Md. Hasan Ali	Madde vadroogate Kamar Khando	Farmer	01916-995953	Hasan
4	Md. Nazrul Islam	DO	Business	01672-341569	Nazrul
5	Md. Rangon Moya	Nalka, Salanga, Sirajganj	Mob. Serv.	01682-55726	Rangon
6	Md. Esmail Hasan	Madde vadroogate Kamar Khando	Business	01739-825770	Esmail
7	Md. Golam Motofa	Nalka, Salanga Sirajganj	Business	01712-229107	Motofa
8	Md. Kholilur Rahman	Nalka, Salanga Sirajganj	Farmer	01674-208632	Kholilur
9	Md. Lokman Hossain	Madde vadroogate Kamar Khando	Farmer	01739-457471	Lokman
10	Md. Asraful Islam	Madde vadroogate	Service	01724-862486	Asraful
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APPENDIX L: PUBLIC CONSULTATIONS

PUBLIC CONSULTATION NO- 1

SITE: KODDAR MOOR

DATE: 18th FEBRUARY 2014

TIME: 04.00 PM TO 05.15 PM.

A. Outcome of the Public Consultation

1. A consultation meeting was held during 04:00 PM to 05:15 PM on 18th February 2014 at Koddar Moor, Sirajganj. The Consultation meeting was arranged by the environment and social team to inform the potential affected people about goals and objective of the project, probable timeline of starting civil construction, roles and responsibilities of the project authority and affected people/stakeholders, probable impacts and mitigation measures. The local people (48, all male) including representative of the Koddar Moor Bazar Committee, local residence, businessmen and potential affected people were present in the meeting. Mr. Samar Prashad Das, Sociologist/Resettlement Specialist, Mr. Raisin Akhter Feroz, Jr. Environmental Specialist, and other representatives from sub-consultant facilitated the consultation meeting.

2. Mr. Samar Das delivered inaugural speech and described the project components, timeline, necessity of the project, etc. He also briefed the participants in a nutshell about importance of the consultation meeting to ensure participation of the local people in project process. Then the community representatives also introduced themselves.

3. Mr. Raisin Akhter Feroz, Jr. Environmental Specialist described the environmental issues of the project. He pointed out that each development project causes environmental hazards such as dust, noise, water and so on. This project will have some activities which may create environmental hazard. We have to ensure some environmental hazard mitigation measures. If these are neglected, then the nation would face long term adverse impact.

4. In consultation meeting, environmental and social issues were examined. The main focus was to dig out information on how does indiscriminate use of natural resources cause poverty and environmental degradation by declining the homestead forests, depleting biodiversity and decreasing livelihood of people. The issue on potential impact of construction works has also been raised.

5. The floor was open for the question answer session and the participants were encouraged to raise question if they have. The local representatives then asked their questions about the issue.

6. The local people gave some important advice. They said that government lands have to be cleared from encroachers to make sure proper use of the land. Without a flyover, four lanes will not serve the purpose at Koddar Moor as vendors will start another market on the road. The project has to ensure dividers to prevent accidents. There should be a foot over bridge at Koddar Moor as this is a commercial area and people are crossing this road all the time. The road should have provision of drainage system in both sides to keep the bazar free from water logging. In their opinion they were surprised that Bangladesh has many environmental laws and regulations but their implementation is not satisfactory. They urged the project authority to follow and implement all rules to protect the environment particularly for the project.

7. From the consultation meeting it is evident that not much people have knowledge and idea about noise pollution. Most of them are willing to tolerate noise pollution to some extent. No major impact will take place due to the project. Most of the people argued that they are willing to endure the negative impact to some extent for the sake of project which they believe will improve their livelihood. Nonetheless, they will accept eviction if the government takes appropriate mitigation measure.

8. Another problem the stakeholders raised is air pollution during the construction work. Some of them suggested that spraying of water can minimize the dust pollution. To minimize water pollution, they expect necessary measure will be taken during construction work.

B. Suggestions:

- Rehabilitation should be in an appropriate way with decent compensation.
- Effective measure should be taken to minimize the adverse impact of road construction.
- Drainage system should be developed to prevent water logging in that urban area.
- There should be effective mitigation measures to reduce noise pollution. Tree plantation and construction of noise protection walls is suggested.
- Water could be sprayed at the construction site to reduce dust, particularly during the construction phase.

ಸರ್ಕಾರಿ ಉದ್ಯೋಗ ಅಭಿವೃದ್ಧಿ (ಸಿ.ಇ.ಇ.)
 ಸಾರ್ವಜನಿಕ ಸೇವಾ ನಿಕಾಯ
 - ಸಿ.ಇ.ಇ. ನಿರ್ದೇಶನ - ಸಿ.ಇ.ಇ. -
 ಸಾರ್ವಜನಿಕ-12-2-2014 - ಸಮಯ: 4:00 ಗಂಟೆಗೆ - ಸ್ಥಾನ: ಸಿ.ಇ.ಇ.ನಿರ್ದೇಶನ, ಬೆಂಗಳೂರು

ಕ್ರ. ಸಂ.	ನಾಮ	ನಿರ್ದೇಶನ ನಾಮ	ಪ್ರಾಚಾರ್ಯ ಹೆಸರು	ಪ್ರಾಚಾರ್ಯ ನಂ.	ಹೆಸರು
1.	ಶ್ರೀಮತಿ ಸೀಮಾ ಕುಮಾರ್ ಕಾರ್ತವೀರ್ಯ	ಶ್ರೀಮತಿ. ಕುಮಾರ್ ಕಾರ್ತವೀರ್ಯ	ಅನುಕೂಲ	02222803600	ಅನುಕೂಲ
2.	ಶ್ರೀಮತಿ. ಸುಜಾತಾ ಕುಮಾರ್ ಕುಮಾರ್	ಶ್ರೀಮತಿ. ಸುಜಾತಾ ಕುಮಾರ್	"	06980828080	ಅನುಕೂಲ
3.	ಶ್ರೀಮತಿ. (ಎಂ.ಎಸ್.ಎಂ.) ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	"	01961235052	ಅನುಕೂಲ
4.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಅನುಕೂಲ	01219-616825	ಅನುಕೂಲ
5.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	"	01212-914268	ಅನುಕೂಲ
6.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಅನುಕೂಲ	01200546544	ಅನುಕೂಲ
7.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಅನುಕೂಲ	01774735824	ಅನುಕೂಲ
8.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಅನುಕೂಲ	01925215084	ಅನುಕೂಲ
9.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಅನುಕೂಲ	01913002515	ಅನುಕೂಲ
10.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಅನುಕೂಲ	01918783186	ಅನುಕೂಲ
11.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಅನುಕೂಲ	01912677373	ಅನುಕೂಲ
12.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಅನುಕೂಲ	01916-797431	ಅನುಕೂಲ
13.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಅನುಕೂಲ	01915028800	ಅನುಕೂಲ
14.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಅನುಕೂಲ	02930-48059	ಅನುಕೂಲ
15.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಅನುಕೂಲ	029306-26629	ಅನುಕೂಲ
16.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಅನುಕೂಲ	0733110446	ಅನುಕೂಲ
17.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಅನುಕೂಲ	0733110446	ಅನುಕೂಲ
18.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಅನುಕೂಲ	0733110446	ಅನುಕೂಲ
19.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಅನುಕೂಲ	0742142858	ಅನುಕೂಲ
20.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಅನುಕೂಲ	08266-66045	ಅನುಕೂಲ
21.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಅನುಕೂಲ	01203829835	ಅನುಕೂಲ
22.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಅನುಕೂಲ	0124362943	ಅನುಕೂಲ
23.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಅನುಕೂಲ	0124619246	ಅನುಕೂಲ
24.	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಶ್ರೀಮತಿ. ಅನುಕೂಲ	ಅನುಕೂಲ	01982163820	ಅನುಕೂಲ

"સત્ય વિનિયમ" ગ્રામ

તારીખ - 12-2-2019, સમય - 4:00

સુચિબદ્ધ સભ્યો, કાર્ગીલ, કચ્છ

ક્રમ	નામ :-	સંસ્થા નામ	સંસ્થા ટાઇપ	સંપર્ક નંબર	સહી
15	શશિવલ ભટ્ટ	ભા. કમલેશભાઈ	સેમેટરી	01712862410	- સહી
16	કર્ણેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	01258803818	- સહી
17	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	01213212056	- સહી
18	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	01918882959	- સહી
19	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	-	- સહી
20	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	01852-241082	- સહી
21	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	01258362211	- સહી
22	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	01936963052	- સહી
23	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	-	- સહી
24	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	01240-392114	- સહી
25	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	01772-606399	- સહી
26	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	01917769226	- સહી
27	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	-	- સહી
28	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	01727421519	- સહી
29	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	01960-871911	- સહી
30	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	017399989316	- સહી
31	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	017392099752	- સહી
32	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	01917-087330	- સહી
33	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	01271-423982	- સહી
34	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	01234808310	- સહી
35	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	01216028533	- સહી
36	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	01840920321	- સહી
37	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	01920091211	- સહી
38	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	01712-555517	- સહી
39	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	01830-229412	- સહી
40	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	-	- સહી
41	ભા. કમલેશભાઈ	ભા. કમલેશભાઈ	સેમેટરી	01720206107	- સહી

PUBLIC CONSULTATION NO- 2
SITE: PASLIYA GOVERNMENT PRIMARY SCHOOL
DATE: 19th FEBRUARY 2014
TIME: 10:00 AM TO 11:30 AM

A. Outcome of the Public Consultation

1. A consultation meeting was held during 10.00 AM to 11.30 AM on 18 February 2014 at Pasliya Govt. Primary School. The Consultation meeting was arranged by the environment and social team to inform potential affected people about goals and objective of the project, probable timeline of starting civil construction, roles and responsibilities of the project authority and affected people/stakeholders, probable impacts and mitigation measures. The local residents, businessmen, female day laborers and potential affected people (Total of 108, all male) were present in the meeting. Mr. Samar Pashad Das, Sociologist/Resettlement Specialist, Mr. Raisin Akhter Feroz, Jr. Environmental Specialist, and Md. Zahurul Islam, Field Coordinator (Sub-consultant) facilitated the consultation meeting.

2. Mr. Samar Das delivered inaugural speech and described the project components, timeline, necessity of the project, etc. Md. Zahurul Islam briefed the participants in a nutshell about importance of the consultation meeting to ensure participation of the local people in project process. He gave a brief team introduction of the KMC and SMEC team correspondents. Then the community representatives also introduced themselves.

3. Mr. Raisin Akhter Feroz, Jr. Environmental Specialist described the environmental issues of the project. He pointed out that for each development projects causes environmental hazards such as dust, noise and so on. This project will have some activities which may create environmental hazard. We have to ensure some environmental hazard mitigation measures. If these are neglected then the nation would face long term adverse impact.

4. The floor was open for the question answer session and the participants were encouraged to raise question if they have. The local representatives then asked their questions about the issue.

5. The local people suggested, as the expansion of roads will be done near my school, so Highway will come closer to my school. So it will get risky for my students because they cross this road to come to school from the other side. So, if the project constructs one foot over bridge near the school it will be better to avoid accidents.

B. Suggestions:

- As most of the people engaged in business at the roadsides so rehabilitation program should consider appropriate measure.
- To minimize the impact on cultural (mosque) sites and business places try to change the design of the proposed alignment.
- To mitigate the noise and air pollution improved technology should be used during construction.
- Local employment need to be created during the construction phase.
- There should be acceptable and effective mitigation measures to reduce noise and dust pollution.

work package 202

Roads and Highways Department Page-1

Date: 18.2.19

Time: 10 AM

Place: Pasliya Conf. primary school.

क्र.सं.	नाम	पता	संस्था	फोन नं.	विवरण
1.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	01722042832	
2.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	-	
3.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	01769493135	
4.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	01289494298	
5.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	01235428440	
6.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	01239821542	
7.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	01776-937958	
8.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	02960388600	
9.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	01715419805	
10.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	01734-601564	
11.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	02625072488	
12.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	01738-255426	
13.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	01725-80556	
14.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	01790-273636	
15.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	0174439610	
16.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	01765-02027	
17.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	02905020209	
18.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	022060420480	
19.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	01919969323	
20.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	02960388600	
21.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	02920230050	
22.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	02906992962	
23.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	0292002874	
24.	श्री. अशोक चव्हाण	राज्यपाल भवन, मुंबई	संस्था	02920000000	

Policy & Process
Consultation meeting

Sl. No.	Name	Address	Phone	Contact No.	Signature
26	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	01240-896930	-	Srinivasan
27	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	11	01228-389413	Dr. Srinivasan
28	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	11	01252-483532	Dr. Srinivasan
29	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	11	0113806080	Srinivasan
30	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	01757-300664	-	Srinivasan
31	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	11	00756022110	Srinivasan
32	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	01783623301	-	Srinivasan
33	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	-	-	Srinivasan
34	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	01205-245142	-	Srinivasan
35	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	01762107663	-	Srinivasan
36	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	01725-245141	-	Srinivasan
37	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	0	-	Srinivasan
38	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	01230963505	-	Srinivasan
39	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	01218-324542	-	Srinivasan
40	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	01212-362200	-	Srinivasan
41	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	01633-323912	-	Srinivasan
42	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	02958-020945	-	Srinivasan
43	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	01712-555517	-	Srinivasan
44	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	01712-204811	-	Srinivasan
45	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	01720966107	-	Srinivasan
46	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	07357514	-	Srinivasan
47	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	01791-696655	-	Srinivasan
48	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	0246070000	-	Srinivasan
49	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	01728629165	-	Srinivasan
50	Dr. S. S. Srinivasan	Dr. S. S. Srinivasan	0298200000	-	Srinivasan

क्र.सं.	नाम	पिता/पति नाम	व्यंजक	संपर्क नं.	वर्ग
७	अनिकुलकुमार	शुभ सुभा शर्मा	वैसाखी	०१२५२९८१३२	भा.भा.सं.प.प.
७	अमृत	श्री. श्यामलदेवी	वैसाखी	०१८२०८८०५३४	संस्कृत
७	श्यामलदेवी	श्री. अशोक उदय शर्मा	"	०१८१३-२३९८५२	कान्हापुर
७	श्री. श्यामलदेवी	श्री. अशोक उदय शर्मा	"	०१२२९९१३६	श्री. श्यामलदेवी
७	श्री. अशोक उदय शर्मा	श्री. अशोक उदय शर्मा	"	०१७९७५३१४२	श्री. अशोक
७	श्री. अशोक उदय शर्मा	श्री. अशोक उदय शर्मा	"	०१७९७९०९५२	श्री. अशोक
७	श्री. अशोक उदय शर्मा	श्री. अशोक उदय शर्मा	"	०१७२५०९४४६१	श्री. अशोक
७	श्री. अशोक उदय शर्मा	श्री. अशोक उदय शर्मा	"	०२९६६००९७७६	श्री. अशोक
७	श्री. अशोक उदय शर्मा	श्री. अशोक उदय शर्मा	"	०१७१७-११२०६४	श्री. अशोक
७	श्री. अशोक उदय शर्मा	श्री. अशोक उदय शर्मा	"	०१७१५२३३८३३	श्री. अशोक
७	श्री. अशोक उदय शर्मा	श्री. अशोक उदय शर्मा	"	०१७२४०३८९२५	श्री. अशोक
७	श्री. अशोक उदय शर्मा	श्री. अशोक उदय शर्मा	"	०१४५१२८३०२२	श्री. अशोक
७	श्री. अशोक उदय शर्मा	श्री. अशोक उदय शर्मा	"	०१९४२१४०९१५	श्री. अशोक
७	श्री. अशोक उदय शर्मा	श्री. अशोक उदय शर्मा	"	०१७०७२५०२	श्री. अशोक
७	श्री. अशोक उदय शर्मा	श्री. अशोक उदय शर्मा	"	०१२५२-२३८९३५	श्री. अशोक
७	श्री. अशोक उदय शर्मा	श्री. अशोक उदय शर्मा	"	०१९६८-९५०५३२	श्री. अशोक
७	श्री. अशोक उदय शर्मा	श्री. अशोक उदय शर्मा	"	-	श्री. अशोक
७	श्री. अशोक उदय शर्मा	श्री. अशोक उदय शर्मा	"	०१२४५-८०३२९०	श्री. अशोक
७	श्री. अशोक उदय शर्मा	श्री. अशोक उदय शर्मा	"	०१७१५८६१-२५	श्री. अशोक
७	श्री. अशोक उदय शर्मा	श्री. अशोक उदय शर्मा	"	०१२५०६३९०११	श्री. अशोक
७	श्री. अशोक उदय शर्मा	श्री. अशोक उदय शर्मा	"	०१९५९७७५३२	श्री. अशोक
७	श्री. अशोक उदय शर्मा	श्री. अशोक उदय शर्मा	"	०१२३९२०५९३१	श्री. अशोक
७	श्री. अशोक उदय शर्मा	श्री. अशोक उदय शर्मा	"	०१८४०-	श्री. अशोक
७	श्री. अशोक उदय शर्मा	श्री. अशोक उदय शर्मा	"	९२०३२१	श्री. अशोक