Initial Environmental Examination

May 2017

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

Hatikamrul - Rangpur 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 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 Hatikamrul – Rangpur 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 Transport Project Preparatory 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:** 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.

- 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. 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

61. **Project Location:** The Hatikamrul-Rangpur Road, located north of Dhaka city will start at Hatikamrul roundabout (24°25'8.89"N and 89°33'6.31"E) at an intersection where the three major national highways (N5, N405 and N507) meet. The project road ends at Rangpur (25°42'59.88"N and 89°15'45.80"E). The total length is 156.9 km.

12. The road is a standard two-lane 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 problems for this road. There are several sub-standard horizontal curves. There are areas of distressed pavement. Road passes through various heavily congested areas at Chandikona, Sherpur, Bogra Sadar, Shibganj, Gabindaganj, Palashbari, Shathibari, Mithapukur, Pirganj and Rangpur Sadar.

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

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

Road Components	
Length	156.9 Km
Alignment	Follow the existing road alignment including the bypass area for road widening and improvement. No new road alignment or bypass is proposed.
Flyovers	1 Flyover (at Bogra)
Major Bridges	155 bridges /culverts of which 21 bridges (2 Major Bridges (>100m in length) and 134 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: Super Elevation: 3% normal, 6% desirable maximum, 7% absolute maximum Minimum Curve Radius: 500 m desirable; 252 m
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
Pavement Type	Bituminous Flexible Pavement as per AASHTO Design Method

D. Description of the Environment

14. The baseline condition in the locality of the 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.

1. Physical Environment

15. **Climate:** 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).

16. **Temperature:** The highest temperature recorded in the two weather stations Rangpur and Bogra have been 37.8 °C and 38.2 °C in May accordingly. The lowest temperature recorded at the two weather stations Rangpur and Bogra were found in the same month January which were 7.2°C and 7.9 °C respectively. Both of the average monthly temperature graphs show that these two areas face high temperature from March to May and lowest temperature during winter remains from December to February in the year.

17. **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 both stations experience more than 300 mm rainfall in June and September months during monsoon. In the month of November, December and January of winter season around 10 mm rainfall occurred in the region of Rangpur and Bogra stations.

18. **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 above two stated areas are more than 70% through the year. However, humidity falls 70% in March during the winter season in the considered areas.

19. **Wind Speed:** The statistical wind speed data shows that wind speed at Rangpur was comparatively higher than the area of Bogra. Wind speed remained maximum with 4.1 knots in April and 2.9 knots in April and May for Rangpur and Bogra stations respectively. The minimum wind speed was 2.9 knots and 0.7 knots for Rangpur and Bogra stations accordingly in the month of January and November.

20. **Physiographic Features:** The Hatikamrul-Rangpur road alignment area lies mostly in the north-western part of the country and depends on the Teesta River for freshwater supply. The entire road alignment runs through the following two physiographic units:

- Teesta Floodplain (2)
- Barind Tract (16a)

21. **Topography:** The general topography of the project area comprises floodplains in the majority of the road and terraces. The topography of the project area slopes from north to south with elevation ranged from 32 m a.m.s.l to 15 m a.m.s.l.

22. **Geology:** 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.

23. **Seismicity:** As per the seismic zone map project road falls in zone II means medium seismic intensity. There is no evidence of major earthquakes in the project areas in the past.

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: Grey floodplain soil (5); Red-brown terrace soil (18); and Grey terrace soil (19).

25. **Agroecological Zones within the Project Area:** The project area contains 3 agroecological Zones, namely: Teesta Meander Floodplain (3), Karatoya-Bangali Floodplain (4) and North Eastern Barind Tract (27).

26. 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.

27. **Soil Quality:** The 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 and there are a lot discrete water bodies for fish 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 local land. River bed material (sand) of the Fuljor and Karatoya 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.

28. **Surface Water:** There are two major surface water bodies surrounding the project area which are Fuljor River and Karatoya River. The project road alignment crosses all the rivers at several locations. 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.

29. **Surface Water Quality:** 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.

30. **Groundwater:** 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/litre (mg/l).

31. **Groundwater Quality:** The concentration levels of pH, Mn, As, Fe, Cl^-, Total Hardness, TC and FC for shallow tube well of the project road varied and several parameters were found above the acceptable limit set by the DOE, GoB for drinking water. The coliforms were present in

the water from Bogra Rail Gate and Mithapukur tubewell. The arsenic concentration was within the standard value of drinking water.

32. **Ambient Air Quality:** The ambient air quality was measured at several locations along the project corridor. The particulate matter and gaseous pollutants both were above the standard at some locations of the project road. 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 particulate matters.

33. **Noise Level:** Analysis of the noise data shows that the baseline noise around the project area varies from location to location. The equivalent noise levels recorded at different locations for 24 hours show that the baseline noise level are higher than the standard set Bangladesh Noise Pollution (Control) Rules, 2006 in both day and night time. The noise modeling result also present the higher noise level during the operation period according to the projected traffic volume.

2. Biological Environment

34. **Bio-ecological Zones:** The project road alignment falls below the two bio-ecological zones; Barind Tract (2) and Teesta floodplain (4a).

35. **Terrestrial Flora:** The project influence area (PIA) is highland with mixed vegetation. Crops, vegetables are cultivated at the surrounding mainly include rice, wheat, robi 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 and timber trees that 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. According to the Inventory of Losses (IOL) survey, total 105,339 trees of different types (35,334 fruit trees, 67,170 timber trees, 2,835 medicinal trees) and sizes (large= 10,644 trees, medium= 25,019 trees, small= 48,493 trees, saplings= 21183 trees) will be affected being located within the ROW of the subproject road's alignment. Excluding the affected 105,339 trees, 37,785 banana trees and 39,731 bamboo trees will be affected being located within the ROW.

36. **Terrestrial Fauna:** The diversified habitat and ecosystem in the project area support various types of animals. 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 81 species are identified during field survey among them 2 are Amphibian, 12 Reptilian, 61 Avian faunas and 6 Mammalian faunas. Out of the species identified, 1 is endangered and 7 are vulnerable. No endemic species are found in the project area.

37. **Aquatic Flora:** Different types of aquatic floral 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.

38. **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 fish. Kolabang (*Rana tigrina*); Guishap (*Varanus bengalensis*) and Matia sap (*Enhydris enhydris*) are common. The aquatic birds are – Pancowri (*Phalacrocoraxcarto*), Kanibok (*Ardeolagrayii*), Sadabok (*Egrettagarzetta*), Borobok (Egrettaalba), Machranga (Halcyon pileata), Dahuk (Gallicrexcinerea), and winter migratory birds – Balihash (Dendrocygnajavanica) and Chakha (Tadornaferruginea).

39. The wetlands of this region also support large populations of the commercially important prawn such as Macrobrachium rosenbergii (*Golda Chingri*), M. malcomsoni (*Chatka chingri*) and Leander sp. (*Gura chingri*). 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 (Fuljor and Karatoya) along the project road.

40. **Biodiversity/Environmentally Sensitive Areas:** In and around the project area some wildlife species were identified as locally vulnerable. The name of these vulnerable species are Bengal monitor, Rat snake, Common vine snake, Crested Serpent-eagle, Yellow-footed green pigeon, Common mongoose, Bengal fox, Small Indian Civet. Some species were also identified as locally endangered and these are Ring lizard, Monocellate cobra, and Jungle cat. Any construction must consider impacts on the rate of deforestation, loss of habitat, habitat fragmentation, and interruption of wildlife migration patterns. There is no protected area located within the 5 km buffer zone of this project.

3. Socio-Economic Environment

41. **Settlement and Housing Pattern:** The project is located in densely settlements area. There are many large and small industries and factories situated in the both sides of the RoW. Housing condition of the eleven upazilas (Ullapara, Raiganj, Sherpur, Shajahanpur, Bogra Sadar, Shibganj, Gabindaganj, Palashbari, Pirganj, Mithapukur and Rangpur Sadar) of the project is predominantly kutcha, semi pucca and pucca structures. 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.

42. **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 urban areas than the rural areas.

43. **Transport and Communication:** The project areas are connected with national highways, village roads, waterways, 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 Hatikamrul-Rangpur road alignment which connect the adjacent villages to the highway.

44. **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.

45. There are no archaeological and historic sites in the RoW of the Hatikamrul-Rangpur Road project. Among the cultural sites, fifty six mosques, ten madrasah, twenty three eidgah, fourteen graveyards, seven mazar, twenty three school, eight college and five health complex/hospital fall within the RoW of the road alignment.

E. Anticipated Environmental Impacts and Mitigation Measures

46. 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. 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.

47. 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.

48. 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 PM_{10} concentrations generated from traffic movement on proposed highway.

49. Kerb side locations were selected to compare the model prediction with monitored locations. Compared with the actual measurements of $PM_{2.5}$, PM_{10} and CO concentrations, the predicted concentrations of each pollutant is lower.

50. In addition, the spatial distribution of hourly average predicted CO, $PM_{2.5}$ and PM_{10}, 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.

51. Noise pollution propagation generated from traffic was predicted using Canarina CUSTIC 3.2 software, where noise emission from vehicles along the proposed Hatikamrul - Rangpur 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: (1) N5-28 Hatikamrul-Bhuyangati (Dadupur Sahebgonj Govt. High School, National Skill Development Institute, Royhati Madrasa Mor; (2) N5-31, Sherpur Int. with Z-5049)-Sherpur (Int. with Z-5401) (Krishnapur Govt. Primart School and Jameya Hafizia Madrasha); (3) N5-45, between Kashipur (Mokamtola)-Gabindaganj, Pakurtala, km 243.512 (Makamtola Mohila Degree College, Rahbol Girls High School and TMSS Health Complex); (4) N5-48, between Palashbari-Pirganj, Ekberpur, km 275.511 (R. V. Cold Storage Mosque, Dhaperhat Bazar and Lillah Boarding Madrasha); (5) N5-50, between Pirganj-Mithapukur, km

292.502 (unnamed Mosque); (6) N5-51, between Mithapukur-Rangpur Modern More, Pairabond, km 316.022 (N5-51, between Mithapukur-Rangpur Modern More, Pairabond, km 316.022, Islampur Mondon Para Mosque, Payrabondo Salehkiya Madrasa, and Drishtiprotibondhi School). Predicted noise levels ranged from 65 -73.7 Leq.

F. Greenhouse Gases Emission and Climate Change Assessment

52. 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 Asia[2] was utilized to assess the CO_2 gross emissions with and without the project improvements. In terms of intensity, total CO_2 emissions at business-as-usual, with-project (without induced traffic) and with project (with induced traffic) scenarios were estimated at 1,350,548.73 tons/year, 740,172.06 tons/year and 959,115.5 tons/year, respectively. These values are significantly above the 100,000 tons CO_2e/year threshold[3] 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.

53. 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 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

54. **Environmental Management Plan (EMP):** On the basis of identification of the environmental impacts and recommended mitigation measures linked with the Hatikamrul-Rangpur 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 and 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.

55. **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

[1] TEEMP is an excel-based, free-of-charge spreadsheet models to evaluate emissions impacts of transport projects.
[2] A 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.
[3] Page 38, Appendix I, footnote 10 of SPS 2009

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.

56. **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.

57. **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.

58. The total budget is estimated as US$ 1.42 million.

H. Institutional Arrangement, Capacity Building and Grievance Redress Mechanism

59. **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.

60. 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.

61. 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.

62. 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.

63. 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

64. **Capacity Building:** 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 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.

65. **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.

66. The Environmental and Social Circle (SEC) 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

67. 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.

68. Public Consultations, Focus Group Discussions (FGDs), Government Officials, 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

69. **Conclusions:** This EIA concludes that the adverse 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.

70. 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.

71. **Recommendations:** The EMP, its mitigation and monitoring programs, contained herewith should 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.

72. 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 contractors should employ a national environmental specialist to monitor and report project activities throughout the project construction phase.

73. 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.

74. 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

1. **Background:** The Government of Bangladesh is emphasizing on improved connectivity between each part of the country. In line 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 Hatikamrul – Rangpur 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 Transport Project Preparatory Facility (Road Component: Package-1). 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.

5. **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.

6. **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.

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

(i) Orientation

8. 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.

(ii) Data Collection Planning

9. 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 **r**equirements 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.

(iii) Data Collection

10. 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

A. Physical Environment

11. 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.

1. Geology, Topography, Soils

12. 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.

2. Hydrology and Drainage

13. 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.

3. Air Quality

14. 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 (SO_2), Oxides of Nitrogen (NOx), Particulate Matter (PM_{10} & $PM_{2.5}$), 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.

4. Noise

15. 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.

5. Ground /Drinking Water Quality

16. 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).

6. Surface Water Quality

17. Sampling and analysis of surface water quality has been carried out for the following parameters: pH, Total Organic Carbon (TOC), Total Phosphate (PO_4), Total Suspended Solids (TSS), Oil and Grease, and Dissolved Oxygen (DO).

7. Noise

18. The noise monitoring was performed by a trained specialist, using a calibrated SVAN 949 Sound Level Meter set to A-weighting, fast **r**esponse 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 15 minutes at each location and was calibrated before and after the survey; no significant drift was detected.

8. Ground /Drinking Water Quality

19. Sampling and analysis of ground/drinking water has been carried for the following parameters: pH, Manganese (Mn), Arsenic (As), Iron (Fe), Chloride as Residual Chlorine (Cl^-), Total Hardness, Fecal Coliform (FC) and Total Coliform (TC).

9. Surface Water Quality

20. Sampling and analysis of surface water quality has been carried out for the following parameters: pH, Dissolved Oxygen (DO), Electrical Conductivity (EC), Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Free Chlorine (Cl_2), Iron (Fe), and Ammonia-Nitrogen (NH_3-N).

10. Soil Quality

21. 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).

B. Biological Environment

22. 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.

1. Flora

23. 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.

2. Fauna

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

C. Socio-Cultural Environment

25. 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.

26. **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

27. 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. PROJECT DESCRIPTION

A. Background

28. The Government of Bangladesh is emphasizing on improved connectivity between each part of the country. In line 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 Hatikamrul–Rangpur 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.

29. The existing road suffers from inadequate capacity and has safety problem. 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 some intersections.

30. 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.

31. 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 roads have been categorized under Category B of ADB's environmental classification system. The required level of environmental assessment for Hatikamrul-Rangpur (HR) 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

32. 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 Transport Project Preparatory Facility (Road Component: Package-1).

33. In this report, the different activities that are likely to take place to achieve the project objectives in Hatikamrul – Rangpur road were analysed and the potential impacts that may accompany them have been assessed.

34. 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.

35. The Hatikamrul–Rangpur road largely passes through inhabited and commercial areas. This road crosses various water bodies, which are important from aquatic ecology prospective. 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. In order to mitigate the potential impacts, appropriate measures have also been proposed in the Environmental Management Plan (EMP). Extensive public consultations undertaken as part of the EIA work have been considered for identifying the mitigation measures.

C. Extent of the Study

36. 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 5km 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 5km of the project areas have also been assessed.

37. 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.

38. 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.

D. Approach and Methodology

1. Approach

39. 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.

2. Methodology

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

41. **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.

42. **Data Collection and 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.

43. **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 and Studies
- Laboratory Analysis ****

E. Physical Environment.

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

1. Geology, Topography, Soils

45. 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.

2. Hydrology and Drainage

46. 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.

3. Air Quality

47. 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 (SO_2), Oxides of nitrogen oxide (NOx), particulate matter (PM_{10} & $PM_{2.5}$), 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.

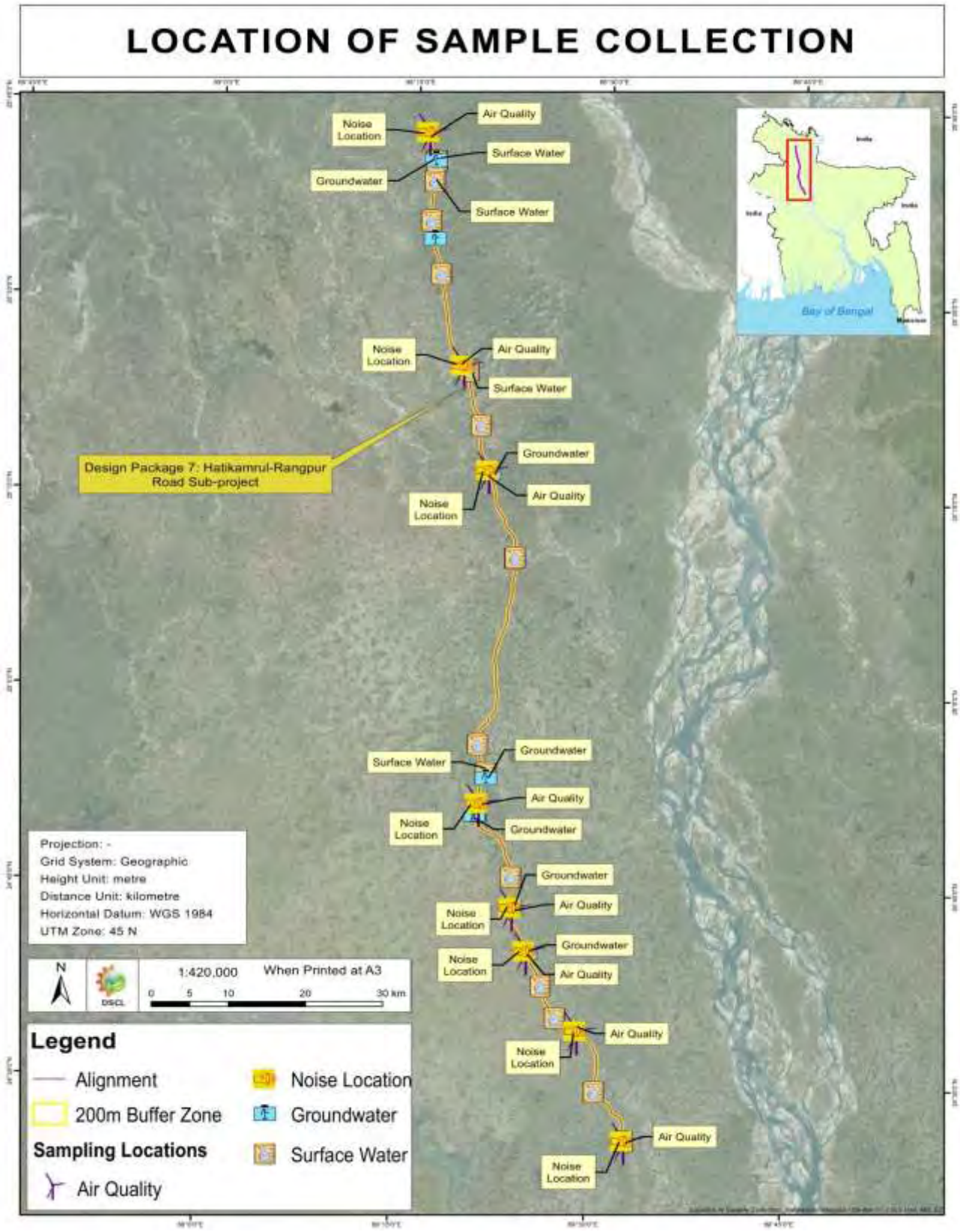


Figure 1: Location of Sample Collection along the Project Road

4. Noise

48. 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.

5. Ground /Drinking Water Quality

49. 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).

6. Surface Water Quality

50. Sampling and analysis of surface water quality has been carried out for the following parameters: pH, Total Organic Carbon (TOC), Total Phosphate (PO_4), Total Suspended Solids (TSS), Oil and Grease, and Dissolved Oxygen (DO).

7. Soil Quality

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

8. Air Quality

52. 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), carbon dioxide (CO_2), sulphur dioxide (SO_2), hydrogen sulphide (H_2S), nitrogen oxide (NO), nitrogen dioxide (NO2), particulate matter (PM_{10}), suspendate particulate matters (SPM) for 24 hours.

9. Noise

53. The noise monitoring was performed by a trained specialist, using a calibrated SVAN 949 Sound Level Meter 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 15 minutes at each location and was calibrated before and after the survey; no significant drift was detected.

10. Ground /Drinking Water Quality

54. Sampling and analysis of ground/drinking water has been carried for the following parameters: pH, Colour, Turbidity, Manganese (Mn), Arsenic (As), Iron (Fe), Chloride as Residual Chlorine (Cl^-), Total Hardness as $CaCO_3$, Total Dissolved Solids (TDS), Fecal Coliform (FC) and Total Coliform (TC).

11. Surface Water Quality

55. Sampling and analysis of surface water quality has been carried out for the following parameters: pH, Dissolved Oxygen (DO), Electrical Conductivity (EC), Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Free Chlorine (Cl_2), Iron (Fe), and Ammonia-Nitrogen (NH_3-N).

12. Soil Quality

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

F. Biological Environment

57. 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.

1. Flora

58. 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.

2. Fauna

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

G. Socio-Cultural Environment

60. 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. Data was collected on the following aspects given below:

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

61. **Public Consultation**. Public consultation is an important component of the EIA preparation activities. Local anecdotal 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 villagers, road users and people whose livelihood depends on these roads, were executed. Detailed description of public consultation has been presented at Chapter 8.

H. The Environmental Impact Assessment (EIA) Team

62. 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 3.

Table 3: The EIA Team

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

IV. ENVIRONMENTAL POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. Regulatory Requirements for the Project

63. 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 requirements are summarized below.

B. GOB Environmental Policy, Regulations, and Guidelines

1. National Environmental Policy, 1992

64. 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:

a) maintaining the ecological balance for ensuring sustainable development;
b) protection of the country against natural disasters;
c) identifying and controlling activities which are polluting and destroying the environment;
d) ensuring environment-friendly development in all sectors;
e) promoting sustainable and sound management of natural resources; and
f) active collaboration with international initiatives related to the environment.

65. With regard to the transport sector, the environmental policy 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

66. The National Environmental Management Action Plan (NEMAP) builds on the 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:

a. to identify key environmental issues affecting Bangladesh;
b. to identify actions to halt or reduce the rate of environmental degradation;
c. to improve management of the natural environment;
d. to conserve and protect habitats and bio-diversity;
e. to promote sustainable development; and
f. to improve the quality of life.

3. Environmental Conservation Act (ECA), 1995

67. 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.

68. The main objectives of ECA are:

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

69. The main focuses of the Act can be summarized as:

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

70. The main focuses of the Act can be summarized as:

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

4. Environmental Conservation Act (Amendment 2000)

71. 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)

72. 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)

73. This amendment of the act introduces new rules and restriction on:

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

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

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

75. 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 four categories;
- Procedures for issuing the Environmental Clearance Certificate (ECC); and
- Determination of environmental standards.

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

77. 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.

78. The categorization of a project determines the procedure for issuance of an Environmental Clearance Certificate (ECC). All proposed industrial units and projects that are considered to be low polluting are categorized under "Green" and shall be granted Environmental Clearance. For proposed industrial units and projects falling in the Orange-A, Orange-B and Red Categories, firstly a site clearance certificate and thereafter an environmental clearance certificate will be required. A detailed description of those four categories of industry/project is in Schedule-1 of ECR (1997). The Rules were essentially developed for industrial developments, but under Schedule 1 of the Guidelines (Clauses 63 and 64) the following falls into the Orange B Category.

79. All existing industrial units and projects and proposed industrial units and projects, that are considered to be low polluting are categorized under "Green" and shall be granted Environmental Clearance. For proposed industrial units and projects falling in the Orange- A, Orange- B and Red Categories, firstly a site clearance certificate and thereafter an environmental clearance certificate will be issued. A detailed description of those four categories of industries has been given in Schedule-1 of ECR'97. Apart from general requirement, for every Red category proposed industrial unit or project, the application must be accompanied with feasibility report on Initial Environmental Examination, Environmental Impact Assessment based on approved TOR by DOE, Environmental Management Plan EMP etc.

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

- **Red Category:** Item 67: include construction / reconstruction / expansion of roads (regional, national and international). So, EIA study and ECC are required from the DOE.

8. Bangladesh Climate Change Strategy and Action Plan

81. 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.

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

9. National Land Use Policy, 2001

83. 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.

84. The main contents of this policy are

- Stopping the high conversion rate of agricultural land to non-agricultural purposes;
- Utilizing agro-ecological zones to determine maximum land use efficiency;
- Adopting measures to discourage the conversion of agricultural land for urban or development purposes;
- Improving the environmental sustainability of land-use practices.

C. Relevant other Regulatory Requirements for the Project

85. The Government of Bangladesh has framed various laws and regulation for protection and conservation of natural environment. The legislation with applicability to this project is summarized below in Table 4.

Table 4: 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.

No.	Act/Rule/Law/Ordinance	Responsible Agency-Ministry/Authority	Key Features-Potential Applicability
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	▪ 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	▪ 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 benefit of the present and future generations; ▪ 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: 1. food security, social protection and health 2. disaster management 3. protective infrastructure 4. research and knowledge management, 5. decreased carbon development, and

No.	Act/Rule/Law/Ordinance	Responsible Agency-Ministry/Authority	Key Features-Potential Applicability
			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.
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

D. Relevant other Regulatory Requirements for the Project

86. The Government of Bangladesh has framed various laws and regulation for protection and conservation of natural environment. The legislation with applicability to this project is summarized below in Table 5.

Table 5: Applicability of Key Environmental Legislation

No.	Act/Rule/Law/Ordinance	Responsible Agency-Ministry/ Authority	Key Features-Potential Applicability
1	Bangladesh Environmental Conservation Act, 1995 (ECA, 1995) and	Ministry of Environment and Forest (MOEF)	Includes categorization of development projects into green, amber A, Amber B and red. Details procedures for securing environmental clearances for projects that

No.	Act/Rule/Law/Ordinance	Responsible Agency-Ministry/ Authority	Key Features-Potential Applicability
	Environment Conservation Rules 1997 (ECR, 1997)		are under red category. Also details procedures for obtaining site clearance for projects.
2	Environment Court Act, 2000 and subsequent amendments in 2002	MOEF	GOB has given highest priority to environment pollution and passed Environment Court Act, 2000 for completing environment related legal proceedings effectively
3	Bangladesh Wildlife Preservation Order 1973 and Revision 2008 (Draft)	MOEF	Restricts people from damaging or destroying vegetation in wildlife sanctuaries and hunting and capturing of wild animals
4	The National Water Policy, 1999	Ministry of Water Resources (MOWR)	Protection, restoration and enhancement of water resources; Protection of water quality, including strengthening regulations concerning agro-chemicals and industrial effluent; Sanitation and potable water; Fish and fisheries; and Participation of local communities in all water sector development.
5	The Brick Burning (Control) Act, 1989 The Brick Burning (Control) Amendment Act, 1992 and 2001	MOEF	Control of brick burning Requires a license from the MoEF for operation; Restricts brick burning with fuel wood
6	Water Pollution Control Ordinance 1970	MOWR	Prevents water pollution
7	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.
8	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.
9	National Forest Policy and Forest Sector Review (1994, 2005)	Forest Department, MOEF	▪ 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.

No.	Act/Rule/Law/Ordinance	Responsible Agency-Ministry/ Authority	Key Features-Potential Applicability
10	The Forest Act 1927,Amendment 2000 (Protected, village Forests and Social Forestry)	Forest Department, MOEF	Declare any forests land or wasteland as protected forests. May stop public or private way or watercourse in the interest of preservation of the forest Declare a reserved forest area as Village Forests Declare an area as Social forests or launch a social forestry programme in Govt. land or private land with permission
11	National Biodiversity Strategy and Action Plan (2004)	MOEF	▪ 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 benefit of the present and future generations; ▪ 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.
12	Bangladesh Climate Change Strategy and Action Plan (2008)	MOEF	Establishment of six strategic pillars for action, including: • food security, social protection and health • disaster management • protective infrastructure • research and knowledge management, • decreased carbon development, and • capacity building and institutional strengthening.
13	National Fisheries Policy, 1998	Ministry of Fisheries and Livestock (MOFL)	Preservation and management of inland open water fisheries.
14	The Protection and Conservation of Fish Act, 1950 and The Protection and Conservation of Fish Rules, 1985	MOFL	Prohibits and regulates the construction of temporary or permanent of weirs, dams, bunds, embankment and other structures
15	Wetland Protection Act 2000	MOWR	Advocates protection against degradation and resuscitation of natural water-bodies such as lakes, ponds, beels, khals, tanks,

No.	Act/Rule/Law/Ordinance	Responsible Agency-Ministry/ Authority	Key Features-Potential Applicability
			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.
16	Embankment and drainage Act	MOWR	An Act to consolidate the law relating to embankment and drainage.
17	The ground Water Management Ordinance 1985	MOWR	Focuses on management of Ground Water Resources. Disallows digging of tube wells without permission from the Upazilla Parishad
18	Vehicle Act 1927 and Motor vehicle ordinance 1983	BRTA	Road/traffic safety Vehicular air and noise pollutions Fitness of vehicles and registration

87. Under the Environmental Conservation Act (1995) and Rules (1997), the project will be required to obtain a site clearance as well as an environmental clearance. The procedure for obtaining environmental clearance is given in the Figure 2.

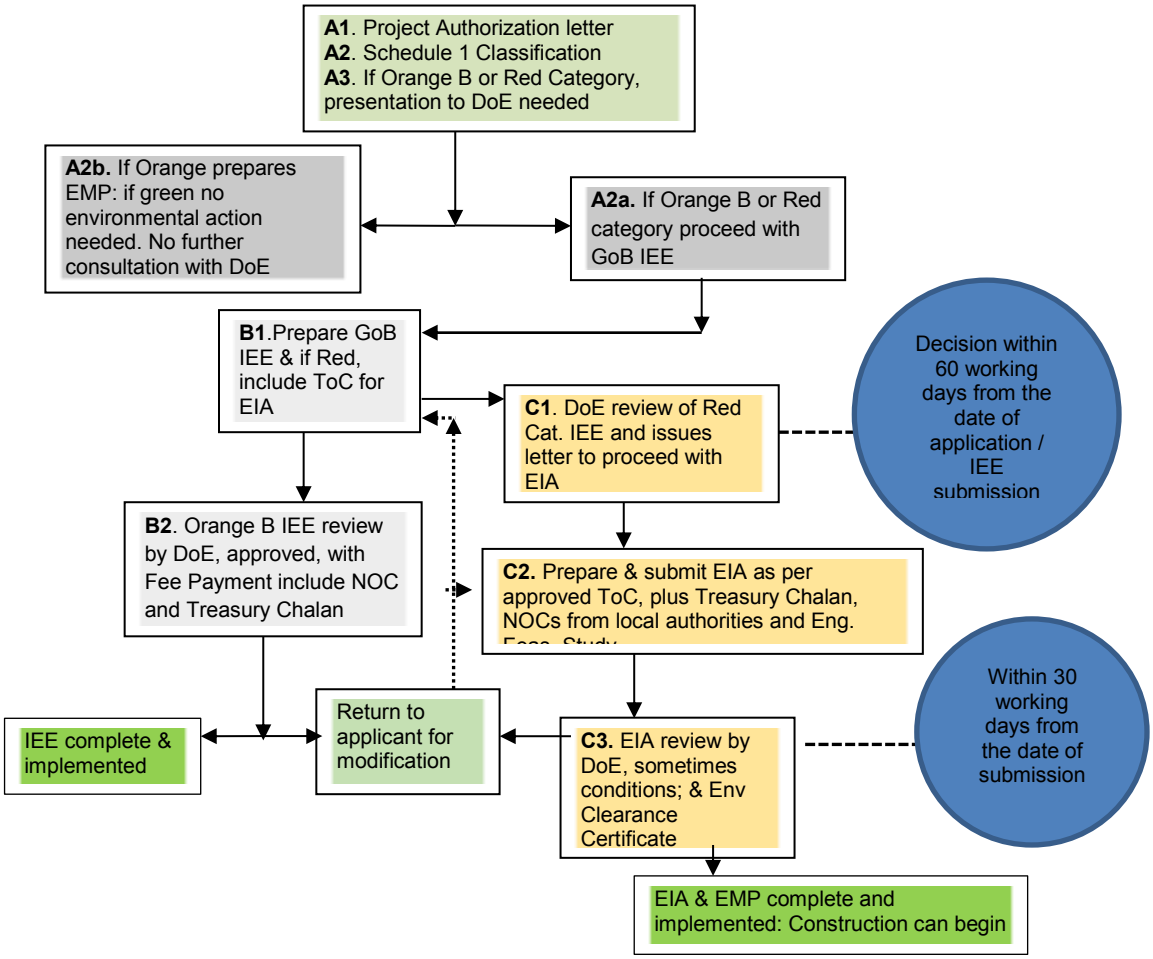


Figure 2: Government of Bangladesh Environmental Assessment Process

E. International Treaties

88. Bangladesh has signed most international treaties, conventions and protocols on environment, pollution control, bio-diversity conservation and climate change, including the Ramsar Convention, the Bonn Convention on migratory birds, the Rio de Janeiro Convention on biodiversity conservation and the Kyoto protocol on climate change. An overview of the relevant international treaties and conventions signed by GOB is shown in Table 6.

Table 6: 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 and 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

Treaty or Convention	Year	Brief description	Responsible Agency
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. Administrative Framework

89. Bangladesh has a very clear administrative framework regarding environmental aspect. It has strong interface between local government and federal Government. Department of Environment is responsible for grant of environmental clearance to a project. In addition there are other ministries to deal with specific area of importance to the country like Forests, Water and others. The administrative stages for grant of clearance of a project are also shown in Figure 2.

G. Asian Development Bank Safeguard Policies, 2009

90. 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[4].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 multitranche 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 reflected in an update of the Safeguard Policy by 2009, announced through the Safeguard Policy Statement 2009.

91. According to the Safeguard Policies 2009 (SPS 2009) of ADB, ADB‘s overarching statement on its commitment and policy principles are:

92. 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.

93. 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.

[4] ADB.2009. Safeguard Policy Statement, Manila

94. 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

95. 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.

96. 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.

97. 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.

98. 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

99. 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 underscores 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.

100. 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

101. 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.

102. 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.

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

104. 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.

105. 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.

4. Project Category

106. 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. Stakeholder consultation was an integral part of the IEE, and an environmental management plan (EMP) specifying mitigation measures to be adhered to during implementation of the project has been prepared.

107. According to ECR Schedule 1, the project is red category because it involves construction, reconstruction, and extension of roads and bridges[5]. 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 7 shows the summary of environmental regulatory compliance required for the project.

[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.

Table 7: Environmental Regulatory Compliance

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

5. Occupational Health and Safety

108. During construction, the project will conform to the labour laws and occupational and health related rules as outlined in Table 8.

Table 8: 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 workmsn'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 with regard to public health. In case of emergency, it is necessary to make special provisions for 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.

V. DESCRIPTION OF THE PROJECT

A. Background

109. Bangladesh, due to its location, 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.

110. The Hatikamrul-Rangpur road is a vital link in the national highway network. This road is part of Asian Highway Network route AH2.

111. The upgrading of these roads is consistent with the Road Master Plan 2008 of Bangladesh. The existing roads are two lane roads with shoulders. There is no separate provision for slow moving vehicular traffic (SMVT) or non-motorised traffic (NMT). There are capacities constraints caused by congested junctions, markets and built up areas.

112. The completion of the proposed upgrading will substantially improve transport efficiency on the road linking the Bangabandhu Bridge to Dhaka 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

113. The Hatikamrul-Rangpur road located north of Dhaka city will start at Hatikamrul roundabout (24°25'8.89"N and 89°33'6.31"E) at an intersection where the three major national highways (N5, N405 and N507) meet. The project road ends at Rangpur (25°42'59.88"N and 89°15'45.80"E). The total length is 156.9 km. Figure 3 shows the project location.

114. The road is a standard two-lane 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. There are areas of distressed pavement. Road passes through various heavily congested areas at Chandikona, Sherpur, Bogra Sadar, Shibganj, Gabindaganj, Palashbari, Shathibari, Mithapukur, Pirganj and Rangpur Sadar.

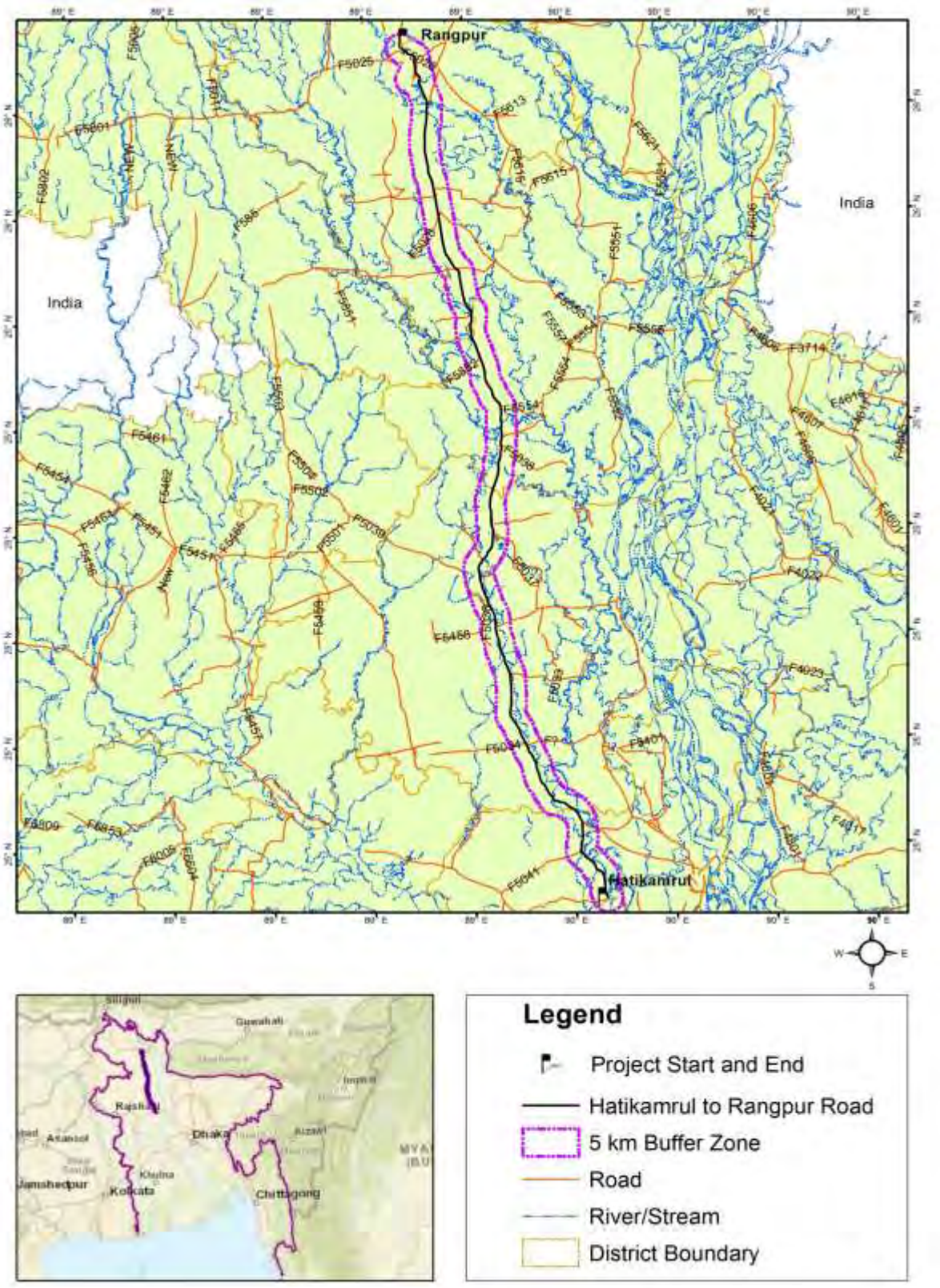


Figure 3: Locality Plan of the Project

C. Project Components

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

Table 9: Road Components and Design Standards for Hatikamrul-Rangpur Road

ROAD COMPONENTS	
Length	156.9 Km
Alignment	Follow the existing road alignment including the bypass area for road widening and improvement. No new road alignment or bypass is proposed.
Flyovers	1 Flyover (at Bogra)
Major Bridges	155 bridges /culverts of which 21 bridges (2 Major Bridges (>100m in length) and 134 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: Super Elevation: 3% normal, 6% desirable maximum, 7% absolute maximum Minimum Curve Radius: 500 m desirable; 252 m
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
Pavement Type	Bituminous Flexible Pavement as per AASHTO Design Method

D. Alignment and ROW

116. The project road is two lanes at most of the places, and will be upgraded to 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. Largely it will be left aligned. The RoW required is 40m, 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, urban, and densely populated areas. In many areas, ROW is encroached by the people. At some of the places, either ROW may not be available for the desired embankment height or is un-utilisable due to encroachment. At such places, RC retaining wall option will be exercised to reduce the ROW requirement. Widening will be either right aligned or left aligned.

117. Typical cross sections of road alignment for normal road, constricted road and highly constricted road are given at Figure 3.2. The pavement works comprise construction of sub-grade, sub-base, base binder course and wearing course. All roads has 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 3.3 and Figure 3.4.

118. 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 Block, Concrete Blocks, Sand Cement Blocks and sand geo-bags may be used for construction of protective works.

E. Existing and Proposed Cross Drainage Structures

119. Two major bridges of more than 100m length are proposed to be constructed over defined perennial waterways. These bridges are listed in Table 10, which will be constructed mostly downstream at all the bridge location where river training structures are used in the upstream.

Table 10: List of New Major Bridges (> 100 m length) in Hatikamrul-Rangpur Road

Bridge Name	Location chainage	Length (m)
Jora	7+984	122.33
Karatoya River Bridge	93+851	158.10

120. The Hatikamrul-Rangpur project EIA TOR has been approved from the concerned authorities and that will cover the possible impact and mitigation measures for the entire project. These major two bridges are within the Hatikamrul-Rangpur Road project and work activities are within the same project. Therefore, this EIA has been fulfilled details environmental impacts and mitigation measure for these bridges. In addition to above major bridges, 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 11.

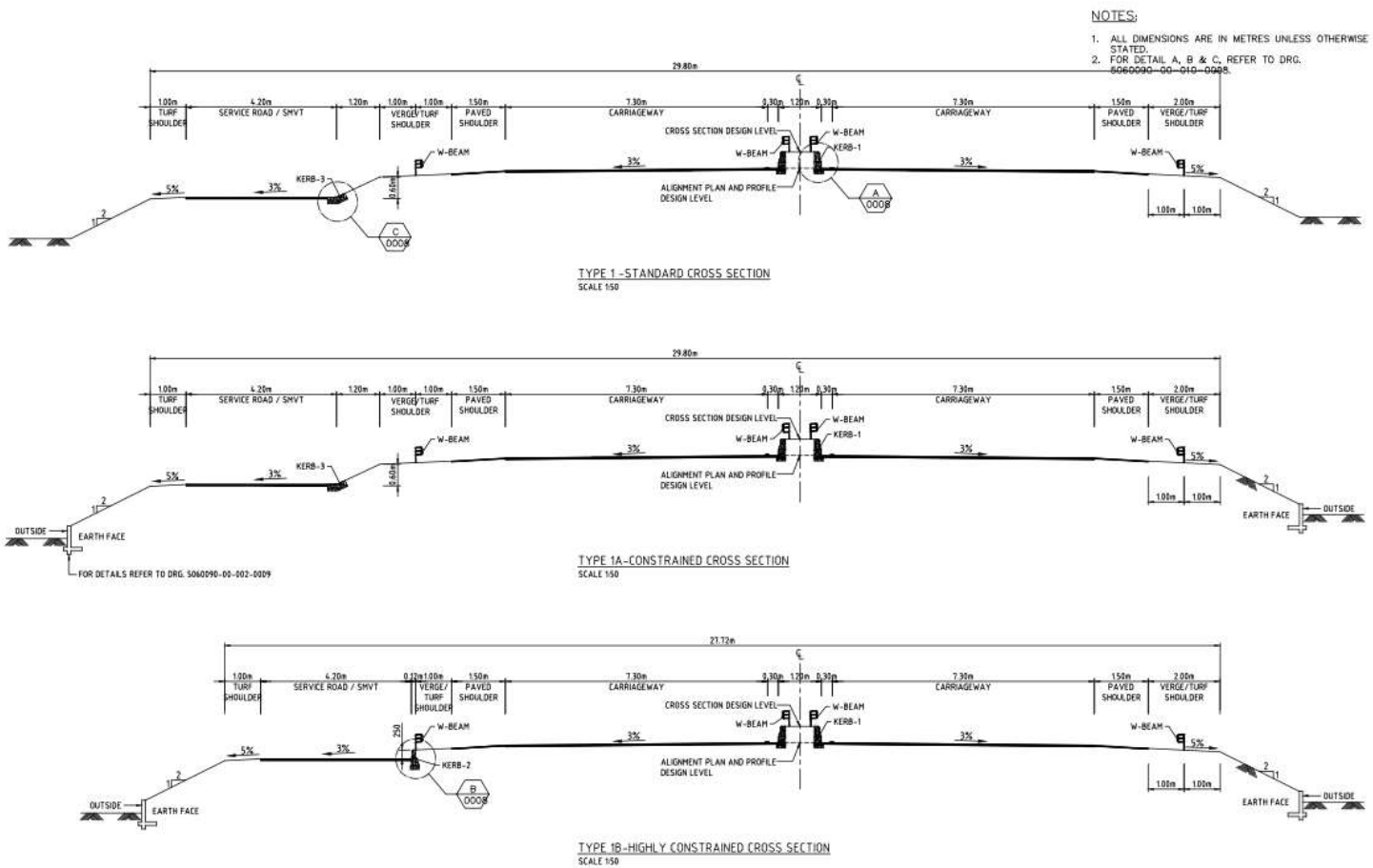


Figure 4: Typical Cross Section

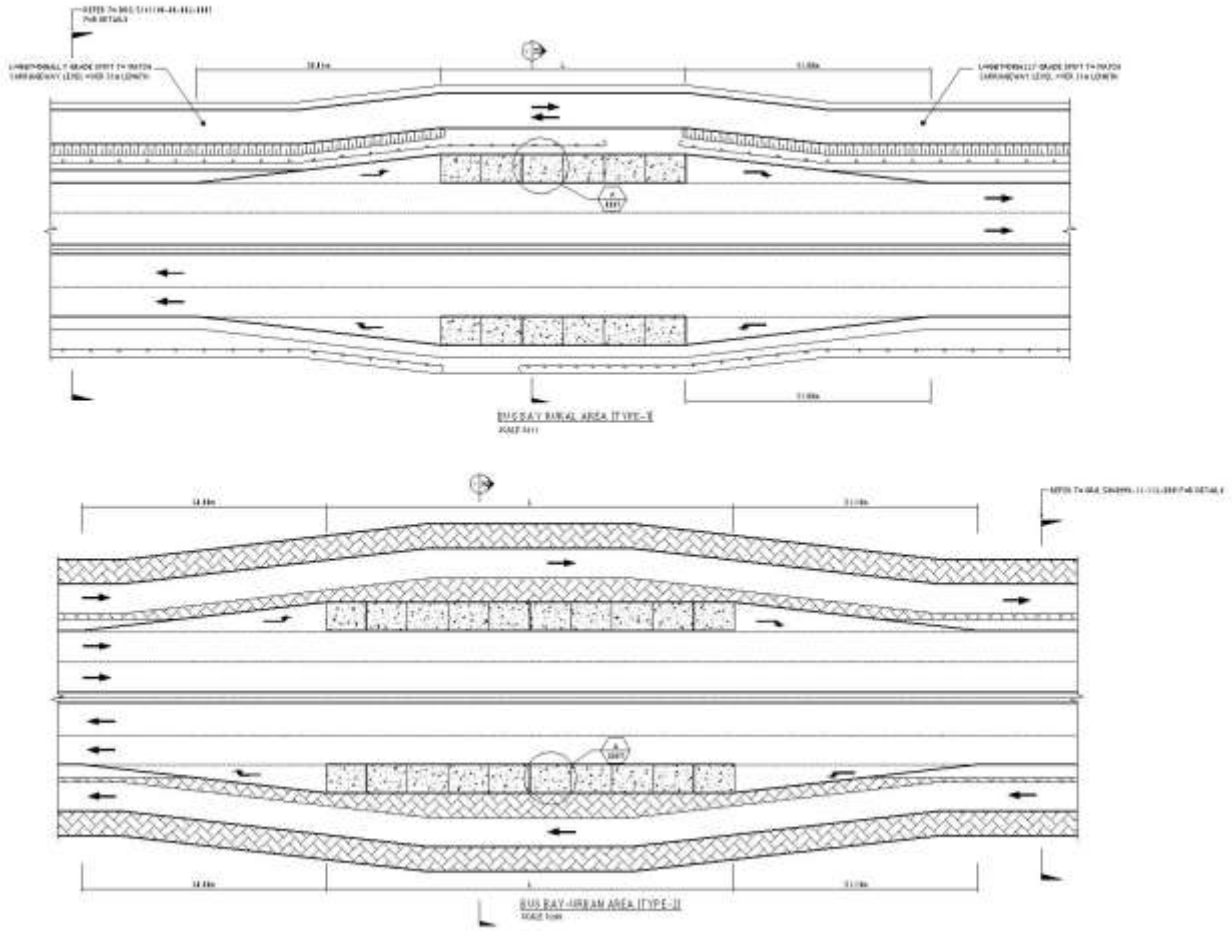


Figure 5: Layout Plan of Bus Bay at Urban and Rural Area

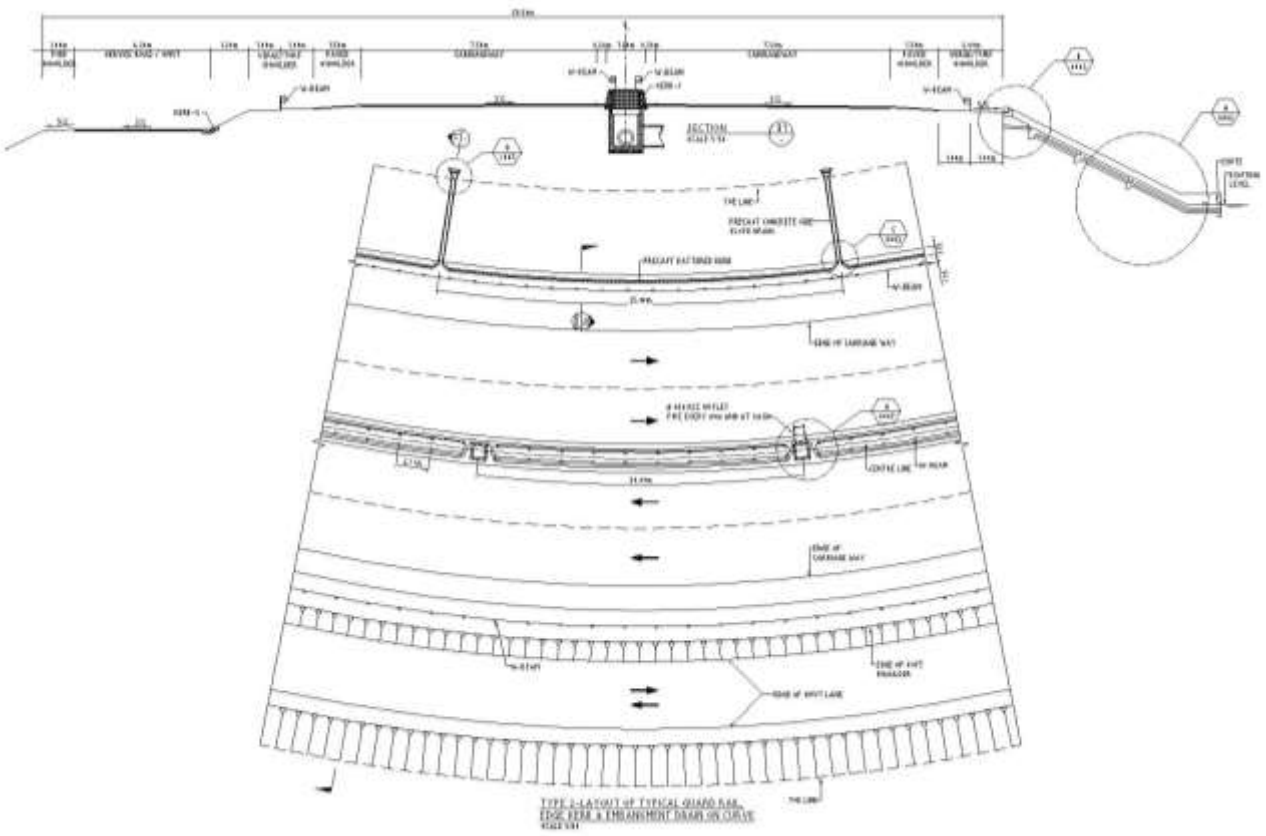


Figure 6: Embankment Drain on Curve

Table 11: Drainage Structures on the Hatikamrul-Rangpur Road

Sl. No.	Chainage	Type of Structure	Bridge Name	Span Arrangement	Total Length (m)	Width (m)	Nature of Treatment
1	0+373	Box Culvert		4 x 6.0m	24.00	35.42	Widening
2	0+777	Box Culvert		2 x 2.5m	5.00	35.49	Widening
3	1+823	Box Culvert		6 x 6.0m	36.00	35.75	Widening
4	2+365	Box Culvert		4 x 2.5m	10.00	35.15	Widening
5	2+670	Box Culvert		4 x 2.5m	10.00	35.80	Widening
6	3+024	Box Culvert		4 x 2.5m	10.00	36.19	Widening
7	3+225	Box Culvert		10 x 6.0m	60.00	35.60	Widening
8	4+171	Box Culvert		3 x 3.5m	10.50	42.98	Widening
9	5+026	Box Culvert		4 x 3.5m	14.00	35.80	Widening
10	5+396	RCC Girder Bridge	Gurka Beltala	12.200m + 18.290m + 12.200m	46.10	14.715	New Bridge (2Lane + SMVT)
11	6+035	Box Culvert		6 x 3.0m	18.00	35.88	Widening
12	6+928	Box Culvert		4 x 6.0m	24.00	35.72	Widening
13	7+363	Box Culvert		2 x 2.5m	5.00	35.86	Widening
14	7+984	PC Girder Bridge	Jora	3 x 39.640m	122.33	14.715	New Bridge (2Lane + SMVT)
15	8+594	Box Culvert		2 x 2.5m	5.00	37.85	Widening
16	9+625	PC Girder Bridge		21.340m + 30.490m + 21.340m	76.58	14.715	New Bridge (2Lane + SMVT)
17	10+586	Box Culvert		1 x 6.5m	6.50	37.54	New culvert
18	11+066	RCC Girder Bridge		18.290m	19.46	14.715	New Bridge (2Lane + SMVT)
19	12+537	RCC Girder Bridge	Dhatia	3x18.290m	58.28	14.715	New Bridge (2Lane + SMVT)
20	13+560	Box Culvert		4 x 3.0m	12.00	35.50	Widening
21	14+170	Box Culvert		4 x 3.5m	14.00	35.66	Widening
22	14+648	Box Culvert		2 x 3.0m	6.00	35.29	Widening
23	15+087	Box Culvert		3 x 3.0m	9.00	36.55	Widening
24	15+510	Box Culvert		4 x 2.5m	10.00	36.14	Widening
25	15+920	Box Culvert		4 x 2.5m	10.00	35.92	Widening
26	16+641	PC Girder Bridge	Chandaikana-1	33.540m	34.71	14.715	New Bridge (2Lane + SMVT)
27	16+641	PC Girder Bridge	Chandaikana-2	33.540m	34.71	14.715	New Bridge (2Lane + SMVT)
28	17+602	Box Culvert		1 x 6.5m	6.50	35.79	Widening
29	17+983	Box Culvert		3 x 4.0m	12.00	36.69	New culvert
30	18+740	Box Culvert		2 x 2.5m	5.00	37.26	Widening
31	19+151	Box Culvert		8 x 3.0m	24.00	36.58	Widening
32	19+329	Box Culvert		4 x 2.5m	10.00	37.94	Widening
33	20+017	Box Culvert		4 x 1.5m	6.00	38.35	Widening
34	20+656	Box Culvert		4 x 3.0m	12.00	35.97	New culvert
35	21+040	Box Culvert		2 x 3.0m	6.00	36.57	Widening
36	21+515	RCC Girder Bridge	Ghorer-1	15.240m + 18.290m + 15.240m	52.18	14.715	New Bridge (2Lane + SMVT)
37	21+515	RCC Girder Bridge	Ghorer-2	15.240m + 18.290m + 15.240m	52.18	14.715	New Bridge (2Lane + SMVT)
38	22+667	Box Culvert		4 x 3.5m	14.00	37.32	Widening

Sl. No.	Chainage	Type of Structure	Bridge Name	Span Arrangement	Total Length (m)	Width (m)	Nature of Treatment
39	23+509	Box Culvert		1 x 1.5m	1.50	36.57	New culvert
40	26+780	Box Culvert		1 x 1.5m	1.50	37.41	New culvert
41	27+357	Box Culvert		1 x 1.5m	1.50	35.41	Widening
42	29+168	Box Culvert		1 x 1.5m	1.50	29.20	New culvert
43	29+781	Box Culvert		1 x 1.5m	1.50	30.60	New culvert
44	30+218	Box Culvert		1 x 1.5m	1.50	30.10	New culvert
45	35+186	Box Culvert		3 x 2.5m	7.50	31.15	Widening
46	35+512	Box Culvert		1 x 5.0m	5.00	32.31	Widening
47	41+583	Box Culvert		1 x 2.0m	2.00	31.37	Widening
48	43+600	Box Culvert		1 x 3.0m	3.00	31.67	Widening
49	44+394	Box Culvert		1 x 1.5m	1.50	35.93	New culvert
50	48+323	PC Girder Bridge		30.490m	31.66	14.715	New Bridge (2Lane + SMVT)
51	48+323	PC Girder Bridge		30.490m	31.66	14.715	New Bridge (2Lane + SMVT)
52	51+100	Box Culvert		1 x 6.5m	6.50	30.20	New culvert
53	52+964	Box Culvert		1 x 6.5m	6.50	30.19	New culvert
54	56+526	Box Culvert		1 x 2.0m	2.00	30.21	New culvert
55	57+880	Box Culvert		1 x 2.5m	2.50	30.73	New culvert
56	58+560	Box Culvert		1 x 6.0m	6.00	30.59	Widening
57	60+285	Box Culvert		2 x 4.5m	9.00	30.47	Widening
58	60+460	Box Culvert		1 x 2.0m	2.00	30.44	New culvert
59	64+710	Box Culvert		1 x 1.5m	1.50	30.02	Widening
60	65+029	Box Culvert		2 x 2.0m	4.00	32.53	Widening
61	66+267	Box Culvert		1 x 2.0m	2.00	30.46	Widening
62	66+699	Box Culvert		1 x 1.5m	1.50	30.43	Widening
63	67+127	Box Culvert		1 x 1.5m	1.50	32.08	New culvert
64	67+224	Box Culvert		1 x 1.5m	1.50	31.77	New culvert
65	67+401	Box Culvert		1 x 1.5m	1.50	30.39	New culvert
66	67+762	Box Culvert		2 x 2.0m	4.00	32.15	Widening
67	68+561	PC Girder Bridge	Mohastan	3 x 24.390m	76.58	14.715	New Bridge (2Lane + SMVT)
68	69+426	Box Culvert		6 x 2.0m	12.00	35.80	Widening
69	70+114	Box Culvert		2 x 2.0m	4.00	36.80	Widening
70	72+060	Box Culvert		4 x 2.0m	8.00	35.17	Widening
71	73+241	Box Culvert		4 x 2.0m	8.00	35.66	Widening
72	73+813	RCC Girder Bridge		12.200m	13.37	14.715	New Bridge (2Lane + SMVT)
73	74+722	Box Culvert		1 x 1.5m	1.50	31.56	Widening
74	76+948	Box Culvert		1 x 2.5m	2.50	30.06	Widening
75	77+532	Box Culvert		1 x 6.0m	6.00	35.77	New culvert
76	78+349	Box Culvert		1 x 2.5m	2.50	35.80	Widening
77	79+223	Box Culvert		1 x 2.0m	2.00	35.40	Widening
78	80+255	Box Culvert		1 x 1.5m	1.50	35.79	New culvert
79	80+750	Box Culvert		1 x 1.5m	1.50	37.00	New culvert
80	81+717	Box Culvert		2 x 1.5m	3.00	36.53	Widening
81	82+528	Box Culvert		5 x 3.0m	15.00	35.70	Widening
82	85+730	Box Culvert		1 x 1.5m	1.50	35.80	Widening
83	91+097	Box Culvert		5 x 2.0m	10.00	35.70	Widening
84	91+566	Box Culvert		1 x 6.0m	6.00	37.26	Widening
85	91+876	Box Culvert		3 x 2.0m	6.00	35.80	Widening

Sl. No.	Chainage	Type of Structure	Bridge Name	Span Arrangement	Total Length (m)	Width (m)	Nature of Treatment
86	92+677	Box Culvert		1 x 2.0m	2.00	35.80	Widening
87	92+877	Box Culvert		4 x 2.0m	8.00	35.80	Widening
88	93+082	Box Culvert		5 x 2.0m	10.00	35.82	Widening
89	93+851	PC Girder Bridge	Karatoya River Bridge	5 x 30.490m	158.10	14.715	New Bridge (2Lane + SMVT)
90	94+377	Box Culvert		4 x 2.0m	8.00	35.40	Widening
91	95+177	PC Girder Bridge	Chantipur	2 x 21.340m	44.97	14.715	New Bridge (2Lane + SMVT)
92	95+746	Box Culvert		3 x 2.0m	6.00	36.54	Widening
93	95+972	PC Girder Bridge	Shomaspara	2 x 21.340m	44.97	14.715	New Bridge (2Lane + SMVT)
94	96+960	Box Culvert		5 x 2.0m	10.00	35.08	Widening
95	97+400	Box Culvert		4 x 2.0m	8.00	37.15	Widening
96	98+276	PC Girder Bridge	Kalithola	2 x 21.340m	44.97	14.715	New Bridge (2Lane + SMVT)
97	98+717	Box Culvert		4 x 2.5m	10.00	35.79	Widening
98	100+020	Box Culvert		6 x 2.0m	12.00	35.59	Widening
99	100+440	Box Culvert		2 x 2.0m	4.00	37.00	Widening
100	102+101	Box Culvert		3 x 1.5m	4.50	36.04	Widening
101	102+834	RCC Girder Bridge	Ovirampur-1	18.290m + 18.290m	38.87	14.715	New Bridge (2Lane + SMVT)
102	102+834	RCC Girder Bridge	Ovirampur-2	18.290m + 18.290m	38.87	14.715	New Bridge (2Lane + SMVT)
103	103+794	Box Culvert		10 x 3.0m	30.00	35.36	Widening
104	104+621	Box Culvert		2 x 2.0m	4.00	35.56	Widening
105	104+964	Box Culvert		2 x 2.0m	4.00	35.80	Widening
106	105+490	Box Culvert		2 x 2.0m	4.00	35.78	Widening
107	108+438	Box Culvert		3 x 1.5m	4.50	36.38	Widening
108	110+340	Box Culvert		2 x 2.0m	4.00	35.80	Widening
109	110+974	Box Culvert		2 x 2.0m	4.00	35.80	Widening
110	111+564	Box Culvert		2 x 2.0m	4.00	35.81	Widening
111	112+292	Box Culvert		5 x 3.0m	15.00	36.29	Widening
112	112+664	Box Culvert		6 x 2.0m	12.00	36.27	Widening
113	113+346	Box Culvert		2 x 2.0m	4.00	34.36	Widening
114	113+597	Box Culvert		1 x 1.5m	1.50	29.85	Widening
115	113+752	Box Culvert		1 x 1.5m	1.50	31.33	Widening
116	114+239	Box Culvert		1 x 3.0m	3.00	31.14	Widening
117	115+251	Box Culvert		5 x 3.0m	15.00	35.47	Widening
118	116+392	Box Culvert		1 x 1.5m	1.50	37.00	New culvert
119	117+412	Box Culvert		1 x 1.5m	1.50	35.44	Widening
120	117+637	Box Culvert		1 x 1.5m	1.50	35.19	New culvert
121	117+912	Box Culvert		1 x 1.5m	1.50	30.45	Widening
122	119+060	Box Culvert		3 x 1.5m	4.50	35.80	Widening
123	119+710	Box Culvert		3 x 1.5m	4.50	35.81	Widening
124	120+160	Box Culvert		3 x 1.5m	4.50	35.80	Widening
125	121+111	Box Culvert		3 x 1.5m	4.50	35.20	Widening
126	121+880	Box Culvert		3 x 5.0m	15.00	36.68	Widening
127	122+192	Box Culvert		2 x 2.0m	4.00	37.84	Widening
128	123+471	Box Culvert		1 x 1.5m	1.50	30.21	New culvert
129	124+286	Box Culvert		1 x 1.5m	1.50	35.80	Widening
130	124+360	Box Culvert		1 x 1.5m	1.50	35.80	New culvert
131	126+797	Box Culvert		1 x 1.5m	1.50	35.80	New culvert

Sl. No.	Chainage	Type of Structure	Bridge Name	Span Arrangement	Total Length (m)	Width (m)	Nature of Treatment
132	127+870	Box Culvert		1 x 1.5m	1.50	35.79	New culvert
133	129+117	Box Culvert		1 x 1.5m	1.50	35.79	New culvert
134	130+178	Box Culvert		1 x 2.5m	2.50	36.25	Widening
135	131+578	Box Culvert		1 x 2.5m	2.50	35.69	Widening
136	132+703	Box Culvert		1 x 2.5m	2.50	35.79	Widening
137	133+640	Box Culvert		1 x 1.5m	1.50	35.31	New culvert
138	135+142	Box Culvert		1 x 2.5m	2.50	35.51	Widening
139	137+770	Box Culvert		2 x 2.5m	5.00	35.81	Widening
140	139+307	Box Culvert		2 x 2.0m	4.00	35.74	Widening
141	141+809	Box Culvert		2 x 2.5m	5.00	35.40	Widening
142	143+095	Box Culvert		2 x 2.5m	5.00	35.77	Widening
143	144+291	Box Culvert		2 x 2.5m	5.00	36.97	Widening
144	144+683	Box Culvert		1 x 1.5m	1.50	35.81	New culvert
145	145+952	Box Culvert		2 x 2.5m	5.00	35.52	Widening
146	146+568	Box Culvert		1 x 2.5m	2.50	35.80	Widening
147	147+462	Box Culvert		2 x 3.0m	6.00	35.49	Widening
148	148+407	Box Culvert		1 x 3.5m	3.50	35.58	Widening
149	149+094	Box Culvert		2 x 2.5m	5.00	37.80	Widening
150	150+393	Box Culvert		1 x 1.5m	1.50	35.79	New culvert
151	150+993	Box Culvert		5 x 6.0m	30.00	36.78	Widening
152	151+751	Box Culvert		1 x 1.5m	1.50	35.81	New culvert
153	152+683	PC Girder Bridge	Domdoma	3 x 21.340m	67.43	14.715	New Bridge (2Lane + SMVT)
154	154+711	Box Culvert		1 x 3.0m	3.00	35.81	Widening
155	156+003	PC Girder Bridge	Modern More	24.390m	25.56	14.715	New Bridge (2Lane + SMVT)

F. Major Bridge with Design Features

121. The Jora Bridge at Km 7+984 is 122.33 m long bridge and it is in good condition. This bridge is on a large water body which contains significant amount of water almost through the year. However, during the summer season it becomes dry. One new additional 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.

122. The Karatoya Bridge at 93+851 chainage is 158.10 m long bridge. A new two traffic lanes plus a SMVT lane required for the upgrading to four-lane standard, is proposed at this location.

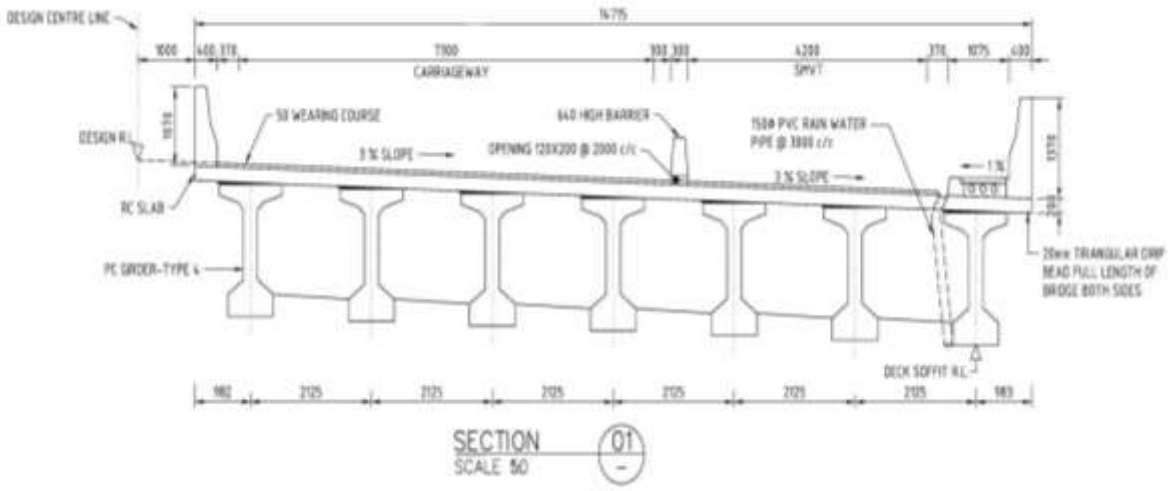


Figure 7: Cross Section of the Proposed Karatoya Bridge

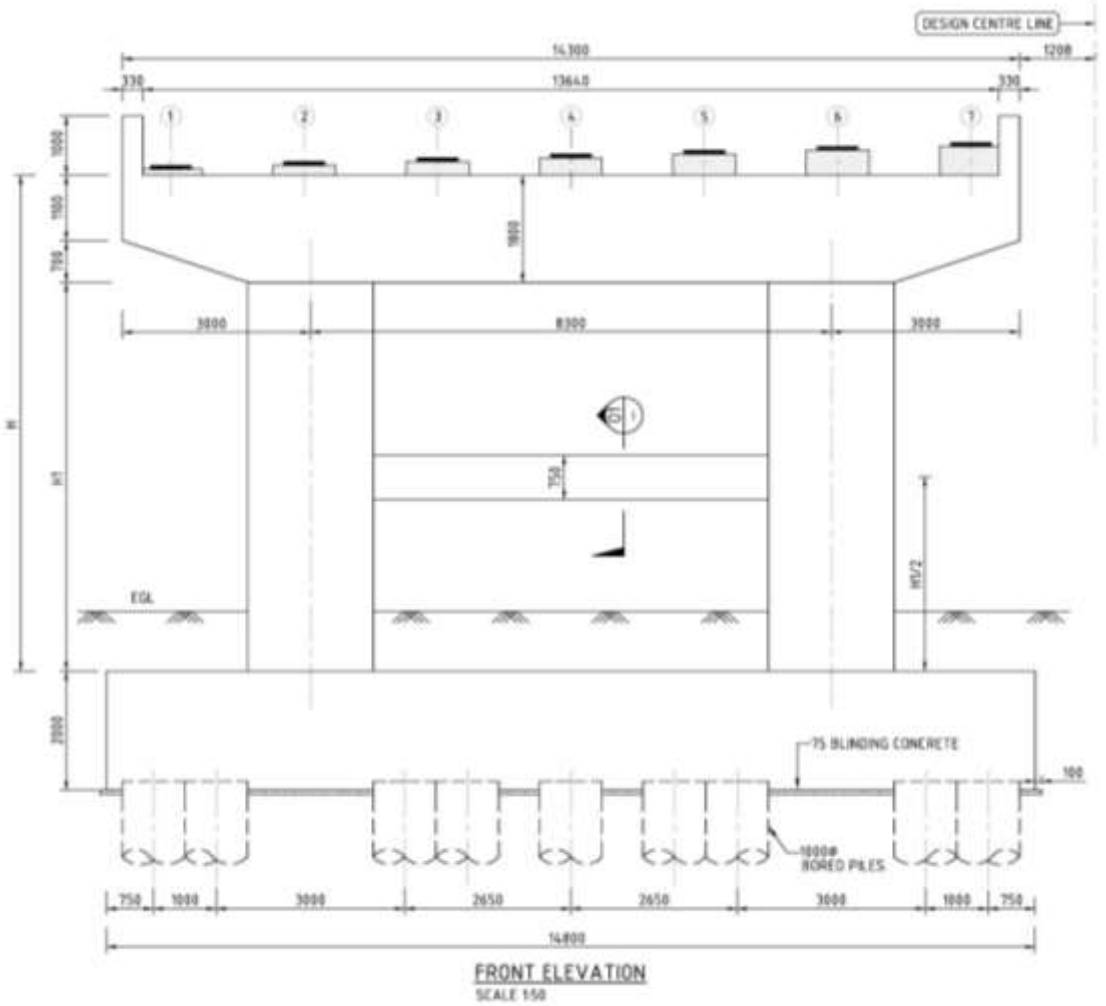
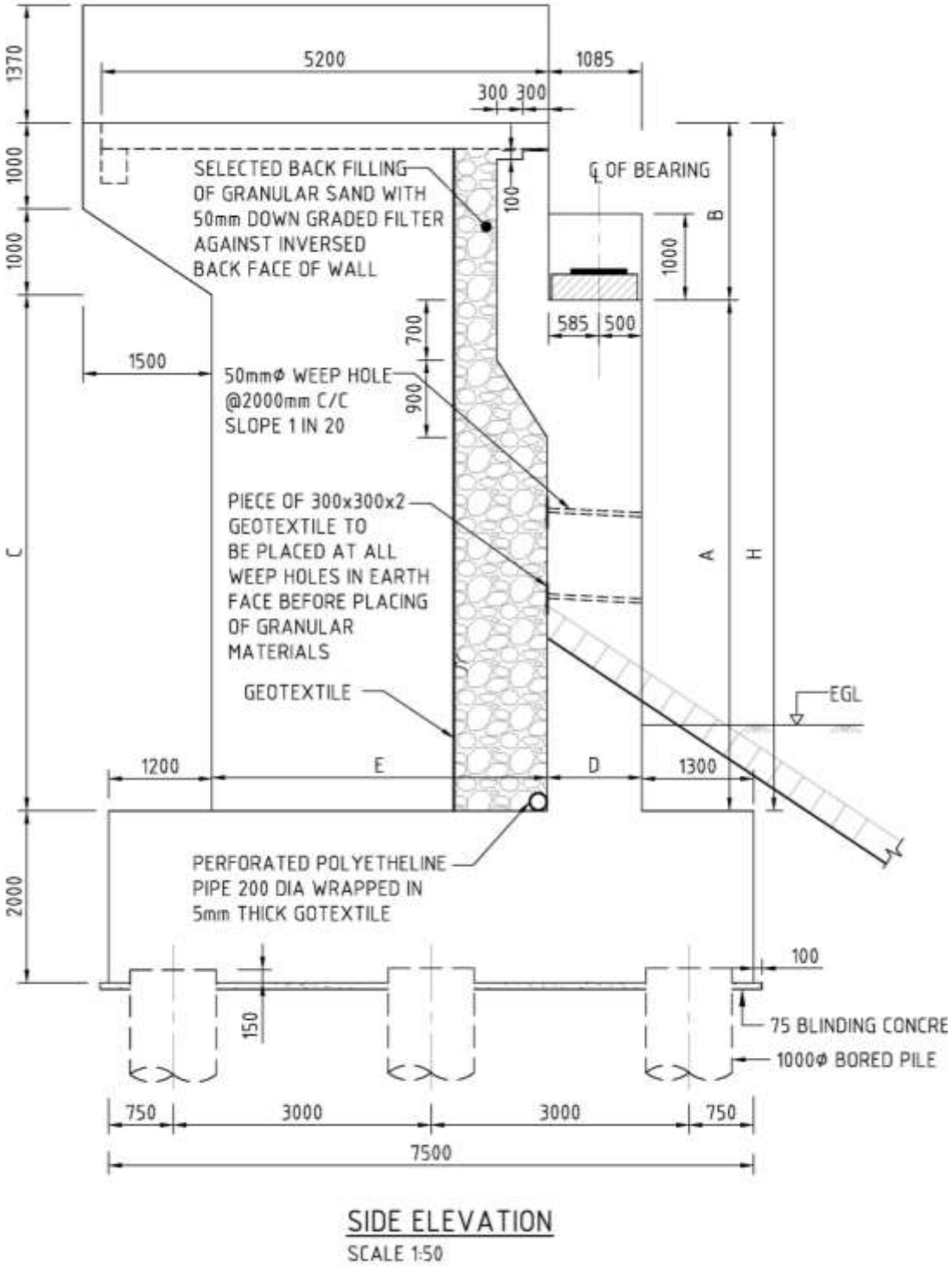


Figure 8: Cross Section of the Proposed Karatoya Bridge



SIDE ELEVATION
SCALE 1:50

Figure 9: Abutment Design of the Proposed Karatoya Bridge

G. Rail over Bridges (ROBs)/Flyovers and Overpasses

123. To improve road efficiency and safety, one flyover and several pedestrian overpasses are proposed in Hatikamrul-Rangpur road. The list of these structures is given at Table 12.

Table 12: Details of Proposed Flyovers and Pedestrian Overpasses in Hatikamrul-Rangpur Road

Sl. No.	Location	Chainage	Length (m)	Width (m)	Type of Structure
1	Bogra Railway	55+473	411.25	19.120	New Flyover
2	Chandaikona	16+836	38.2	3	New Overpass
3	Shrepur	33+527	38.2	3	New Overpass
4	Banani Bazar	50+340	35.2	3	New Overpass
5	Bogra Bus Stand	57+250	35.2	3	New Overpass
6	Mohasthan	68+127	35.2	3	New Overpass
7	Mokamtola	75+728	35.2	3	New Overpass
8	Gobindaganj	89+683	38.2	3	New Overpass
9	Palashbari	106+539	35.2	3	New Overpass
10	Pirganj	122+695	35.2	3	New Overpass
11	Mithapukur	141+478	35.2	3	New Overpass

H. Construction Material and Sources

1. Embankment Fills

124. 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.

2. Concrete Aggregate

125. 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. Aggregate of high strength concrete is likely to be imported from India also.

3. Cement and Steel Reinforcement

126. 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.

4. Bitumen

127. 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.

5. Recycled Pavement Materials

128. 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.

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

129. 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 (RHDTC) 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.

130. 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.

131. 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.

J. Establishment of Road Operations Unit (ROU)

132. 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.

133. 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.

K. Existing Traffic and Forecast

134. 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 2011 including two and three wheelers and forecast traffic are given at Table 13.

Table 13: Existing and Traffic Forecast for Hatikamrul-Rangpur Road

Traffic Assessment Year	Traffic in AADT (Maximum of any section of the road)
2011*	21,420
2015	28,242
2016	30,632
2020	43,332
2025	57,865
2030	76,542
2033	90,594
2035	101,395
2040	134,488

*Source: RHD Traffic survey 2011

135. The nature of traffic is mix in nature except in case of Hatikamrul-Rangpur road where a high proportion goods vehicles and Heavy Goods Vehicle (HGVs) is high. It is probably due to the common route between Dhaka and the Northern part of Bangladesh.

L. Project Schedule

136. 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 are 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.

M. ADB's Environmental Categorisation

137. 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 flyovers or underpasses.

VI. DESCRIPTION OF THE ENVIRONMENT

A. General

138. 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.

139. Information of baseline environmental status of the project area is useful for impact assessment process of assessing and predicting the environmental consequences of the significant actions. Based on the existing environmental scenario potential impacts of road improvement 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.

140. Data was collected from secondary sources for the macro-environmental setting like climate (temperature, rainfall, humidity, and wind speed), physiography, geology etc. Firsthand 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 and to explain local environmental conditions, impacts, and suggestions, etc.

141. The following section describes the baseline environment in three broad categories:

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

B. Physical Environment

1. Climate

142. Although less than half of Bangladesh lies within the tropics, the presence of the Himalaya 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 the North-western climatic zone (Figure 4.2). Except that the extremes are less and the rainfall is lower. In summer the mean maximum temperature is well above 32°C whereas in winter the mean minimum is below 10°C. The summer is dry, with a scorching westerly wind, but the rainy season is very wet, with 2,000 to 3,000 mm of rainfall. The lower rainfall makes this area both atmospherically and pedologically drier (Banglapedia, 2012).

143. 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).

144. 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, at this time can account for 10 to 25 percent of the annual total.

145. 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.

146. 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.

2. Temperature

147. Long-term average monthly temperature data (1991-2012) collected at Rangpur and Bogra weather station of Bangladesh Meteorological Department. The highest temperature recorded in the two weather stations Rangpur and Bogra have been 37.8 °C and 38.2 °C in May accordingly. The lowest temperature recorded at the two weather stations Rangpur and Bogra were found in the same month January which were 7.2°C and 7.9 °C respectively (Figure 10). Both of the average monthly temperature graphs show that these two areas face high temperature from March to May and lowest temperature during winter remains from December to February in the year.

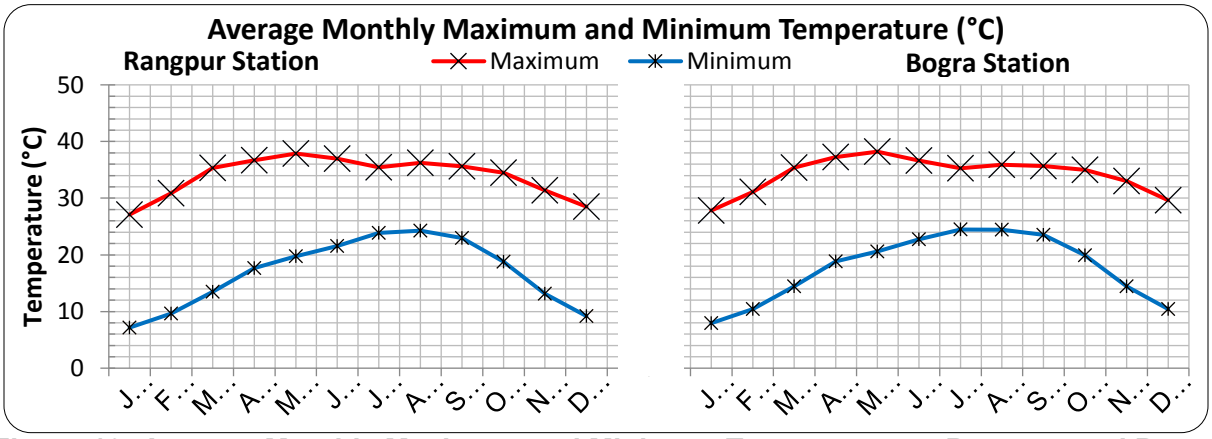
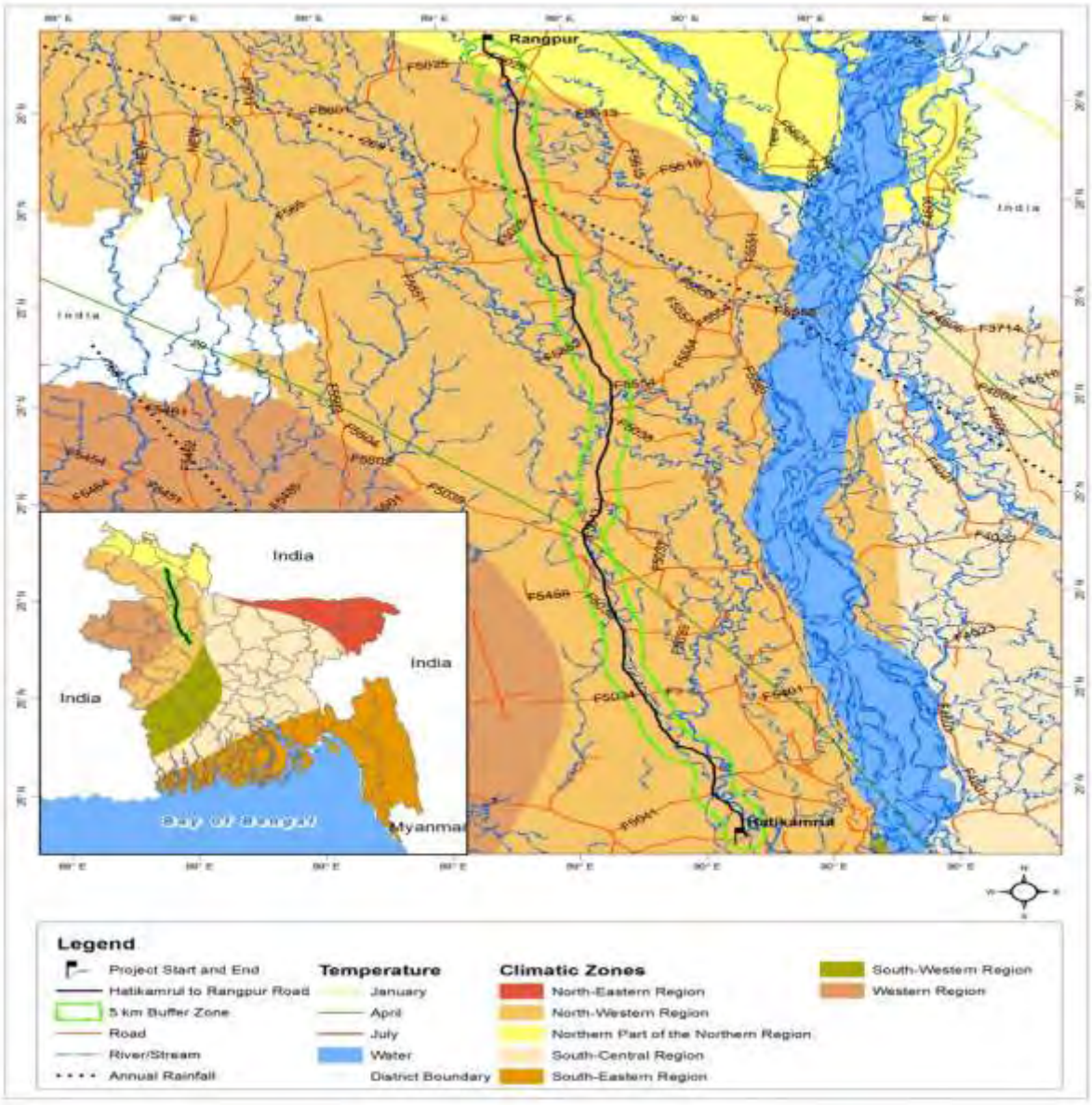


Figure 10: Average Monthly Maximum and Minimum Temperature at Rangpur and Bogra Station (1991-2012)



(Source: Rashid, 1991)

Figure 11: Climatic Zones

3. Rainfall

148. The rainfall data collected from the two above stated stations represents that 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 both stations experience more than 300 mm rainfall in June and September months during monsoon. In the month of November, December and January of winter season around 10 mm rainfall occurred in the region of Rangpur and Bogra stations (Figure 12).

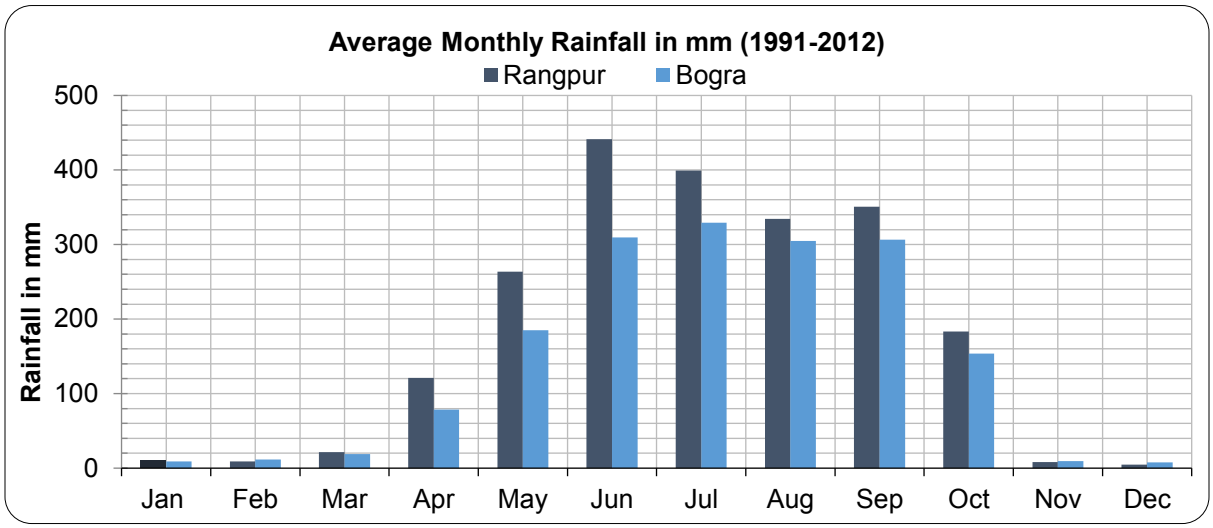


Figure 12: Average Monthly Total Rainfall at Rangpur and Bogra Station, 1991-2012

Humidity

149. 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.

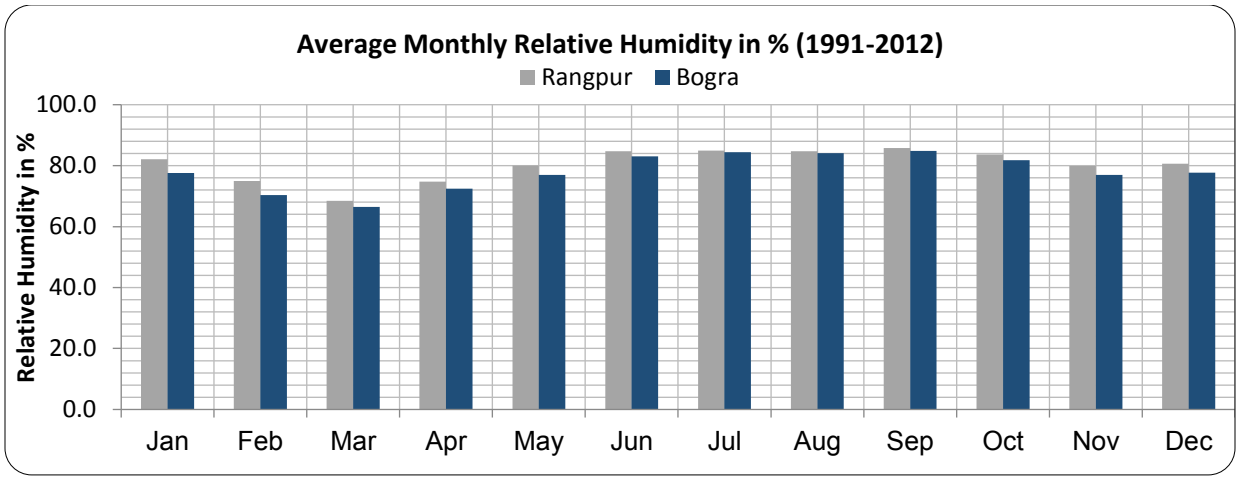


Figure 13: Average Monthly Humidity at Rangpur and Bogra Station, 1991-2012

150. 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 above two stated areas are more than 70% through the year. However, humidity falls 70% in March during the winter season in the considered areas (Figure 4.4).

4. Wind Speed

151. 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.

152. The statistical wind speed data (Figure 14) shows that wind speed at Rangpur was comparatively higher than the area of Bogra. Wind speed remained maximum with 4.1 knots in April and 2.9 knots in April and May for Rangpur and Bogra stations respectively. The minimum wind speed was 2.9 knots and 0.7 knots for Rangpur and Bogra stations accordingly in the month of January and November.

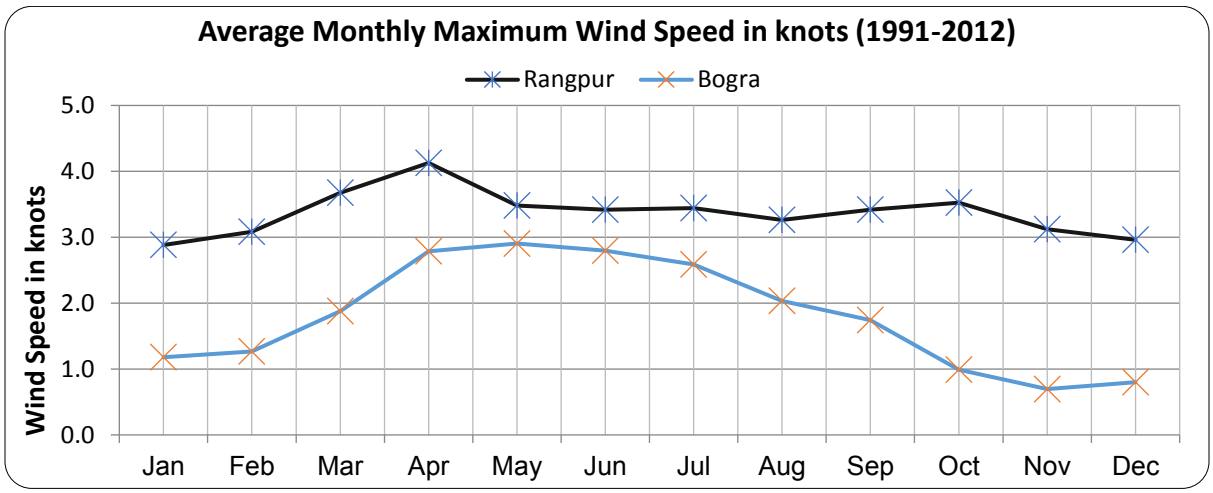


Figure 14: Average Monthly Maximum Wind Speed at Rangpur and Bogra Station, 1991-2012

5. Physiographic Features

153. Physiography is the description of the physical nature (form, substance, arrangement, changes) of objects, especially of natural features. 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.

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

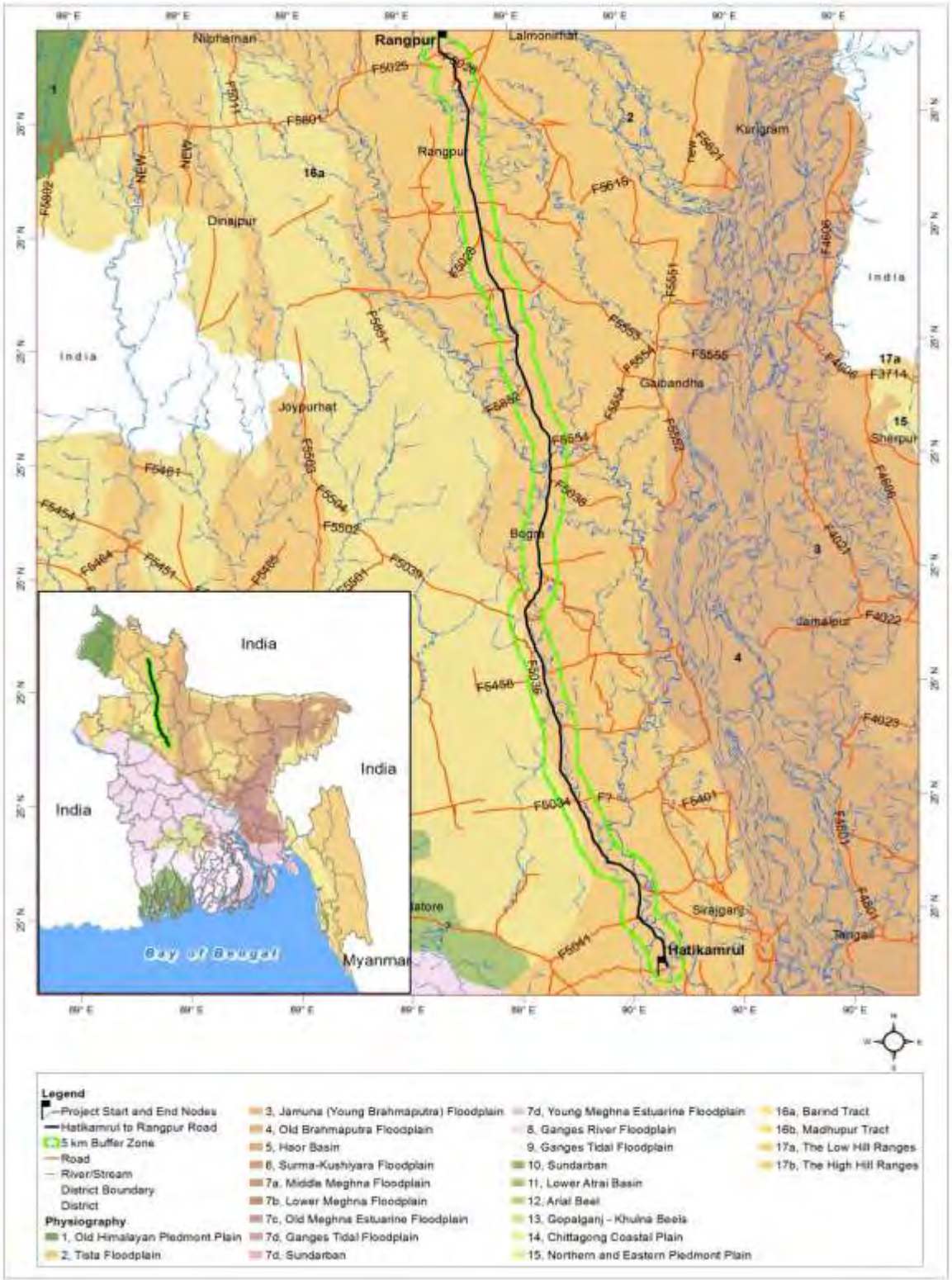
- Floodplains
- Terraces
- Hills

155. Within these 3 broad categories, a number of authors have further divided the land surface into a series of Physiographic Units based on a combination of topographical/landscape features, underlying geology and surface soils (Bramer, 1996, Rashid, 1991, Morgan and McIntyre, 1959). The most recent study was undertaken by the Soil Resource Development Institute (SRDI) who further refined the previous classifications into 26 Physiographic Units (20 primary units and 6 sub-units) based on an assessment of more recent and detailed data (SRDI, 1997).

156. The Hatikamrul-Rangpur road alignment area lies mostly in the north-western part of the country and depends on the Teesta River for freshwater supply. The entire road alignment runs through the following two physiographic units 2 and 16a (Figure 15).

Photograph 1: Physiography of the Project Area.

- ***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 (Banglapedia, 2012).
- ***Barind Tract (16a):*** It comprises mid and lower western part of Rajshahi division, between the Ganges and Brahmaputra. The largest one of the three Pleistocene upland blocks, the Barind Tract spreads over an area of about 7,770 sq km. In the south, the Barind Tract is an older pleistocene terrace forming a small plateau with a flat or in some sectors a slightly undulating surface. This terrace consists of reddish and yellowish and partially mottled clays and is characterised morphologically by a dendritic drainage pattern, which is typical of all older Pleistocene terraces in Bangladesh. The Barind unit is comparatively at higher elevation than the adjoining floodplains. The contours of the tract suggest that there are two terrace levels one at 40m and the other between 19.8 and 22.9m. Therefore, when the floodplains go under water during monsoon the Barind Tract stands free from flooding and is drained by a few small streams. About 47% of the Barind region is classified as highland, about 41% as medium-high land, and the rest are lowland. The depression at the southeast of the Barind Tract is called the *Bhar Basin*. It includes parts of Rajshahi and Pabna districts, with its centre in the vast marshy area called the Chalan Beel (Banglapedia, 2012).



(Source: SRDI, 1997)

Figure 15: Physiographic Sub-regions of Bangladesh

6. Topography

157. 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.

158. The general topography of the project area comprises floodplains in the majority of the road and terraces. The topography of the project area slopes from north to south with elevation ranged from 32 m a.m.s.l to 15 m a.m.s.l (Figure 16).

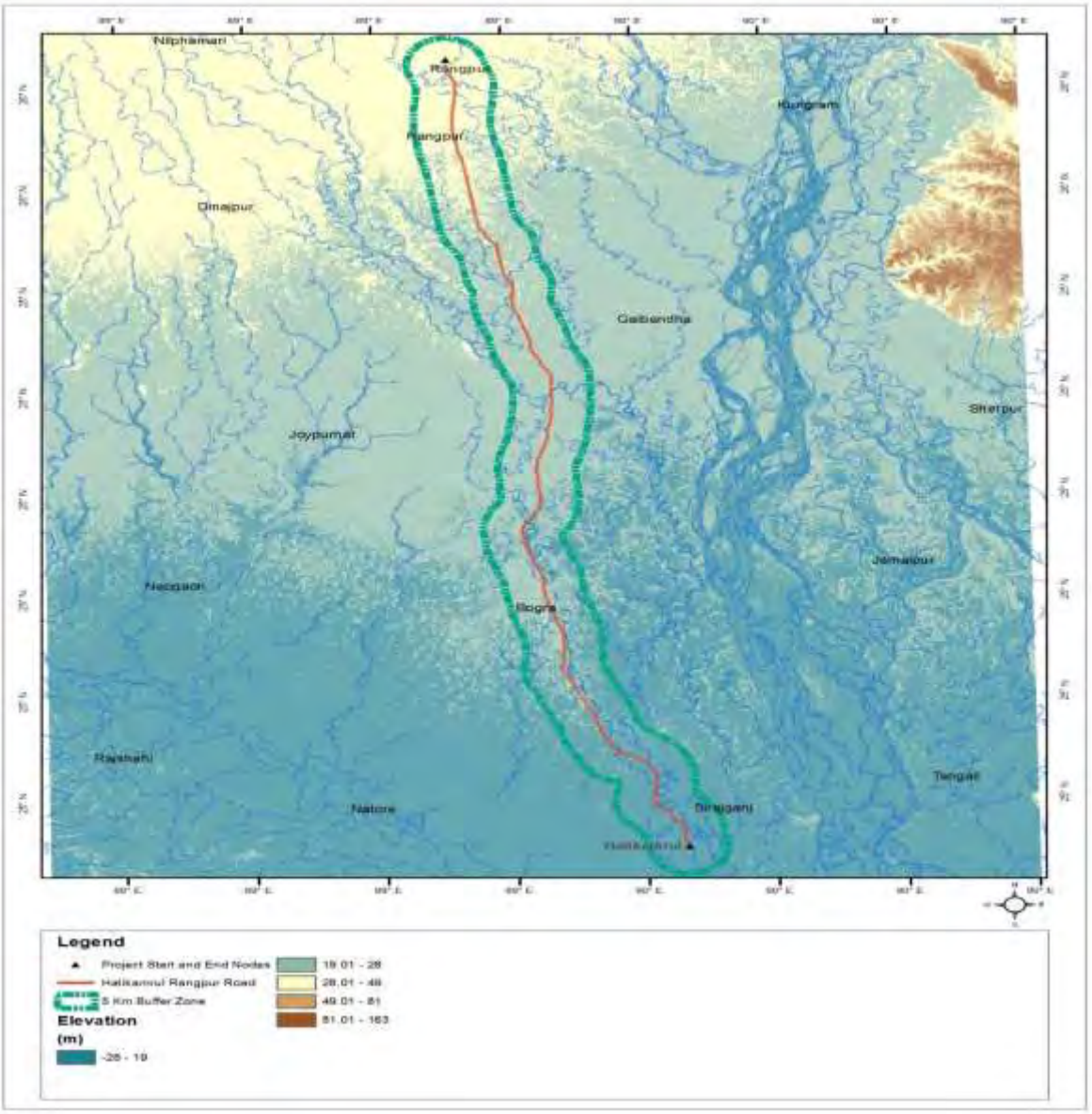


Figure 16: Topography

7. Geology

159. 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 (Figures 17).

- **Rangpur Saddle** represents Indian Platform and connects the Indian Shield with the shillong massif and the Mikir Hills. Shillong Massif is a large thrust block of the Indian Shield. In Rangpur Saddle the basement is the most uplifted and is covered with thin sedimentary deposits. In Madhyapara area of Dinajpur the basement is only 130m deep from the ground surface and is overlain by Dupi Tila Sandstone and Madhupur Clay of Plio-Pliestocene age. Rangpur Saddle can be divided into 3 parts- Rangpur Saddle, Northern Slope of Rangpur Saddle and Southern Slope of Rangpur Saddle. The basement plunges gently from Madhyapara towards the southeast upto the Hinge Zone, which is known as the Southern Slope of Rangpur Saddle. The tentative boundary of the Rangpur Saddle with the northern and the southern slopes has been marked at approximately 700m contour line on the basement. It separates the Bengal Foredeep and the Himalayan Foredeep. The Northern Slope of Rangpur Saddle also known as Dinajpur Slope, occupies the north western part of Rangpur-Dinajpur districts and gently slopes towards the Sub-Himalayan Foredeep with dips 3-4° which sharply increases in Tetulia area (Banglapedia, 2012).
- **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 (Banglapedia, 2012).

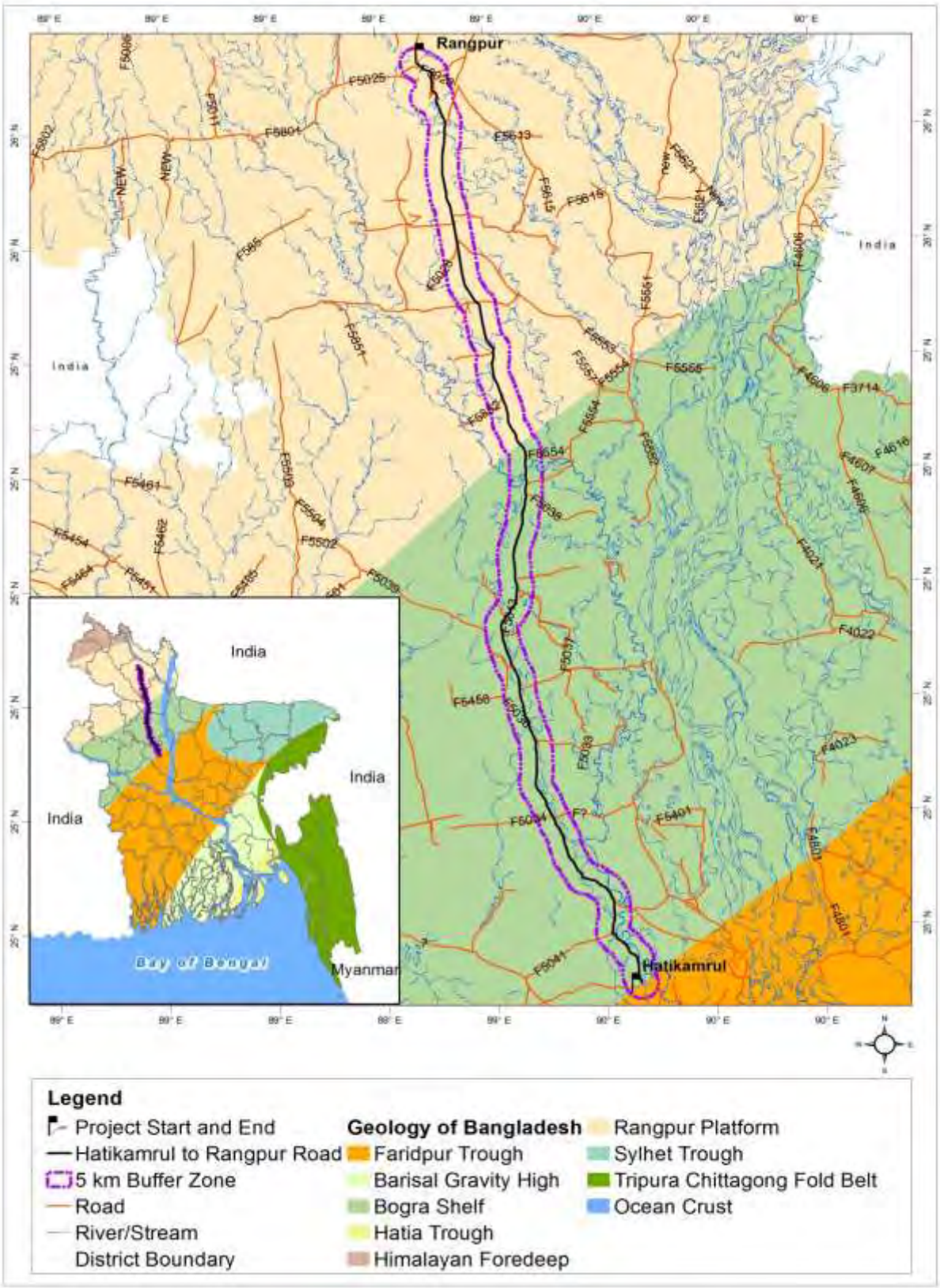


Figure 17: Geology

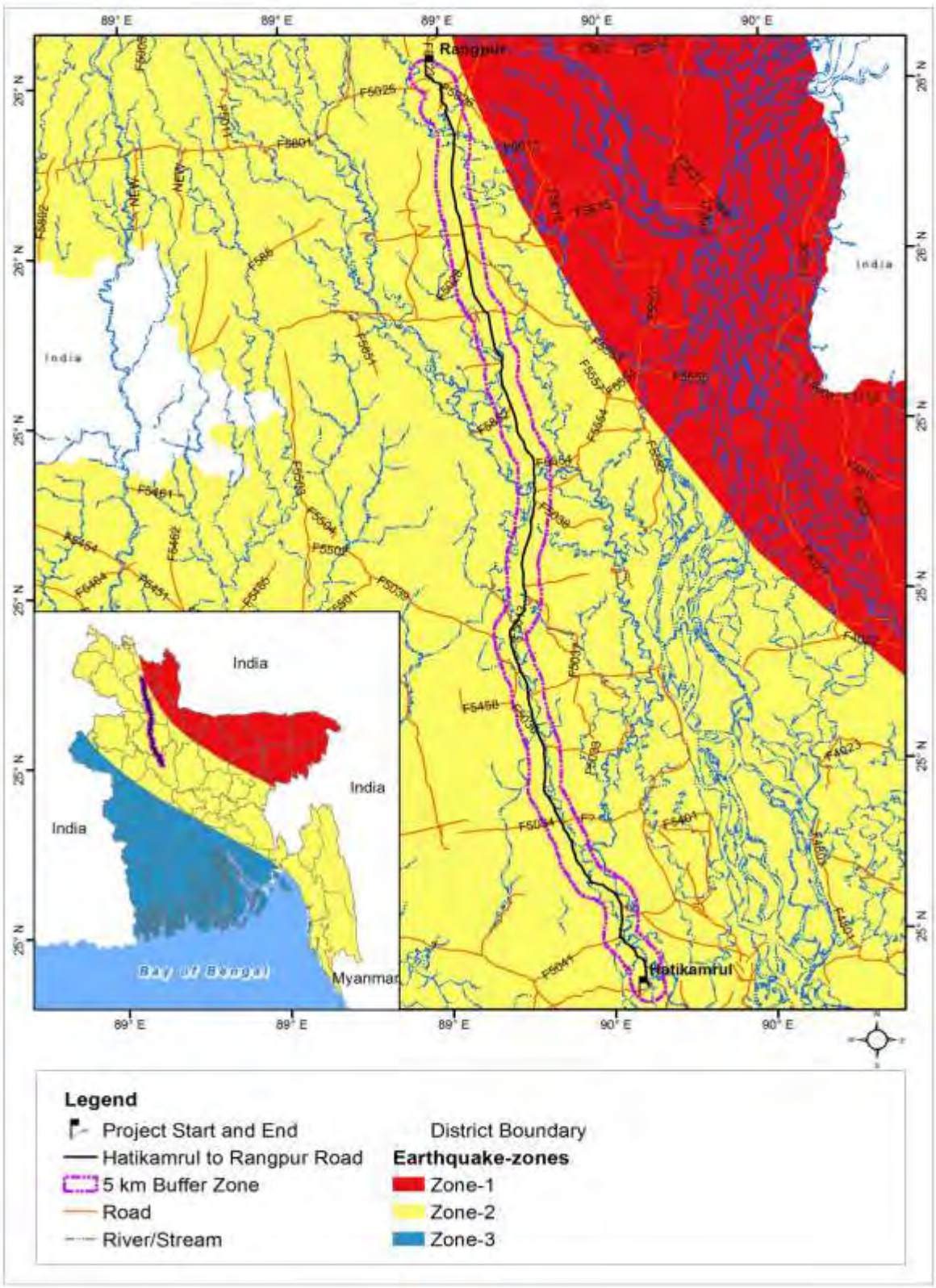
8. Seismicity

160. 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.

161. 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 14), 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*). As per the seismic zone map (Figure 17), project road falls in zone II means medium seismic intensity. There is no evidence of major earthquakes in the project areas in the past.

Table 14: Seismic Zonation 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



(Source: Hossain, 1988 and Zahiruddin, 1993)

Figure 18: Seismic Zones within Bangladesh

9. Soil

162. The project road passes through three different soil formation zones (Figure 19). The general soil types of the project road area predominantly include the following:

- ***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 Teesta, 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 Teesta 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, 2012).

- ***Red-brown terrace soil (18):*** This type of soil can be divided into two classes; one is shallow red-brown terrace soil and deep red-brown terrace soil. Shallow red-brown terrace soil occurs extensively on gently undulating to rolling relief on the Madhupur Tract and locally in the Barind tract. They are pale olive-brown to reddish-brown soils overlying grey, little altered, Madhupur Clay at less than 90 cm depth. The subsoil ranges from a porous yellow brown loam to olive brown, strong or reddish brown structured clay in different soils. Generally these soils are strongly to extremely acidic. The majority of them have been classified as Haplic and Gleyic Alisols. Deep Red Brown Terrace soils Occur extensively in the north-eastern Barind Tract, on the Madhupur Tract and on the Akhaura Terrace. These soils are well to moderately well drained, reddish brown to yellow-brown, strongly to extremely acidic, friable clay soils over deeply weathered, red-mottled, Madhupur Clay. They are mainly Ferric Alisols (Banglapedia, 2012).

- ***Grey terrace soil (19):*** This type of soil can be divided into three classes. These are shallow grey terrace soils, deep grey terrace soils and grey valley soils. Shallow Grey Terrace soils occur extensively on the level Barind Tract and the high Barind Tract. The soils are grey, silty and poorly drained, which overlie heavy, grey, little-altered Madhupur Clay at a shallow depth. Below the cultivated layer, there is an E-horizon. They have been classified as Eutric Planosols. Deep Grey Terrace soils Occupy extensive parts of the north-eastern Barind Tract and the Madhupur Tract. They also occur in the northwest of the Northern and Eastern Piedmont Plains. The soils are poorly drained, grey and silty and overlie pervious, deeply weathered Madhupur or Piedmont clay. The major part of the subsoil is an E-horizon. The majority of these soils are Albic Gleysols, Gleyic Luvisols and Gleyic Alisols. Grey Valley soils are broadly similar to deep grey terrace soils but differ from them in being developed in valleys and in generally not overlying a strongly red-mottled clay substratum. They are Albic and Eutric Gleysols (Banglapedia, 2012).

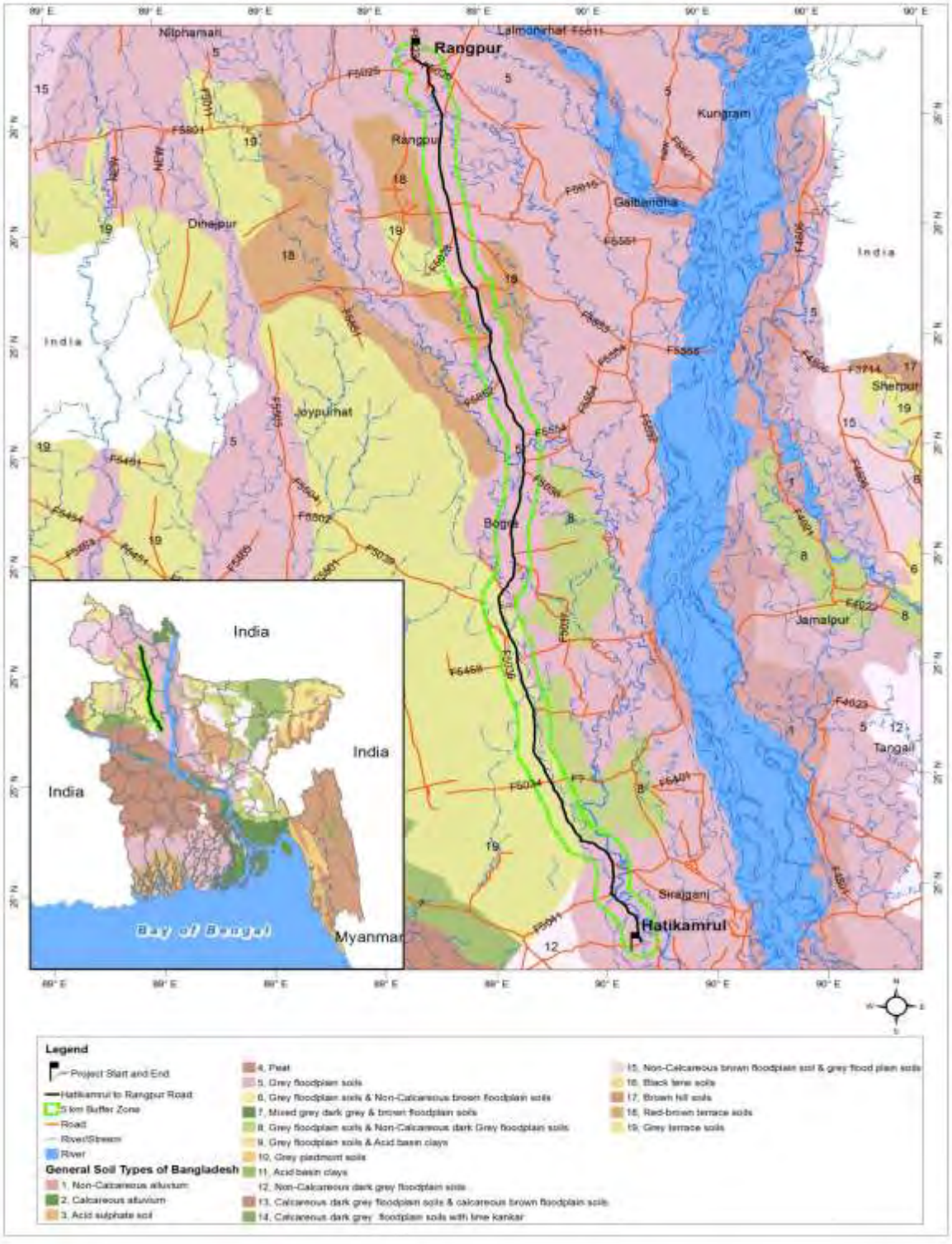


Figure 19: General Soil Classification of the Project Area

10. Agroecological Zones within the Project Area

163. A 1988 study carried out by the United Nations Development Program (UNDP) classified Bangladesh into a series of Agroecological Zones (AEZs) based on an assessment of commonalities in characteristics such as physiography, soil types, climate and drainage. In total, 34 regions were identified and characterized, however this information has been updated and further refined on numerous occasions since the original study was undertaken.

164. 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.

165. The most recent assessment was completed by the Soil Resource Development Institute (SRDI, 1998) which classified Bangladesh into 30 AEZs. The project area contains 3 AEZs (refer Figure 20), namely:

- **Teesta Meander Floodplain (3)**: This region occupies the major part of the Teesta floodplain as well as the floodplain of the Atrai, little Jamuna, Karatoya, Dharla and Dudhkumar rivers. Most areas have broad floodplain ridges and almost level basins. There is an overall pattern of olive brown, rapidly permeable, loamy soils on the floodplain ridges, and grey or dark grey, slowly permeable, heavy silt loam or silty clay loam soils on the lower land and parent materials medium in weatherable K minerals. Eight general soil types occur in the region, moderately acidic throughout, low in organic matter content on the higher land, but moderate in the lower parts. Fertility level is low to medium. Soils, in general, have good moisture holding capacity (Banglapedia, 2012).
- **Karatoya-Bangali Floodplain (4):** This region is very similar to the Teesta Meander Floodplain in physiography and soil, and comprises a mixture of Teesta 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, 2012).
- **North Eastern Barind Tract (27):** This region occupies several discontinuous areas on the north-eastern margins of the Barind Tract. It has silty or loamy topsoil and clay loams to clay subsoil. The soils are strongly acidic in reaction. Organic matter in the soils is low. General fertility is poor (Banglapedia, 2012).

166. 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.

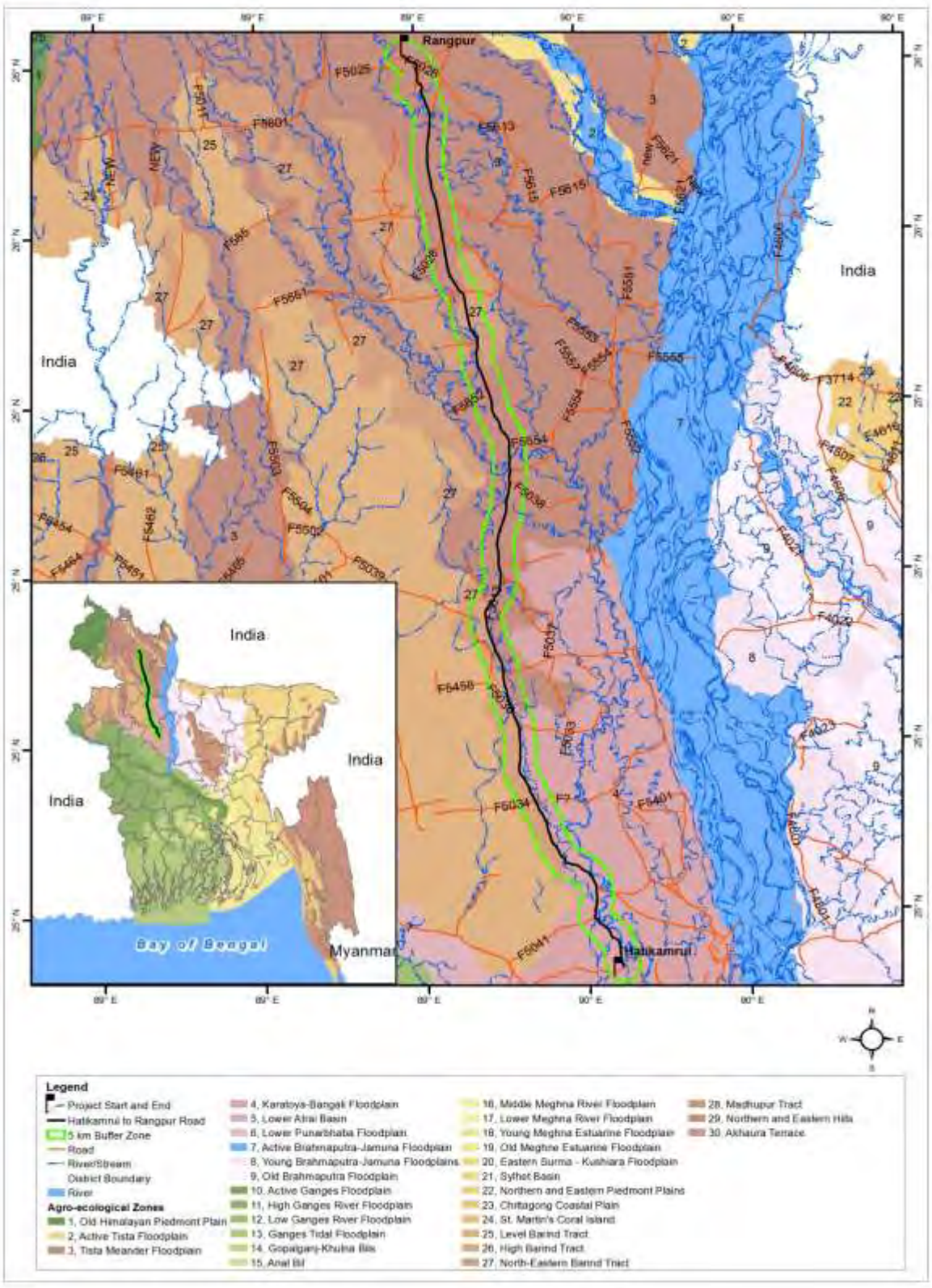


Figure 20: Agroecological Zones of the Project Area

11. Soil Quality

167. 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. The 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 and there are a lot discrete water bodies for fish 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 local land. This is why; soil sample in 1 m depth from the bed of the Fuljor River and Karatoya River will be analysed in the environmental laboratory of BUET to assess the current soil quality of the dredged material. Table 15 reflects the test results of the soil sample collected from the bed of the two rivers. Test report (see Appendix D) of soil analysis proofs that river bed material (sand) of the Fuljor and Karatoya 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.

Photograph 2: Riverbed Materials Collection at Karatoya River, Gaibandha and Fuljor River, Sirajganj

Table 15: Test Results of Soil Quality

Parameter	Concentration Present (ppm)		EU Directive 86/278/EEC for Land Application	Method of Analysis
	Fuljor River Location: 24° 26' 54.2" N 89° 32' 50.3" E	Karatoya River Location: 25° 10' 26.0" N 89° 23' 18.1" E		
Arsenic (As)	10.59	1.178	-	USEPA 206.2; SM 3113 B
Lead (Pb)	5	8	1200	USEPA 200.9 Rev 2.2;SM 3111 B
Zinc (Zn)	21.8	40.7	4000	USEPA 200.9; SM 3111 B
Mercury (Hg)	<MDL	103	25	----------
Cadmium (Cd)	<MDL	<MDL	40	USEPA 213.2; SM 3113 B
Copper (Cu)	6.7	11.8	1750	----------
Chromium (Cr)	11.3	23.6	-	USEPA 200.9 Rev 2.2;SM 3111 B

Source: Lab Analysis, February 2014, BUET

12. Water Resources and Hydrology

168. 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 metres to around 400 metres (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, 2012).

169. **Surfarce Water.** There are two major surface water bodies surrounding the project area which are Fuljor River and Karatoya River. The project road alignment crosses all the rivers at several locations (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 16 represents the affected water bodies and fish resources in the RoW of the project road alignment.

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

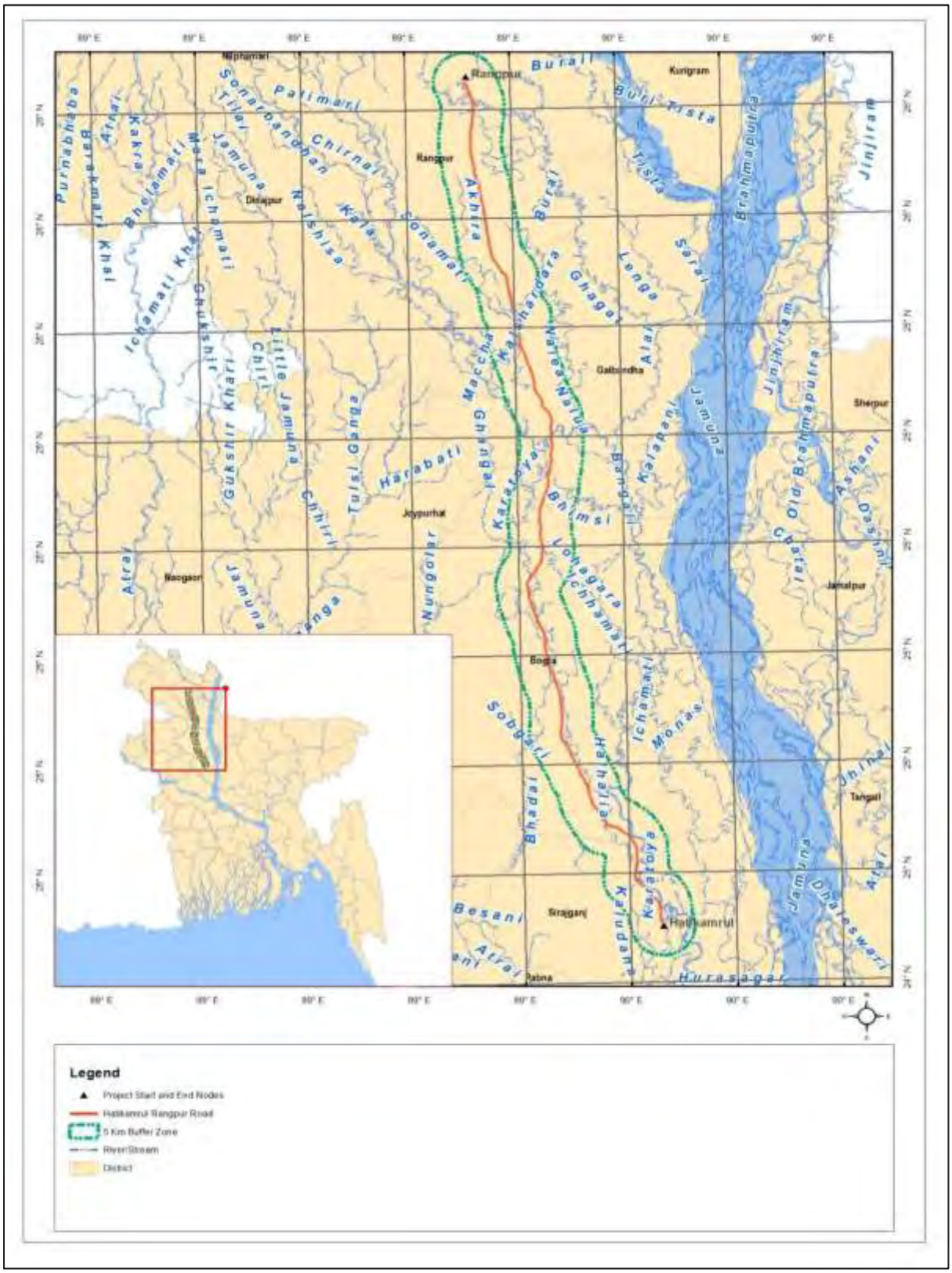


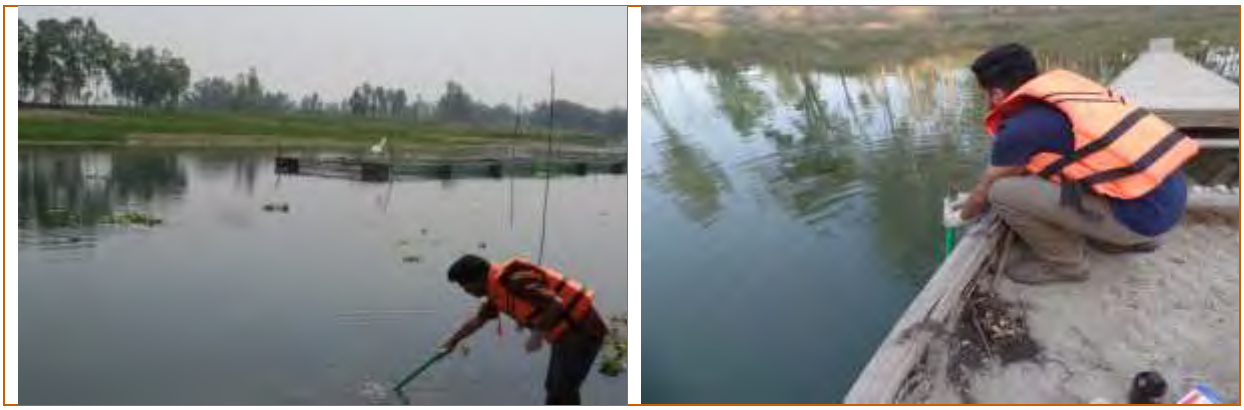
Figure 21: River Network Table 16: Water Bodies and Fish Resources within the Rows of the Alignment

Type of Water Bodies	Total No. of Water Bodies	Area (ha)		Affected Total Fish Production	
		Total Area	Affected Area	MT/ha/Year[6]	Total Production (MT)
River		-	-	-	-
Canal	4	2.14	1.63	-	-
Pond	87	25.19	7.60	1.25	9.5
Khal		-	-	-	-
Ditch	285	30.13	16.67	0.60	10.00
Borrowpit	3	3.20	0.81	0.60	0.47
Hatchery	7	3.74	0.51	-	-

170. **Surface Water Quality.** To assess the current quality of ground and surface water, water samples were collected from two locations along the whole alignment.

171. 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.

172. In March 2017, surface water samples were collected by environmental team from several 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 (See Appendix E). The result of the surface water samples are shown in Table 17.



Photograph 4: Surface Water Collection from along the Project Road

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

Table 17: Test 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
01	SW 01	Terminal Road, Bogra	7.22	3.16	4.95	58.21	6.24	18.2
02	SW 02	Mithapukur Post Office Road, Bogra	6.88	6.42	7.35	141.53	6.05	5.20
03	SW 03	BoroBila, Pirganj Bus Stand, Bogra	6.93	6.35	4.58	148.50	7.46	5.40
04	SW 04	Korotoya River, Nauda Para	6.86	3.16	4.52	50.21	7.70	7.60
05	SW 05	Korotoya River, TMSS, Gokul	7.45	6.29	3.48	62.34	7.72	4.00
06	SW 06	Akhira River, Dhaperhat Bazar, Pirganj	7.30	6.39	4.22	195.21	6.86	3.40
07	SW 7.1 (50m US)	Bangali River, Gobindoganj	7.64	6.41	4.65	102.35	7.73	9.60
08	SW 7.2 (50m DS)	Bangali River, Gobindoganj	6.92	6.28	6.06	130.63	5.23	15.4
09	SW 08	Shathibari High School Pond, Rangpur	7.21	12.63	5.81	183.02	5.26	16.0
10	SW 09	PairabandMozaPukur, Rangpur	6.84	6.37	7.83	198.51	5.31	16.0
11	SW 10.1 (50m US)	Ghaghat River	7.28	9.52	3.67	135.21	7.64	6.00
12	SW 10.2 (50m DS)	Ghaghat River	7.72	9.48	4.03	112.41	7.02	10.0
13	SW 11	Majhira, Cantonment Pond, Bogra	7.22	15.84	6.79	212.59	5.10	9.60
14	SW 12	Mirapur, Shollaghati Pond, Bogra	7.32	32.12	63.50	316.35	1.01	6.80
15	SW 13.1 (50m US)	Chandiakona, Bogra Bazar, Bogra	7.37	18.94	4.22	253.81	1.47	7.40
16	SW 13.2 (50m DS)	Bhuiyagati, Bogra	7.22	12.61	5.26	222.79	2.96	11.4
17	SW 15	Hatikumrul, Shahebganj	7.33	2.42	< 0.2	< 5	4.88	< 5
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

173. **Groundwater.** 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/litre (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 litre of water. The acceptable quantity of arsenic in potable water is 0.05 mg per litre under the Department of Environment standard and 0.01 mg per litre under the WHO standards (Figure 22).

174. 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 18). The groundwater reservoir usually recharges from rainfall, floods and river. In summer season, the water table slightly goes down and goes up in rainy season.

Table 18: Source of Drinking Water in the Project Area

District	Upazila (sub-district)	No. of Households	Source of Drinking Water (%)		
			Tap	Tube-well	Others
Sirajganj	Ullapara	123630	0.9	94.7	4.4
	Raiganj	77104	0.7	95.4	3.9
Bogra	Sherpur	81639	3.8	93.7	2.5
	Shajahanpur	72323	7.9	90.6	1.5
	Bogra Sadar	129597	16.7	82.1	1.2
	Shibganj	99124	1.1	95.8	3.0
Gaibandha	Gabindaganj	132402	0.9	95.4	3.7
	Palashbari	63178	0.6	96.2	3.2
Rangpur	Pirganj	101485	0.4	97.9	1.7
	Mithapukur	134898	0.3	97.4	2.3
	Rangpur Sadar	163052	7.1	91.3	1.6

Source: Population Census, 2011

175. **Groundwater Quality.** In March 2017, groundwater samples were collected by environmental team from shallow tube wells in the project area. The Bangladesh Council of Scientific and Industrial Research (BCSIR) analysed the samples (See Appendix E). The result of the groundwater samples and the GoB standards for potable water (ECR, 1997) are shown in Table 19. The concentration of Mn is higher than the standard value of most the measured water sources and only Fe is higher at Hatikamrul. The microbial contamination was identified at Bogra Rail Gate and Mithapukur water sources.

Table 19: Results for Groundwater Field Samples

Parameters	Unit	Hatikamrul (GW-02)	Sherpur Bazar (GW-03)	Aria Bazar (GW-04)	Bogra Rail Gate (GW-05)	Matidali, Biman More (GW-6)	Polashbari Chowmatha (GW-07)	Mithipur Paurashava (GW-08)	Mithapukur (GW-09)	Asshotpur, Parker Mor, Rangpur (GW-10)	Drinking Water Quality Standard, DOE (ECR,97)	Method of Analysis
pH	---	7.20	6.02	6.84	6.95	6.66	6.56	5.99	6.47	6.76	6.5-8.5	pH Meter
Total Hardness (as $CaCO_3$)	ppm	172	40.05	27.41	26.79	81.19	73.43	50.38	47.43	10.73	200-500	Potentiometric Titration
Chloride (Cl^-)	ppm	2.66	40.05	27.41	26.79	81.19	73.43	50.38	47.43	10.73	150-600	Ion Chromatography
Manganese (Mn)	ppm	**0.67**	**0.144**	0.017	**0.363**	**0.584**	**0.522**	0.031	**0.191**	0.026	0.1	AAS
Arsenic (As)	ppm	0.022	0.00464	0.0062	0.0066	0.0029	0.003	0.0048	0.005	0.0041	0.05	AAS with HVG Unit
Iron (Fe)	ppm	**12.7**	0.025	0.026	0.059	0.021	0.022	0.020	0.022	0.040	0.3-1.0	AAS
Total Coliform (TC)	CFU/100ml	0	0	0	**24**	0	0	0	**15**	0	0	Membrane Filtration
Fecal Coliform (FC)	CFU/100ml	0	0	0	**16**	0	0	0	**5**	0	0	Membrane Filtration

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

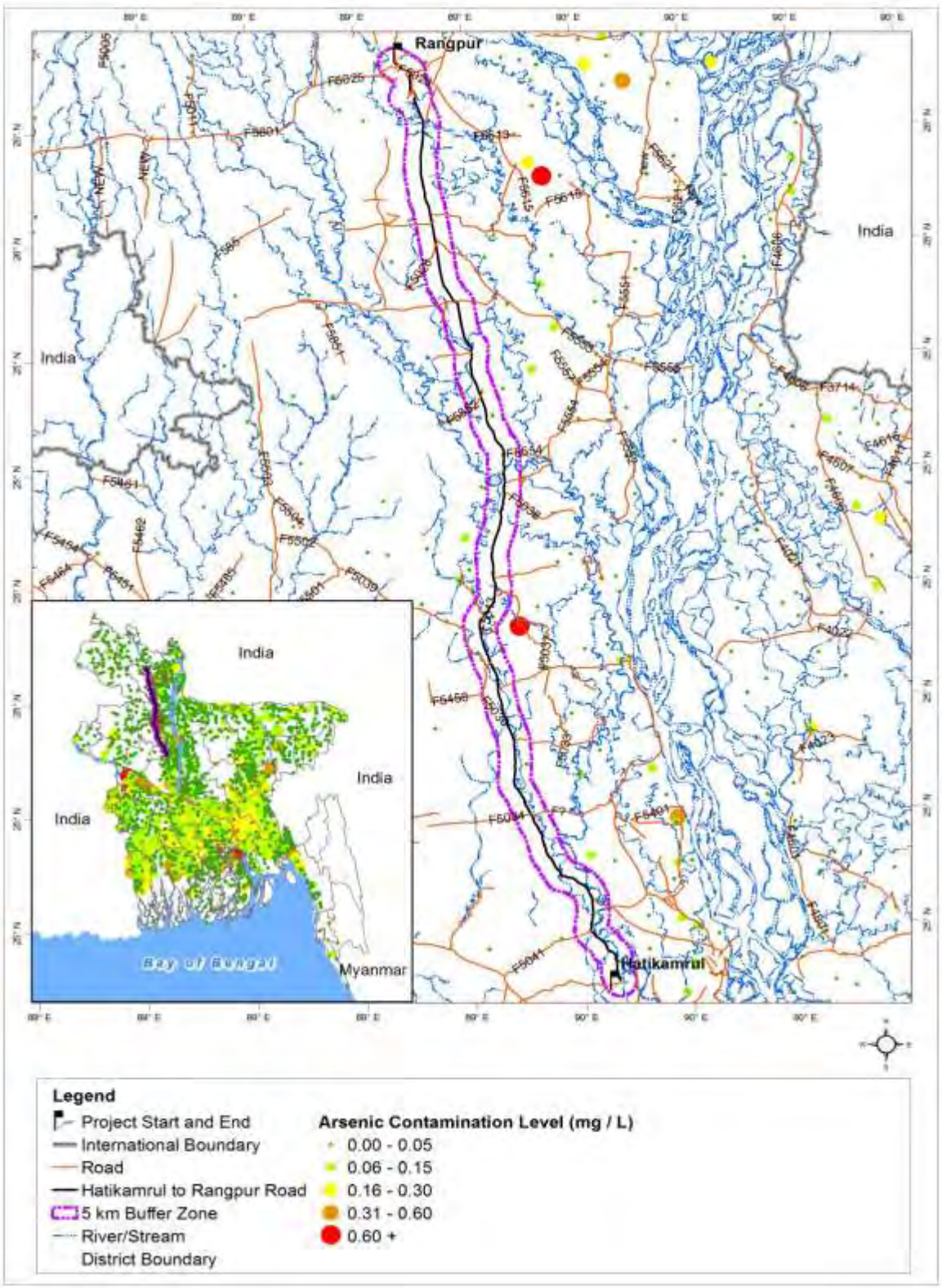


Figure 22: Arsenic Concentrations in Groundwater

13. Ambient Air Quality

176. 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.

177. The activities, which generate modify atmospheric air quality, are transportation (i.e., motor vehicle emissions, which are addressed in this report); industry; domestic and construction. The principal sources of air pollution due to road projects are hot mix plants and machinery 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 (SO_2), nitrogen oxides (NOx), hydrocarbons (HC), carbon-monoxide (CO), total volatile organic carbon (TVOC).

178. Dispersal of pollutants depends upon factors like prevailing wind direction and other weather conditions, atmospheric stability, height of the source, NOx, SOx or relevant to photochemical smog rather than roadside.

179. There are significant numbers of small and big factories/industries are located in the project areas; therefore, air pollution is comparatively higher than in other areas of Bangladesh. In addition, air pollution in the project area is from road dust, black smoke from diesel engines, construction dust, windblown dust from agricultural lands, domestic heating and cooking, industries, transportations and brick kilns. Photograph 5 shows the several sources of air pollution within the project area.

180. In order to monitor air quality at the different locations, the field investigation was undertaken during March, 2017. The parameters were obtained by monitoring over a period of 24 hours. Measured ambient air quality (data are recorded in Table 20. Photograph 6 shows a few snapshots of air quality monitoring processes and Photograph 7 shows the several sources of air pollution within the project area.

Photograph 5: Air quality measurement at the Project Road

Table 20: Ambient Air Quality in Different Locations along the Project Road

Air Quality Parameters	Unit	Concentration Present								Bangladesh Standard (ECR, 2005)
		Hatikamrul	Chandaikona Bazar	Nandigram - Sherpur	Noymail Bus Stand	Bir Shrestho Square	Elenga – Gaibandha Rangpur Intersection	Pirganj Bus Stand	Rangpur Parker Mor	
GPS Location		24°27'12.21"N 89°42'9.94"E	24°34'8.17"N 89°29'2.64"E	24°40'11.15"N 89°24'58.66"E	24°43'29.99"N 89°23'47.65"E	24°50'50.90"N 89°22'21.78"E	25°17'4.21"N 89°21'4.25"E	25°25'5.41"N 89°18'54.77"E	25°42'57.32"N 89°15'44.66"E	
Temperature	°C	26.15	23.55	25.95	28.39	25.83	25.47	22.76	23.82	
Relative Humidity	%	79.84	81.87	82.64	76.10	85.43	86.72	92.01	88.36	
Wind Speed	Km/h	0.14	0.09	0.34	0.62	0.11	0.09	0.20	0.17	
Wind Direction	Degree	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	
O_3	$\mu g/m^3$	3.09	3.40	6.53	4.65	7.16	3.45	4.03	3.15	157 (8-hr Average) 235 (1-hr Average)
NO_x	$\mu g/m^3$	92.42	34.82	99.86	**120.70**	99.37	66.60	55.17	53.39	100 (annual)
SO_2	$\mu g/m^3$	9.85	7.46	10.40	12.60	6.50	10.64	14.82	4.68	80 (Annual) 365 (24-hr Average)
CO	$\mu g/m^3$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10 (8-hr Average) 40 (1-hr Average)
VOC	ppm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	NYS
PM_{10}	$\mu g/m^3$	65.78	86.95	**159.72**	145.17	133.92	70.07	93.75	66.66	50 (annual average) 150 (24-hr average)
$PM_{2.5}$	$\mu g/m^3$	27.77	42.62	63.13	**88.56**	**71.68**	30.88	40.32	37.63	15 (annual average) 65 (24-hr average)

181. 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.

182. 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 PM_{10} concentrations generated from traffic movement on proposed highway. Details are in Appendix F.

183. Kerb side locations were selected to compare the model prediction with monitored locations. Compared with the actual measurements of $PM_{2.5}$, PM_{10} and CO concentrations, the predicted concentrations of each pollutant is lower, as shown in Table 21.

Table 21: Predicted vs. Monitored Air Quality Parameters

Parameter	Concentrations					
	Monitored			Predicted		
	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	CO (ppm)	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	CO (ppm)
Hatikamrul	27.77	65.78	0	18	29	0.1
Elenga – Gaibandha Rangpur Intersection	30.88	70.07	0	13	26	0
Pirganj Bus Stand	40.32	93.75	0	18	29	0
Rangpur Parker Mor	37.63	66.66	0	15	28.6	0

184. In addition, the spatial distribution of hourly average predicted CO, $PM_{2.5}$ and PM_{10}, 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.

Photograph 6: Sources of Air Pollution along the Hatikamrul-Rangpur Road

14. Noise Level

185. Excessive noise is a potential issue for both human and biological receivers and can 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.

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

- **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.
- **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.

187. Monitoring of ambient noise levels was undertaken by the environment team at 07 locations for twenty four hours in March 2017 within the project area. The outcomes of this monitoring are presented in Table 22. Photograph 7 shows some of the snapshots during the monitoring phases.

188. 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.

189. Additionally, a noise analysis for different sections of the project road is carried out by noise modeling software. The predicted noise during operation period also indicates a high level noise at different places of the road. The noise analysis result using noise modeling software is given in Appendix F of this EIA report.

Photograph 7: Monitoring of Ambient Noise Level

190. Noise pollution propagation generated from traffic was predicted using Canarina CUSTIC 3.2 software, where noise emission from vehicles along the proposed Hatikamrul - Rangpur 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 sensitive receptors is indicated in Table 22.

191. Based on the model prediction, the predicted noise for the following sensitive receptors will be exceeded by 2040, compared to the current scenario: (1) N5-28 Hatikamrul-Bhuyangati (Dadupur Sahebgonj Govt. High School, National Skill Development Institute, Royhati Madrasa Mor; (2) N5-31, Sherpur Int. with Z-5049)-Sherpur (Int. with Z-5401) (Krishnapur Govt. Primart School and Jameya Hafizia Madrasha); (3) N5-45, between Kashipur (Mokamtola)-Gabindaganj, Pakurtala, km 243.512 (Makamtola Mohila Degree College, Rahbol Girls High School and TMSS Health Complex); (4) N5-48, between Palashbari-Pirganj, Ekberpur, km 275.511 (R. V. Cold Storage Mosque, Dhaperhat Bazar and Lillah Boarding Madrasha); (5) N5-50, between Pirganj-Mithapukur, km 292.502 (unnamed Mosque); (6) N5-51, between Mithapukur-Rangpur Modern More, Pairabond, km 316.022 (N5-51, between Mithapukur-Rangpur Modern More, Pairabond, km 316.022, Islampur Mondon Para Mosque, Payrabondo Salehkiya Madrasa, and Drishtiprotibondhi School). Predicted noise levels ranged from 65 -73.7 Leq.

Table 22: 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)
N5-28 Hatikamrul-Bhuyangati	Dadupur Sahebgonj Govt. High School	Educational	24.45099	89.5454	68.6	69.9	Marginal increase
	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
N5-31, Sherpur Int. with Z-5049)-Sherpur (Int. with Z-5401)	Krishnapur Govt. Primart School	Educational	24.63901	89.43226	57.6	70.6	Net increase
	Jameya Hafizia Madrasha	Educational	24.66334	89.42091	61.8	70.4	Net increase
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
	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
N5-48, between Palashbari-Pirganj,	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

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)
Ekberpur, km 275.511	Lillah Boarding Madrasha	Educational	25.39123	89.32641	61.5	64.4	Increase
N5-50, between Pirganj-Mithapukur, km 292.502	Mosque	Religious	25.45452	89.29762	65.4	69.9	Increase
N5-51, between Mithapukur-Rangpur Modern More, Pairabond, km 316.022	Mithapukur Autistic School	Educational	25.57818	89.27351	67.2	70.1	Increase
	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
	Drishtiprotibondhi School	Educational	25.68816	89.27077	61.2	67.0	Increase

192. Permitted noise level in different area according to Bangladesh Noise Pollution (Control) Rules, 2006 is listed below in Table 23. Comparing the monitored noise level with the values of Table 24, it can be concluded that, the noise level at the five locations are above the standard set in both day and night time. The corresponding World Bank EHS guidelines as shown in Table 25, showed that 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 23: 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

Source: Noise Pollution (Control) Rules, 2006

Table 24: Noise Level at Different Locations of the Project Alignment

Location	Noise Level Description (dBA)
	L_{Aeq}
Sirajganj Road Chowrasta	64.93
Chandaikona Bazar	76.59
Nandigram – Sherpur	92.06
Noymail Bus Stand	92.41
Bir Shrestho Square	87.05
Elenga – Gaibandha Rangpur Intersection	87.09
Pirganj Bus Stand	69.41
Rangpur Parker Mor	70.42

Table 25: Noise Level at Different Locations of the Project Alignment

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

1. General

193. The countries of South and Southeast Asia are recognized by International Union for Conservation of Nature (IUCN) to be regions of high species diversity. A large number of native plants, including 3,000-4,000 species of woody flora, have been recorded from Bangladesh. The country lies at the meeting point (ecotonal region) of several floristic provinces, including the Manipur-Khasia, Bengal and North Burman provinces within the Indo-Malayan realm (IUCN, 2002).

194. 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).

195. 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).

2. Bio-ecological Zones

196. 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.

197. 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 4.14). The project road alignment falls below the two bio-ecological zones.

- ***Barind Tract (2):*** Barind Tract is located in the centre and western part of Rajshahi division. The greater part of the tract is almost plain and is crisscrossed by only a few minor rivers. This tract is considered an ecologically fragile ecosystem with extremely low vegetation cover. Though this zone was rich with faunal diversity in the past, it has now noticeably reduced mostly due to various pressures like expansion of human habitat, agricultural extension, unwise use of agrochemicals and illegal hunting. (IUCN, 2002f).
- ***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 channel 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 been disappeared- form this area but most of common bird species are still found in this location. (IUCN, 2002f).

3. Diversity of Terrestrial Floral and Faunal Species

198. The status of terrestrial floras and faunas at the project site 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, fish, snakes rodents and a few mammals. The homestead ecosystem provides the main tree covered areas within rural Bangladesh including 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.

199. **Terrestrial Flora.** The project influence area (PIA) is highland with mixed vegetation. Crops, vegetables are cultivated at the surrounding mainly include rice, wheat, robi 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 25.

200. According to the Inventroy of Losses (IOL) survey done in March 2015, total 105339 trees of different types (35334 fruit trees, 67170 timber trees, 2835 medicinal trees) and sizes (large= 10644 trees, medium= 25019 trees, small= 48493 trees, saplings= 21183 trees) will be affected

being located within the ROW of the subproject road's alignment (Details in Appendix E). Excluding the affected 105339 trees, 37785 banana trees and 39731 bamoo trees will be affected being located within the ROW.

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

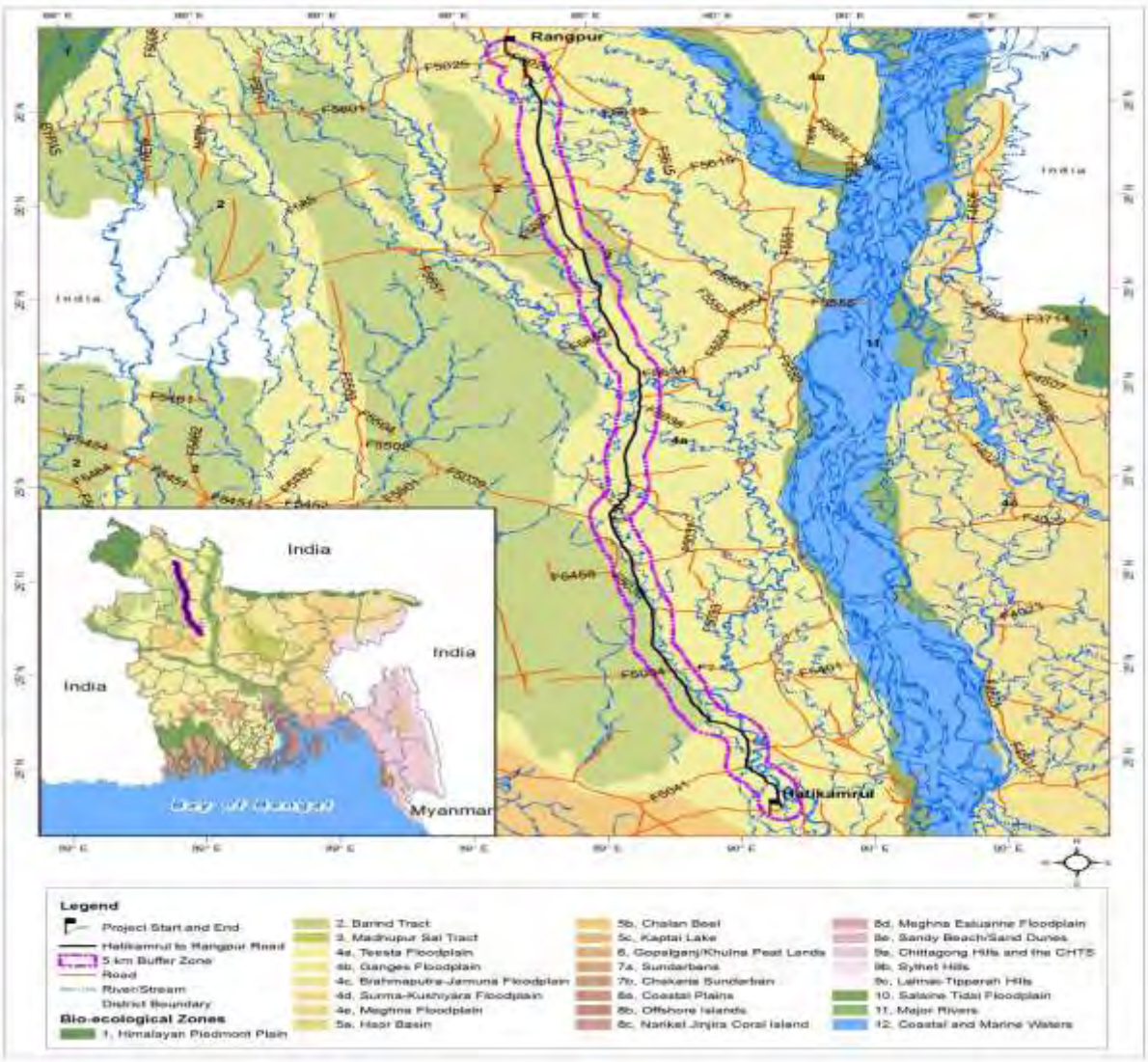


Figure 23: Bio-ecological Zones

Table 26: List of Plants along the Project Road

Common Name	Scientific Name	English Name	Family
Ata	*Annona squamosa*	Bullock's heart	Annonaceae
Akashmoni	*Acacia aurculiformios*		
Akanda	*Calotropis procera*	Swallow wort	Asclepiadaceae
Ishw Armol	*Hemidesmus indicus*	Indian sarasaparilla	Asclepiadaceae
Ashok	Saraca indica	Ashoka	Caesalpinioideae
Aurjun	Terminalia arjuna	Aurjun	Combretaceae
Amra	*Spondias pinnata*	Wild mango	Anacardiceae
Am	*Mangifera indica*	Mango	Anacardiceae
Babla	*Acacia nilotica*		
Bashak	Adhatoda vasica	Malabar Nut Tree	Acanthaceae
Bamboo	*Bambosa spp.*		
Banana	*Musa sapientum*		
Bel	*Aegle marmelos*	Wood apple	Rutaceae
Bet	*Calamus rotung*		

Common Name	Scientific Name	English Name	Family
Ban Chandal/Ban charal	*Cadariocalyx motorius*	-	Leguminosae
Banar Lathi	*Cassia fistula*	Indian laburnum	Caesalpinioideae
Bichuti	*Girardinia heterophylla*	-	Urticaceae
Bokna Neem	*Melia azadirach*		
Boroi	*Zizyphusm auritiana*		
Bot	*Ficus benghala nsis*	Banyan tree	Moraceae
Bishkatali	*Polygonum orientale*	-	Polygonaceae
Chatim	Alstonia scholaris	Chatian	Apocynaceae
Chalta	*Dellenia indica*		
Coconut	*Cocos nucifera*		
Durba Ghas	Cynodon dactylon	Barmuda grass	Gramineae
Debdaru	*Polyalthia longifolia*	-	Annonaceae
Dhundul	*Luffa 79eregrine79l*	Sponge gourd	Cucurbitaceae
Dalim	*Panica granatum*	Pomegranate	Puniacacaea
Dhotura, Kalo	*Datura metel*	Downy thornapple	Solanaceae
Epil Epil	*Leucaena leucocephala*		
Gheta Kumari	*Aloe indica*	Indian aloe	Liliaceae
Gab	*Diospytos 79eregrine*	River ebony	Ebeanaceae
Guava	*Psidium guajava*		
Gandhoraj	*Gardenia coronaria*		
Olive/Jolpai	*Elaeocarpus robustus*		
Kalpanath/Kalo megh	Andrographis paniculata	Creat	Acanthaceae
Kamranga	*Averrhoa carambola*	Carambola apple	Averhhoaceae
Kathal	*Artocarpus heterophyllus*	Jackfruit	
Koroi	*Albizzia procera*		
Kodbel	*Feronia limonia*		
Lajjabati	Mimosa pudica	Sensitive plant	Mimosoideae
Lebu	*Citrus aurantifolia*	Lemon	Rutaceae
Litchi	*Litchi chinenss*		
Mesta	*Hibiscus cannabinus*	Malvaceae	Mesta
Man Kachu	Alocasia indica	Gaint taro	Araceae
Mehedi/Mendi	*Lawsonia inermis*	-	Lythraceae
Mehogoni	*Swietenia mahagoni*		
Mochi Ganda/ Mochkanda	*Pterospermum acerifolium*	Hatipaila	Sterculiaceae
Nayantara	Vinca rosea	Pri winkle	Apocynaceae
Nishinda	Vitex negundo	Five leaved caste tree	Verbenaceae
Papaya	Carica papaya	Papaw tree	Caricaceae
Racta Jaba	*Hibiscus rosa-sinensis*	Rose of china	Malvaceae
Raktadrun	*Leucas sibiricus*		Labiatae
Racta Chandal	*Pterocarpus santalinus*	Red sanders	*Papilionaceae*
Shimul	*Bombax ceiba*		
Shishu	*Dalbergia sisoo*		
Sofeda	*Manilkara zapota*	Sapota	Sspotaceae
Thankoni	Centella asiatica	Indian pennywort	Umblelliferae
Telakucha	*Coccinea cordifolia*	-	Cucurbitaceae
Torup Chandal	*Desmodium gyrans*	-	Papilionaceae
Tit Begun	*Smilax macrophylla*	-	Liliaceae
Tentul	*Tamarindus indica*	Tamarind	Caesalpinioideae
Tulsi	*Ocimum canum*		
U-caliptas	*Eucalyptus citriodora*		
Ulat chandal	*Gloriosa superba*	Glory Lilly	Liliaceae

Common Name	Scientific Name	English Name	Family
Venna	*Ricinus communes*		
Zamrul	*Syzygium samarangense*		
Ziga	*Lannea coromandelica*		

4. Terrestrial Fauna

201. The diversified habitat and ecosystem in the project area support various types of animals as given in Table 26. 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 81 species are identified during field survey among them 2 are Amphibian, 12 Reptilian, 61 Avian faunas and 6 Mammalian faunas. The list of these species with their vulnerability status is given at Table 26. Out of the species identified, 1 is endangered and 7 are vulnerable. No endemic species are found in the project area.

Table 27: List of Fauna Identified in and around the Project Area

Scientific Name	English Name	Local Name	Local Status
Class: Amphibia			
Bufo melanostictus	Common Toad	Kuno bang	NO
Rana temporalis	Bull Frog	Kola bang	NO
Class: Reptilia			
Hemidactylus flaviviridis	Common House Lizard	Tiktiki	NO
Calotes versicolor	Common Garden Lizard	Rokto-chosha	NO
Mabuya carinata	Common skink	Anjon	NO
Varanus bengalensis	Bengal monitor	Gui shap	VU
Varanus salvator	Ring lizard	Kalo gui	EN
Xenochrophis piscator	Checkered keelback	Dhora shap	NO
Amphiesma stolata	Stripped keelback	Dora shap	NO
Enhydris enhydris	Common smooth water snake	Paina shap	NO
Coluber mucosus	Rat snake	Daraj shap	VU
Ahaetulla nasutus	Common vine snake	Laodoga shap	VU
Atretium schistosum	Olive keelback	Maitta shap	NO
Kachuga tecta	Indian roofed turtle	Kori kaitta	NO
Class: Aves			
Phalacrocorax niger	Little cormorant	Paan-kowri	NO
Dendrocygna javanica	Lesser Whistling-duck	Shorali	NO
Ardeola grayii	Indian pond heron	Kani bok	NO
Casmerodius albus	Great egret	Sada bok	NO
Egretta intermedia	Intermediate egret	Mazla bok	NO
Egretta garzetta	Little egret	Choto bok	NO
Bubulcus ibis	Cattle egret	Go-bok	NO
Nycticorax nycticorax	Black-crowned night heron	Nishi bok	NO
Ixobrychus cinnamomeus	Cinnamon Bittern	Lal bok	NO
Ixobrychus sinensis	Yellow Bittern	Holud bok	NO
Anastomus oscitans	Asian Openbill	Shamuk-khol	NO
Haliastur indus	Brahminy kite	Shankho chil	NO
Milvus migrans	Black kite	Bhubon chil	NO
Spilornis cheela	Crested Serpent-eagle	Khopa Baz	VU
Ichthyophaga ichthyaetus	Grey-headed fish eegol	Metematha kura eagle	LC
Metopidius indicus	Bronze-winged Jacana	Jolpipi	NO
Columba livia	Rock pigeon	Jalali Kobutar	NO

Scientific Name	English Name	Local Name	Local Status
Streptopelia chinensis	Spotted dove	Tila Ghughu	NO
Streptopelia decaocto	Eurasian collared dove	Raj Ghughu	NO
S. tranquebarica	Red-collared Dove	Lal Ghughu	NO
Treron phoenicopterus	Yellow-footed Green Pigeon	Horial	VU
Psittacula krameri	Rose-ringed parakeet	Tia	NO
Amaurornis phoenicurus	White-breasted waterhen	Dahuk	NO
Eudynamys scolopacea	Asian cuckoo	Kokil	NO
Centropus sinensis	Greater coucal	Kanakua	NO
Cuculus micropterus	Indian cuckoo	Bou-kotha-kao Pakhi	NO
Hierococcyx varies	Common hawk cuckoo	Chokhgelo Pakhi	NO
Athene brama	Spotted owlet	Khuruley Pencha	NO
Tyto alba	Barn owl	Laxmi Pencha	NO
Apus affinis	House swift	Ababil	NO
Cypsiurus balasiensis	Asian palm swift	Nakkati	NO
Alcedo atthis	Common kingfisher	Choto Maachranga	NO
Halcyon smyrnensis	White-throated kingfisher	Sada buk Maachranga	NO
Merops orientalis	Little Green bee-eater	Suichora	NO
Megalaima haemacephala	Coppersmith barbet	Choto Basanta Bauri	NO
M. asiatica	Blue-throated barbet	Basanta Bauri	NO
M. lineate	Lineated barbet	Gurkhod	NO
Dendrocopos macei	Fulvous-breasted woodpecker	Pakra Kaththokra	NO
Dinopium benghalense	Black-rumped flameback	Kaththokra	NO
L. schach	Long-tailed shrike	Bagha tiki	NO
Oriolus xanthornus	Black-headed oriole	Holdey Pakhi	NO
Corvus splendens	House crow	Pati Kak	NO
C. marorhynchos	Jungle crow	Darn Kak	NO
Dendrocitta vagabunda	Rufous treepie	Hanrichacha	NO
Dicrurus macrocercus	Black drongo	Fingey	NO
Artamus fuscus	Ashy woodswallow	Latora	NO
Copsychus saularis	Oriental magpie robin	Doel	NO
Acridotheres fuscus	Jungle myna	Jhuti Shalik	NO
A. tristis	Common myna	Bath Shalik	NO
A. ginginianus	Bank myna	Gang Shalik	NO
Sturnus contra	Asian pied starling	Gobrey Shalik	NO
S. malabaricus	Chestnut-tailed starling	Kath Shalik	NO
Pycnonotus cafer	Red-vented bulbul	Bulbuli	NO
P. jocosus	Red-whiskered Bulbul	Shepahi Bulbul	NO
Turdoides striatus	Jungle babbler	Satbhai	NO
Orthotomus sutorius	Common tailorbird	Tuntuni	NO
Nectarinia asiatica	Purple sunbird	Niltuni	NO
N. zeylonica	Purple-rumped sunbird	Moutusi	NO
D. agile	Thick-billed Flowerpecker	Fuljuri	NO
Passer domesticus	House sparrow	Charui	NO
Ploceus philippinus	Baya weaver	Babui	NO
Class: Mammalia			
Pteropus giganteus	Flying Fox	Badur	NO
H. auropunctatus	Small Indian Mongoose	Benji	NO
Vulpes bengalensis	Bengal Fox	Khek shial	VU
Viverricula indica	Small Indian Civet	Khatash	VU
Rattus rattus	Common House Rat	Indur	NO
Suncus murinus	House Shrew	Chicka	NO

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

5. Diversity of Aquatic Flora and Fauna

202. **Aquatic Flora.** Different types of aquatic flora species were recorded in the project area. 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.

203. **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.), freshalater mussels (Lamellidens sp.) etc. invertebrates and several species of fish. Kolabang (Rana tigrina, NO[7]); Guishap (Varanus bengalensis, NO) and Matia sap (Atretium schistosum, NO) are common. The aquatic birds are – Pancowri (Phalacrocorax niger, NO), Kanibok (Ardeola grayii, NO), Sadabok (Casmerodius albus, NO), Borobok (Egretta alba, NO), Machranga (Halcyon pileata, NO), Dahuk (Amaurornis phoenicurus, NO), and winter migratory birds – Balihash (Dendrocygna javanica), Spotbill duck (Anas poecilorhyncha) and Chakha (Tadorna ferruginea).

204. **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, LC[8]), katla (Catla catla, LC), mrigal (Cirrhinus cirrhosis), kalbashu (Labeo calbasu, LC); shoal (Channa striata), gajar (Channa marulius, EN[9]), taki (Channa punctata), pangash (Pangasius pangasius, EN), boal (Wallago attu, VU[10]), tengra (Mystus tengara, LC), aier (Sperata aor, VU), shing (Heteropneustes fossilis, LC), magur (Clarias gariepinus), baillya (Awaous guamensis, LC), chela (Salmostoma acinaces, LC), batashi (Neotropius atherinoides, LC), kahalisha (Colisa fasciata), puthi (Puntius puntio, DD[11]), kai (Anabas testudineus, LC), falli (Notopterus notopterus, VU), chital (Chitala chitala, EN), baim (Mastacembelus armatus), chanda (Parambassis ranga), and etc. Though some of the species are endangered (EN) of vulnerable (VU) according to IUCN Red Book but these are now widely producing in the aquaculture farm in several places of the country.

Photograph 9: Fishing Practices in Water Bodies along Hatikamrul-Rangpur Road.

[7] NO= Not Threatened
[8] LC= Least Concern
[9] EN= Endangered
[10] VU= Vulnerable
[11] DD= Data Deficient

205. The wetlands of this region also support large populations of the commercially important prawn such as Macrobrachium rosenbergii (Golda Chingri), M. malcomsoni (Chatka chingri) and Leander sp. (Gura chingri). 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 (Fuljor and Karatoya) along the project road.

6. Biodiversity/Environmentally Sensitive Areas

206. 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.

207. In and around the project area some wildlife species were identified as locally vulnerable. The name of these vulnerable species are Bengal monitor, Rat snake, Common vine snake, Crested Serpent-eagle, Yellow-footed green pigeon, Common mongoose, Bengal fox, Small Indian Civet. Some species were also identified as locally endangered and these are Ring lizard, Monocellate cobra, and Jungle cat. Any construction must consider impacts on the rate of deforestation, loss of habitat, habitat fragmentation, and interruption of wildlife migration patterns. There is no protected area located within the 5 km buffer zone of this project (Figure 24).

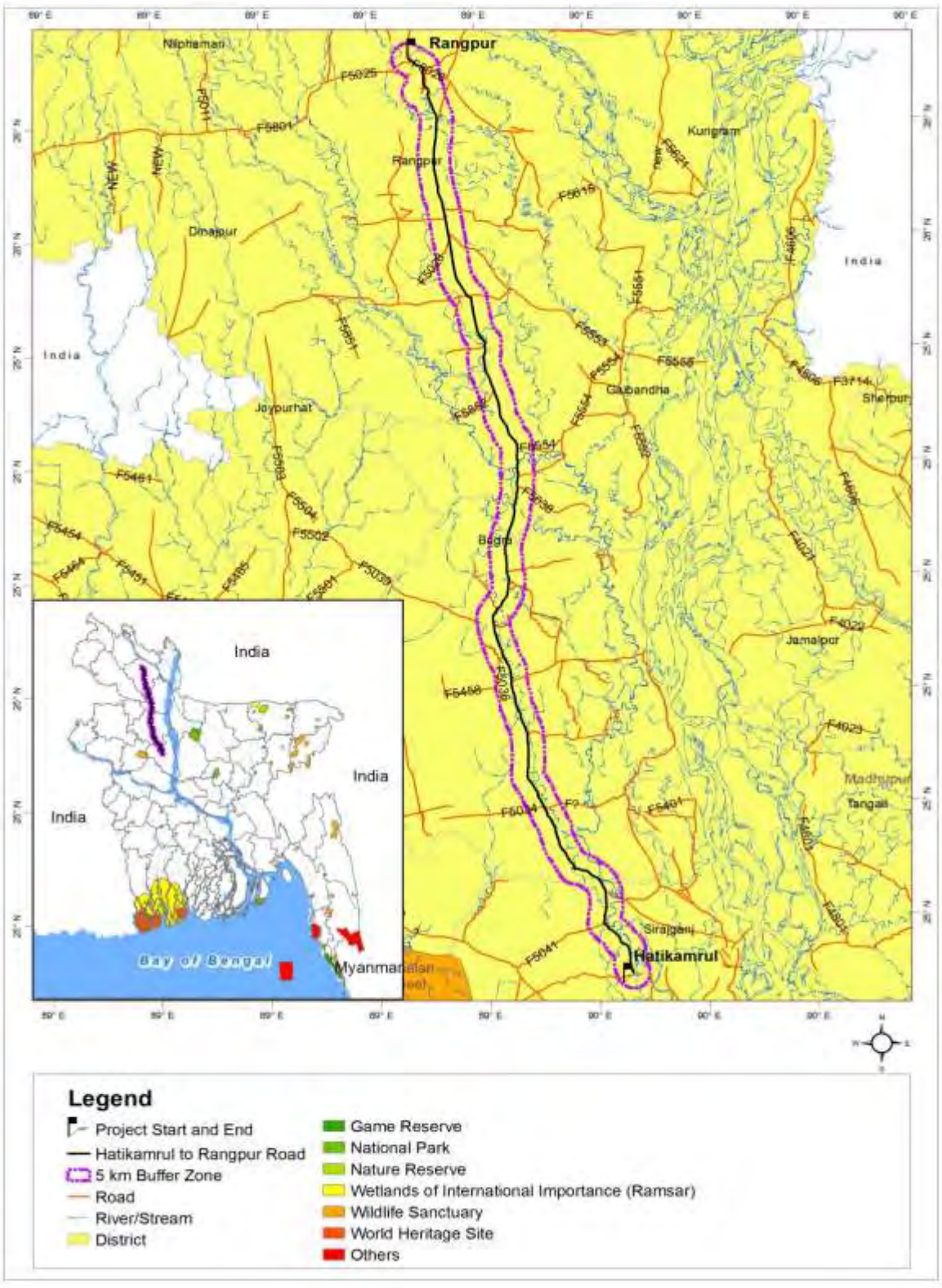


Figure 24: Environmental Protected Areas

D. Socio-Economic Environment

208. 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.

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

210. 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

211. With an estimated 164.4 million inhabitants and an annual population growth rate of 1.4%, Bangladesh is considered to be one of the most densely populated countries in the world (UNFPA, 2010). The details of demographic profile of Hatikamrul-Rangpur area are presented below (Table 27).

212. The road project alignment runs through 4 districts that cover 11 administrative Upazilas (Ullapara, Raiganj, Sherpur, Shajahanpur, Bogra Sadar, Shibganj, Gabindaganj, Palashbari, Pirganj, Mithapukur and Rangpur Sadar).

Table 28: Demographic Status in the Project Area

Upazilas Through	District	Total	Male	Female	Sex Ratio	Population density [sq. km]
Ullapara	Sirajganj	540156	269481	270675	100	1320
Raiganj	Sirajganj	317666	158604	159062	100	1223
Sherpur	Bogra	332825	165527	167298	99	1125
Shajahanpur	Bogra	289804	149458	140346	106	1307
Bogra Sadar	Bogra	555014	288084	266930	108	3143
Shibganj	Bogra	378700	190376	188324	101	1203
Gabindaganj	Gaibandha	514696	255639	259057	99	1118
Palashbari	Gaibandha	244792	120007	124785	96	1321
Pirganj	Rangpur	385499	153524	159795	96	937
Mithapukur	Rangpur	508133	252326	255807	99	985
Rangpur Sadar	Rangpur	718203	366788	351415	104	1998

Source: Population Census, 2011

2. Settlement and Housing Pattern

213. The project is located in densely settlements area. There are many large and small industries and factories situated in the both sides of the RoW. According to the Census and Inventory of Losses (IOL) survey done in March 2015, a total of 7108 entities will be affected by

the project including landowners, structure owners, roadside shops and business owners. Out of these, 1140 households will lose residential structures.

214. Housing condition of the eleven upazilas (Ullapara, Raiganj, Sherpur, Shajahanpur, Bogra Sadar, Shibganj, Gabindaganj, Palashbari, Pirganj, Mithapukur and Rangpur Sadar) of the project is predominantly kutcha, semi pucca and pucca structures. 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, total 700352 m^2 housing/settlement structures of different types will be affected. Details of the affected structures by types along the project road have been given in Table 28.

Table 29: Quantity of Affected Structure along the Project Road

Sl. No.	Category of loss	m^2
1	Pucca (concrete)	276,071
2	Semi Pucca	326,541
3	Tin Made	71,139
4	Katcha (earthen)	20,805
5	Thatched	5,796
Total		700,352

Source: Census and IOL Survey, March 2015

3. Land Use Patterns

164. 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.

165. 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.

166. Land use analysis is carried out along five-kilometre buffer zone from centreline of the Hatikamrul-Rangpur road using optical satellite imageries. Several land use classes were found along Hatikamrul-Rangpur section (Appendix G).

167. The below Table 29 shows the land use category and their area in 200 m buffer zone from the centreline of Hatikamrul-Rangpur road. Agriculture area is in the dominant position along the project road which is 37.73%. A significant portion covers the commercial area which is 8.84%. The residential area covers 34.42% and water bodies covers 4.61% respectively.

Table 30: Land Use Category of Hatikamrul-Rangpur Road Project Area

Category	Area (ha)	Area in %
Agricultural	1188.444	37.73
Residential	1084.286	34.42
Educational	13.470	0.42
Commercial	278.428	8.84

Category	Area (ha)	Area in %
Cantonment	3.617	0.11
Industry	107.081	3.39
Brick Field	45.209	1.43
Playground	10.132	0.32
Road	132.306	4.20
Road Island	1.087	0.03
River	26.612	0.84
Vacant Land	24.793	0.78
Vegetation	88.653	2.81
Water body	145.507	4.61

4. Water Supply and Sanitation

215. Tube well is 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 below Table 30 shows the sanitary facilities in the project area.

Table 31: Sanitary Facilities in the Project Area

Upazila Through	District	Number of Households	Toilet Facility (%)			
			Sanitary (water-sealed)	Sanitary (non-water-sealed)	Non-sanitary	None
Ullapara	Sirajganj	123630	17.1	50.7	29.2	3.0
Raiganj		77104	15.3	46.5	28.8	9.3
Sherpur	Bogra	81639	35.2	36.1	21.8	6.8
Shajahanpur		72323	38.6	33.2	22.6	5.6
Bogra Sadar		129597	45.9	32.0	18.5	3.6
Shibganj		99124	24.1	21.9	30.4	23.6
Gabindaganj	Gaibandha	132402	12.6	17.1	38.3	32.0
Palashbari		63178	12.1	15.9	43.2	28.8
Pirganj	Rangpur	101485	19.0	21.1	33.2	26.7
Mithapukur		134898	8.9	18.4	47.1	25.5
Rangpur Sadar		163052	28.1	31.0	25.3	15.6

Source: Population Census, 2011

216. According to the statistical data mentioned above it can be said that the sanitary facilities are better in the urban areas than the rural areas.

5. Transport and Communication

217. The project areas are connected with national highways, village roads, waterways, and railways in certain locations. The common types of transport 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 Hatikamrul-Rangpur road alignment which connect the adjacent villages to the highway. A list of the crossings are presented in the below Table 31 and Photograph 9 shows a dangerous road crossing.

Photograph 10: Dangerous Road Crossing at Hatikamrul-Rangpur Road

Table 32: List of Crossings along the Alignment

Sl. No.	Chainage	Name of Road	Type of Road
1	1+200	Pacla to Sawlonga Thana	Pucca Road
2	2+560	Kalipur to Kumaspur/Nalka	Katcha Road
3	5+680	Natunpara to Uttar Para	Katcha Road
4	7+640	Doctor para to Madrasha	Katcha Road
5	10+820	Shaidoho to Bhuyiangati	Katcha Road
6	12+020	Lokikhola to Thana Road	Katcha Road
7	14+390	Ganrhat to Dhangora	Pucca Road
8	17+550	Ranirhat to Modrapur	Pucca Road
9	21+150	Garoi to Hasra	Katcha Road
10	28+220	Jolsora to Mirjapur School	Pucca Road
11	33+000	Bazar to Hospital	Pucca Road
12	33+295	Bazar Road to Para Road	Semi Pucca
13	33+460	Bikel Bazar to Nondi Gram	Pucca Road
14	33+660	Bazar to Koli Road	Pucca Road
15	34+300	Khas Para to College	Pucca Road
16	34+485	Thana Road to College	Semi Pucca
17	34+720	Thana Road to Olipur Road	Pucca Road
18	34+860	Thana Road to Hajipur Road	Pucca Road
19	37+305	Pagra to Nondigram Road	Pucca Road
20	40+270	Sonahat Road to Thengamara Road	Pucca Road
21	43+580	Birkustiya Road to Office Road	Pucca Road
22	50+380	Ranirhat to Banani Bazar	Pucca Road
23	54+900	Balail to Malgram	Pucca Road
24	55+410	Village to Town	Pucca Road
25	55+450	Bogra to Shantahar	Rail Crossing
26	55+945	Railgate to College	Pucca Road
27	57+300	Bogra to Joypurhat	Pucca Road
28	58+255	Komira to Upashohor	Pucca Road
29	58+515	Goderpara to Upashohor	Semi Pucca
30	59+390	Bian Bazar to Darom	Pucca Road
31	59+780	Bogra Sadar to Joypurhat	Pucca Road
32	68+260	Village to Shibganj	Pucca Road
33	68+940	Village to Village	Kutcha Road
34	65+810	Village to Village	Katcha Road

Sl. No.	Chainage	Name of Road	Type of Road
35	72+440	Chokpara to Shoilakandi	Katcha Road
36	75+700	Tapagari to Sonatola	Pucca Road
37	78+820	Village to Village	Katcha Road
38	80+600	Ruhobol to Sonatola	Semi Pucca
39	83+880	Mogoltuli to Batgara	Pucca Road
40	85+085	Village to Village	Katcha Road
41	88+140	Purbo Pantha Para to Poschim Panthapara	Katcha Road
42	88+970	Durgapur to Pantha Para	Pucca Road
43	89+220	Govindoganj Upazilla to Ghospara	Pucca Road
44	89+310	Mohimaganj to Bazar	Pucca Road
45	89+430	Mohimaganj to Bazar	Pucca Road
46	89+730	Mohimaganj to Dinajpur	Semi Pucca
47	90+150	Sardarhat to Puraton Bondor	Semi Pucca
48	98+300	Rashedap to Para Road	Semi Pucca
49	99+145	Village to Village	Katcha Road
50	101+350	Doulatpur to Nakihat	Pucca Road
51	104+755	Durgapur to Gorahat	Pucca Road
52	106+235	Gorahat to Village	Pucca Road
53	106+700	Sonagat to Gaibandha	Pucca Road
54	108+300	Asnatpur to Shadullahpur	Semi Pucca
55	112+300	Village to Village	Katcha Road
56	118+580	Talukdar Para to Calsa Para	Semi Pucca
57	124+000	Pirganj to Shanarhat	Pucca Road
58	125+100	Raypur to Shanirhat	Semi Pucca
59	129+950	Vannabari to Ghospur	Pucca Road
60	133+140	Vannabari to Matherganj	Pucca Road
61	134+480	Sukhi Mirzapur to Gaibandha	Semi Pucca
62	134+620	Boromirzapur to Santipur	Semipucca
63	135+490	Boromirzapur to Bowroti	Semi Pucca
64	136+700	Mothurapur to Dargapur	Pucca Road
65	138+520	Dulapur to Dulapur	Pucca Road
66	140+475	Village to Village	Katcha Road
67	144+700	Village to Village	Katcha Road
68	150+750	Payrabondh to Voktipur	Katcha Road
69	151+315	Payrabondh to Panbari	Katcha Road
70	153+650	Village to Cokon Para	Semi Pucca
71	155+340	Model college to Boro Aulia Para	Semi pucca

Source: Baseline Environmental Survey, January, 2014

6. Important Environmental and Social Features

168. 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 32.

169. There are no archaeological and historic sites in the RoW of the Hatikamrul-Rangpur Road project. Among the cultural sites, fifty six mosques, ten madrasah, twenty three eidgah, fourteen graveyards, seven mazar, twenty three school, eight college and five health complex/hospital fall

within the RoW of the road alignment (Table 32). A detail list of the cultural and sensitive areas located within 500 m from the RoW boundary is presented in Appendix E.

Table 33: List of Affected Cultural and Sensitive Structures within the RoW

Name	Chainage	LS/RS	Description
Eidgah	0+880	RS	Boundary wall and some land area will be affected.
Graveyard	1+490	RS	Half of the total area (5 decimal) will be affected.
Mosque	1+510	RS	Half of the tin shed mosque will be affected.
Mosque	3+050	RS	Full building on 6 decimal land will be affected.
Dadpur Girls High School	4+000	RS	The tin shed building of this school will be full affected.
Nurul Ulum Kowme Madrasah	5+880	LS	Tin shed and Semi pucca building. Total land area 25 decimal and 5 decimal will be affected.
Eidgah	8+200	LS	Boundary wall and significant land area will be affected.
Mosque	12+820	LS	1 storied building. Total land area 13 decimal. Half of the total area will be affected.
Chandikona Shahi Jami Mosque	16+300	RS	This is a big one storied building and some part will be affected.
Rabeya Hafezia Madrasah and Mosque	18+140	RS	Tin shed building will be affected.
College Mosque	19+190	LS	Semi pucca mosque. Land area 8 decimal. Affected land area 2 decimal.
Food Village Jami Mosque and Eidgah	19+580	RS	This is big mosque with two storied building which will be full affected due to road widening.
Dankuti Jami Mosque	20+370	LS	Tin Shed Building. Total land area 10 decimal. Total infrastructure is within the RoW.
Dandunti Eidga	20+430	LS	Road side boundary wall and half of the total land will be affected.
Gario Bus Stand Jami Mosque	21+140	LS	One storied Building on 8 decimal land areas which will be full affected.
Gora Govt. Primary School	22+250	LS	Half of one storied building and 10-15% of another building will be affected.
Khadizatul Kobra Mohila Hafizia Kowmi Abashik Madrasah	24+980	LS	10-15% of the tin shed building is within the RoW.
Sonka High School Jami Mosque	25+490	LS	2 Storied Building. Some portion of the building will be affected.
Kazpur Jami Mosque	25+910	LS	Half of the total one storied building will be affected.
Biroil Eidgah	26+420	LS	Roadside boundary wall with 6 decimal land will be affected.
Mirzapur Amraban Madrasah	28+020	RS	Tin shed building will be affected.
Holy Child School	28+770	RS	Half of the tin Shed building will be affected.
Mirzapur Bazar Kendrio Graveyard	29+160	RS	Only boundary wall will be affected.
Eidgah	29+700	LS	Roadside boundary wall with 20 decimal land will be affected.
Graveyard	30+025	LS	One third of the total graveyard (15 decimal) will be affected.
Krishnopur Jami Mosque	30+090	RS	Some portion of the one storied building mosque will be affected.
Krisnopur Jamuna Para Jami Mosque	30+375	LS	Minor portion the tin shed building with some land area will be affected.

Name	Chainage	LS/RS	Description
Sherua Bottola Jami Mosque	31+560	RS	Some portion of the tin shed mosque will be affected.
Baytun Nur Jami Mosque	32+665	LS	Minor portion of the two storied building with some land area will be affected.
Ahale Hadis Sherpur Jami Mosque	33+765	LS	Minor portion of the two storied building with some land area will be affected.
Majibar Rahman Girls Degree College	33+880	RS	There are two building; one tin shed and another one storied pucca building. More than 50% of the total area will be affected of this educational institution due to road widening.
Sherpur Girls Degree College	33+900	RS	There are two building; one tin shed and another one storied pucca building. Only boundary wall will be affected.
Sherpur Technical and B.M. College	33+950	RS	Only boundary wall will be affected.
Upozilla Jami Mosque	33+950	LS	Small portion of the one storied building with some land area will be affected.
Graveyard	34+580	RS	More than 30% of the total area (33 decimal) will be affected due to road widening.
Summit School and College	35+670	RS	This is three storied school building. Only boundary wall will be affected.
Garidaho Jami Mosque	37+290	LS	Minor portion of the semi pucca building with some land area will be affected.
Garidaho Government Primary School	37+460	RS	This is one storied school building and total area is 33 decimal approximately. Full building will be affected because of road widening.
Accademi Bazar Jami Mosque	38+240	LS	Very small portion of the one storied building with some land area will be affected.
Accademi Bazar Jami Eidgha	38+285	LS	30% of the total land area is within the RoW.
Anoroya School	38+560	LS	A significant portion of the tin shed mosque will be affected.
Jamalpur Mazar and Eidgah	39+620	RS	Only eidgah boundary wall will be affected.
Naymail hat Jami Mosque	40+220	LS	This mosque is three storied building on 10 decimal land area. A minor portion of this building will be affected.
Bamoria Jami Mosque	40+450	RS	One storied building will be full affected
Ariya Bazar Primary School	41+980	LS	It is one storied building and some portion will be affected due to road widening.
Aria Rahimabad Government Primary School	42+120	RS	There are two building; one tin shed and another two storied pucca building. Only tin shed building will be affected.
Health Complex	42+190	RS	Half of the total one storied building on 45 decimal land will be affected.
Rahimabad Government Primary School	42+920	RS	Boundary wall and a small portion of one storied building of this school will be affected.
Bogra Ahsania Jami Mosque	43+040	RS	Three storied building on 15 decimal land and will be full affected.
Mohious sunna Ouluin Jami Mosque	45+860	LS	Two storied building mosque will not be affected but some land will be affected.
Mohious sunna Ouluin Jami Madrasah	45+870	LS	The two storied educational structure will be affected due to road widening.

Name	Chainage	LS/RS	Description
Sajapur Nura Alahi Jami Mosque	47+690	LS	One storied building on 20 decimal land will be full affected because of road widening.
Sajapur fooltola Govt. Primary School	49+150	LS	Two storied school building and half of the total building will be affected.
Batgari Government Primary School	49+325	RS	Boundary wall and a significant portion of one storied building of this school will be affected.
Batgari Puraton Jami Mosque	49+360	LS	A small portion of this one storied building will be affected.
Jamia An-Nur Kowmi Cadet Madrasah	49+650	LS	This is four storied educational building on approximately 33 decimal land. A significant portion of this building will be affected due to road widening.
Krishi Somprosaron Jami Mosque	50+430	RS	Almost 50% of the total land 25 decimal) and a portion of the one storied building will be affected.
Open University Bangladesh	51+270	RS	Only boundary wall will be affected.
Fullkoli Kinder Garden School	51+400	RS	Some land is within the RoW but main structure will not be affected.
Fulltola Jami Mosque	52+460	RS	One storied building on 15 decimal will be full affected.
North School and College	52+790	RS	Boundary wall will be affected only.
Graveyard	52+840	RS	This graveyard is on around 33 decimal and half of it will be affected.
Dighipur Eidgah Field	52+990	RS	5 decimal from 20 decimal is within the RoW.
Buytul Mamur Jami Mosque	54+760	LS	This is one storied mosque and will be affected totally.
Soto Balail Paribarik Graveyard	54+800	LS	A family graveyard on 16 decimal land area. Full Affected due to road widening.
Nowda Para Jami Mosque	61+275	RS	Half of the total one storied building on 10 decimal land will be affected.
Thangamara Dokhin Para Jami Mosque	62+620	RS	Half of the total two storied building on 8 decimal land will be affected.
Khatenon Adarsha Junior High School	62+880	RS	This is a two storied school building. Half of the total building is within the RoW due to road extension.
Thangamara Ansar Night College	62+890	RS	Total area of this college is approximately 33 decimal. There is a one storied building and half of it will be affected due to road widening.
Graveyard	63+070	RS	Approximately 4 decimal from 10 decimal land will be affected.
Thangamara Kendrio Jami Mosque	63+150	LS	Half of the total one storied building on 10 decimal land will be affected.
Rafatulla community Hospital	63+160	RS	This is a big hospital. Only boundary wall will be affected.
Hajarot Dewan (R) Mazar	63+200	RS	This is a mausoleum of Muslim spiritual person and will be affected due to road widening.
T.M.S.S Medical College	63+260	RS	This is seven storied building and total area is approximately 66 decimal. Only boundary wall will be affected.
B.C.L Paper Mills	63+300	RS	This is five storied building and total area is approximately 66 decimal. Only boundary wall will be affected.
Graveyard	63+400	RS	This is on 5 decimal land and will be full affected.

Name	Chainage	LS/RS	Description
Bagho Para Danes Uddin School and College	63+650	RS	Only boundary wall will be affected.
Allahma Abu Nashair (Ro) Mazar	64+005	LS	This is a mausoleum of Muslim spiritual person and will be fully affected due to road widening.
Graveyard and Eidgha	64+040	RS	The graveyard and eidgah cover a very big area. However, only boundary wall will be affected.
Bago Para Jami Mosque	65+395	RS	This is one storied building and only front side of it will be affected.
Shah Sufi (R) Mazar	64+400	RS	This is a mausoleum of Muslim spiritual person and will be full affected due to road widening.
Bagho Para Uttar Para Eidgah	64+930	RS	Some land area will be affected.
Graveyard	65+510	RS	Approximately 30% of the total area will be affected.
Graveyard	65+990	RS	Approximately 50% of the total area will be affected.
Gokul Mosque	66+105	RS	The one storied building mosque will be full affected.
Gokul Upo Health Complex	66+205	RS	Only some land area will be affected.
Hajarat Shah Sufi (R) Mazar	66+210	RS	This is a mausoleum of Muslim spiritual person and will be full affected due to road widening.
Gokul Eidgah	66+415	RS	A small portion of the total land area is within the RoW.
Graveyard	69+070	RS	Some land area will be affected.
Dokkhin Chandu Jami Mosque	70+065	RS	A minor portion of this one storied building will be affected.
Eidgah	70+200	RS	A small portion with boundary wall will be affected.
Chondihara Girls School	71+030	RS	A significant land area with boundary wall will be affected of this educational institute.
Eidgah	71+425	RS	Full affected due to road extension.
Chakpara Darul Ulam Madrasha and Primary School	72+405	RS	Only boundary wall of this educational institute will be affected.
Chokir ghat Bazar Mosque	72+615	RS	Full affected due to road extension.
Graveyard	75+540	RS	Full affected due to road extension.
Mokamtala Kendrio Jami Mosque	75+810	RS	10%-15% of this two storied building will be affected.
Mokamtola Joypur Hat Road Jami Mosque	76+200	RS	This tin shed mosque on 10 decimal land will be full affected due to road widening.
Munshi Para Jami Mosque	77+390	RS	This is a tin shed mosque on 5 decimal land. Half of the total area will be affected.
Varia Matree Maya Kinder Garden School	78+060	RS	Tin shed school on 10 decimal land. Only boundary wall will be affected.
64 No. Varia Govt. Primary and High School	78+870	RS	This school has one tin shed and another one storied pucca building. Half of the tin shed building will be affected.
Rohobal Kendrio Bazar Jami Mosque	20+505	RS	Half of the total area (20 decimal) with two storied building will be affected.
Rohubul Eidgah	80+560	RS	Half of the total area (10 decimal) will be affected.
Rahobul Community Clinic	80+865	RS	The one storied building medical centre will be full affected.
Fashitola Jami Mosque	84+595	RS	Two storied building mosque will be full affected.
Nuramodina Hafijia Madrasha and Mosque	85+020	RS	Only boundary wall will be affected.

Name	Chainage	LS/RS	Description
Bokchor Para Jami Mosque	86+700	RS	Small portion of this one storied building is within the RoW.
Bokchor Poschim Para Eidgah	87+835	RS	A significant land area with boundary wall will be affected.
Eden K.G School	88+670	RS	This educational institution will be full affected because of road widening.
Dhokhin Bus Stand Jami Mosque	88+820	RS	The two storied building mosque on 15 decimal area will be full affected.
Knowledge of Holi Child School	90+200	RS	Tin shed school building on 10 decimal which will be full affected.
Gobindo Pouro Model School	90+450	RS	This is a tin shed school on 28 decimal which will be affected with minor portion. However, a significant land is within the RoW due to road widening.
Graveyard	90+840	RS	Full affected due to road extension.
Pekosh Chokkhu Hospital	91+110	RS	This eye hospital is one storied building and will be affected.
Katakhali Baluahat Jami Mosque	94+620	RS	This is two storied building on 8 decimal land. Half of the total area with infrastructure will be affected.
Coksingho Dangga Jami Mosque	97+240	RS	Tin shed mosque on 6 decimal area is within the RoW.
Chatel Jami Mosque	104+850	RS	Tin shed building on 5 decimal which will be full affected.
Mohamadia Jami Mosque and Madrasah	107+600	RS	There are one storied pucca and tin shed infrastructure in 20 decimal land. Approximately half of the total area is within the RoW because of road widening. Only tin shed will be affected.
Matherpur Eidgah	115+445	RS	Half of the total land will be affected.
Matherpur Jami Mosque	115+450	RS	Half of the total tin shed infrastructure on 7decimal land will be affected.
Naibia Kendrio Mosque	116+200	RS	Tin shed building on 6 decimal which will be full affected.
Graveyard	117+025	RS	A family graveyard will be full affected due to road extension.
Khedmodpur Jami Mosque	118+270	RS	Two storied building on 8 decimal which will be full affected.
Gaga Shimultala Mosque	118+508	RS	Approximately 80% of the total tin shed building will be affected.
Lal Dighi Bazar Jami Mosque	126+010	RS	Only a minor portion of the total land is within the RoW.
Sukenchoki Jami Mosque and Madrasah and Eidgah	127+450	RS	Only a minor portion of the total land is within the RoW.
Bro drowga Mazar Jami Mosque	133+160	RS	Some portion of the one storied building will be affected
Boro Dorgha Govt. Primary School	133+240	RS	Some portion of the one storied building will be affected.
Eidgah	134+380	RS	A significant portion of the total land is within the RoW.
Mithapukur Kendrio Eidgah	139+960	RS	Only front side boundary wall will be affected.
Adarshapara Jami Mosque	141+210	RS	This tin shed mosque will be affected due to road widening.
Fatapur Kendrio Eidgah	144+630	RS	Only front side boundary wall will be affected.
Jaigirhat Kendrio Eidgah	145+520	RS	Boundary wall with some land will be affected.

Name	Chainage	LS/RS	Description
Jami Mosque	147+900	RS	One storied building on 5 decimal land will be full affected.
Taragonj Mazar	151+915	RS	This is a mausoleum of Muslim spiritual person and only minor land will be affected.
Sorderpara Eidgah	153+640	RS	Some portion of the total land will be affected.
Boro Auliar Mazar	155+300	RS	This is a mausoleum of Muslim spiritual person and will be fully affected due to road widening.

Source: Baseline Environmental Survey, January, 2014

VII. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. General

218. 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 impact 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.

219. 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.

220. 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.

221. During the field observation and data collection, consultations were also held with people in the locality including those presently living in the project areas, NGOs and Government authorities. Outcome of these consultations were used in impact assessment and devising mitigation measures.

B. Project Corridor

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

C. Project Right of Way (RoW)

223. The proposed project corridor will have a well-defined RoW that will be approximately 50 meters 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.

D. Corridor of Impact (CoI)

224. The corridor of the proposed Impact (CoI) 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 CoI of the surface water bodies will be confined within the RoW of the proposed project and will be temporary only for the construction period.

225. According to the Department of Environment (DoE) guideline 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 5 km as buffer zone for better understanding.

E. Evaluation of Significant Impacts

226. 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 irremediably 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 / Scope	Short-lived	Temporary	Permanent
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

227. The potential impacts due to implementation of the Hatikamrul-Rangpur 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 Hatikamrul-Rangpur 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.

228. 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.

229. As can be observed from the checklist in Table 33, 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 34: 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	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	

F. Pre -construction Phase

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

1. Topography

231. **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.

232. **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 bit 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

233. **Impact.** The project implementation activities, at different locations, will invariably involve trees and vegetation to be removed for the upgrade, widening and geometric improvement of the project road. Implementation of the project particularly during the construction stage will require removal of trees numbering 105339 of different species, types (fruit, timber, medicinal) and sizes (large, medium, small, saplings) along the project alignment. In most of the affected trees occur on homesteads, private waste/marginal lands; agricultural lands as well as on road sides. Of the affected trees 10644 are large, 25019 are medium size, and 48493 are small size, while some 21183 are saplings. Excluding the above stated number (105339) of affected trees 37785 banana trees and 39731 bamboos will be affected being located within ROW. Appendix F shows the different types of trees and their respective number within the ROW. In addition, many social forestry trees are likely to be cut. Trees are of timber value, fruit bearing and medicinal in nature.

234. **Mitigation.** All efforts will be made to minimize the tree cutting by selecting road-widening option based on technical consideration. Public and NGOs will be consulted before cutting of the old trees if its felling is absolutely unavoidable due to technical consideration. 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.

235. 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 at with tree owners before cutting the social trees. These trees will be planted primarily along the road within the RoW. The social forestry can be planted

on the area allocated by local authorities. A total of 215000 saplings will be planted. Permission from the Forest Department will be sought for cutting trees from the roadside or along the water courses if these fall within the RoW. Planting will be done as soon as the construction of the road is completed. Maintenance is the key to the establishment of the plantation and therefore regular monitoring of plantation will be carried out by the executing agency.

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

237. 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

238. **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 effected 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 total 184.43 ha (68.65 ha in Sirajganj, 41.89 ha in Bogra, 54.33 ha in Gaibandha, 19.56 ha in Rangpur) of which 39% are crop lands, 26% are commercial lands, 17% are homestead lands, 11% are vita/highlands, 2.63 % are ponds, 1.11% are wetlands and 1.11% fallow lands.

239. This impact would be permanent and major negative in nature and the mitigation measures will involve careful alignment and route selection by the designer to minimize the impact.

240. 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 be affected adversely.

241. **Mitigation.** 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 is kept to confine the embankment with 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)

242. **Impact.** To implement the Hatikamrul-Rangpur road way, 700352 m^2 dwelling structures will have to be acquired and resettled from the project 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 (details in Resettlement Plan).

243. **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

244. **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 Appendix E).

245. **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

246. **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.

247. **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. water pipes, 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.

G. Construction Phase

248. 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

249. **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. On all the rivers, bridge already exists and new bridge shall be constructed at the same locations.

250. 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.

251. 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. As noted above, bridges currently cross the Karatoya and Ghaghat Rivers and 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. Runoff 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 CoI of the surface water bodies will be confined within the RoW of the project, and it will be minor and temporary in nature.

252. **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 reuse.

2. Drainage Congestion

253. **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.

254. **Mitigation.** Construction shall be so planned that there is no drainage congestion. Wastes should not be disposed near any water body. All waste depending on its characteristics, should be disposed off 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.

3. Soil Erosion and Siltation

255. **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. Slope though is predominant factor amongst these. The existing roads have an average slope of about 1% with alluvial loam soils, which is not prone to soil erosion with reasonable vegetation cover. During construction phase, some trees, shrubs, grasses and will need to be cleared and existing road pavement will need to be removed. This may create localised soil erosion problems during the rains.

256. The slope of 1:2 is proposed for the project road, which is the desired slope internationally. The proposed RoW is sufficient to construct road with this slope level and as such, soil erosion potential is minimal at large. The potential risk of river 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 river. 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.

257. **Mitigation.** The following mitigation measures are proposed to alleviate or avoid the impacts:

- Adopt good engineering and 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

258. **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.

259. 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 agriculture. 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.

260. **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 dispose of in the properly delineated places. The compacted land is restored for agricultural use.

261. 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 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

262. **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.

263. **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

264. **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.

265. 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, i.e. coughing, flue, difficulty in inhaling, irritation in eyes and reduction in visibility. This impact is temporary and major negative in nature.

266. **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 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 and Vibration

267. **Impact.** During construction, noise is likely to be generated form site clearing, excavation, concrete mixing, crushers, piling in bridge construction. The general noise levels during construction phase such as due to working of heavy earth moving equipment and machineries installation may sometimes go up to 100 dB(A) or more at the work sites[12]. Under the worst case scenario, it is 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 the noise level 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.

268. 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.

269. **Mitigation.** All mitigation measures mentioned below should be taken in order to minimize the impacts of noise in the project area. These measures include, but are not limited to the following:

[12] 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 (contruction material & plant & 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).

- 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

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

271. 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.

272. **Mitigation.** The mitigation measures include:

- The construction camps and workshops shall not be located in sensitive areas and shall not be within 500 meters 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 hoardings;
- Water and good sanitation facilities should be provided for the camps.
- Solid waste and sewage shall be managed according to the national regulations. As a rule 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

273. **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.

274. **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

275. **Impact.** There are large number of ponds and borrow pits currently being used for fishing, are likely to be affected. Most of these ponds are seasonal in nature and go dry during dry season. Most of these ponds are used for unorganised fishing. 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.

276. The project road crosses several important water bodies/river. Most of the water bodies are seasonal in nature. Major bridges are proposed on river and large water reservoirs. Dredging and piling activities may have localised impact in terms increase TSS level in river water. Since this will be a temporary phenomenon, no significant adverse impact is anticipated during this phase.

277. 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 into the water bodies may greatly pollute them. Disposal of sewage and wastes from the construction camps to surface water bodies without treatment will deteriorate the water quality. The seasonal beels 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 natives that use this water for meeting domestic requirement. The impact on these water bodies will be only for the period of construction and will vanish as the construction work is over.

278. **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.

279. 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 in the vicinity of the sites.

280. 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

281. **Impact.** Increased demand of 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 waters 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.

282. **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. Waste Pollution

283. **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, health risk to work force and general public at the camp site.

284. 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.

285. **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 up-gradation of road.

13. Dredging and Dredged Materials

286. **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.

287. **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

288. **Impact.** There would be no major impact on flora except cutting of trees during project intervention in both the project area. There is no protected forest, reserved forest or sanctuary etc. present in these areas. About 105339 different species trees in Hatikamrul-Rangpur road section are located along the road alignment and may be affected due to the project. Of the affected trees 10644 are large, 25019 are medium size, and 48493 are small size, while some 21183 are sapling plants. In addition, 37785 banana, 39731 bamboos and many social forestry trees are likely to be cut. Trees are of timber value, fruit bearing and medicinal in nature.

289. Establishment of contractor's camps and warehouses for storage of equipment, material etc. shall involve clearing of vegetation from the area causing a 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 the 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.

290. **Mitigation.** Mitigation measures will include:

- All efforts shall be made to minimize the tree cutting by selecting road-widening option based on technical consideration. Public and NGOs shall be taken into confidence before cutting of the old trees if its felling is absolutely unavoidable due to technical consideration. 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.
- According to Forest Department's recommendation, the tree shall be planted at the ratio of 1:2. This ratio may be more in case of social forestry tree as per mutual understanding arrived with tree owner before cutting the social tree. 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 beautify the landscape. Planting would however be done keeping in view the principles of landscape designing;
- 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 directed not to damage any vegetation such as trees or bushes. They will use the 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 of movement.
- 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 required to be cut on account of their coming in the RoW of road must be paid to farmers/owners in accordance with market rates.

15. Wildlife

291. **Impact.** There are no endemic wild animal within the project area. The project will pose minor negative impact on the fauna present in the project area. There is no presence of any game reserve or wild life sanctuary along the project alignment, therefore no negative impact will happen. There is no direct disturbance is expected to wild animals.

292. **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.
- New and good condition machinery with minimum noise will be used in construction;
- Noisy work will not be carried out in night time so that there should be no disturbance to local birds and animals;
- Contractor will ensure that the no hunting, trapping of animal will be carried out during construction; and
- Borrow pits will be fenced so that no animal can fell into these.

16. Fisheries

293. **Impact.** There would be loss of fish productivity in the pond fishery, borrow pit fishery due to filling of the 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 Hatikamrul-Rangpur road Section (in Karatoya and Fuljor). Migration is more prominent between June to 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.

294. **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 in during the high flood when water depth is usually maximum 6m. Further, it is recommended that construction along the riverbanks must be avoided during the fish breeding season (July to September).

17. Land Use

295. **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 tree around these areas may get affected adversely.

296. 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.

297. **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:

298. 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.

299. 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 30 cm 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 500 m away from the road;
- In case of settlements, borrow pits shall not be selected within a distance 800 m from towns or villages. If unavoidable, earth excavation shall not exceed 30 cm 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

300. **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.

301. **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

302. **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 impact 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 Appendix E) due to construction activities.

303. **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

304. **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.

305. 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.

306. **Mitigation.** In order to minimize the income loss, contractors as far as practicable will recruit construction workers from amongst the locals where possible, and shall maintain gender equity while employing the locals. Priority shall always be given to people from amongst 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.

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

21. Occupational Health and Safety

a) Occupational Health and Safety of Workers

308. **Impact.** Health risks and workers safety problems may result at the workplace if the working conditions provide 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 dust, exhaust from vehicles and noise levels. Workers are often required to work irregular working hours resulting in fatigue and increased risk of accidents. Workers will be provided with safe and healthy working environment taking into account risks inherent to the particular sector and specific classes of hazards in project area.

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

- Obligatory insurance against accidents 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;
- Protection 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 facilities including light up to satisfaction;
- Provision of protective clothing for labourers handling hazardous materials, e.g. helmet, adequate footwear for bituminous pavement works, protective goggles, gloves etc.;
- Adequate signage, lightning devices, barriers, yellow tape and persons with flags during construction to manage traffic at construction sites, haulage and access roads;

Occupational Health and Safety of Community

310. **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 the construction activities, oil spillage and leakage, roadside accidents etc. The labour works with different transmittable diseases may cause spread out of those diseases in the local residents. The borrow pit areas located near the residential, settlements, may cause accident for the people moving near to those areas.

311. **Mitigation.** Mitigation measures will include:

- There should be proper control on construction activities and oil spillage leakage of vehicles.
- The labour works with different transmittable diseases should be restricted within the construction site.
- Efforts will be made to create awareness about road safety among the drivers operating construction vehicles;
- Close consultation with local communities to identify optimal solutions for diversions to maintain community integrity and social links;
- Provision of proper safety and diversion signage, 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
- Bridges and other structures have to be structurally stable enough to bear maximum ground acceleration recorded for the area in past.
- Use of water should not disturb public water availability. Source of water should be selected carefully.

22. Impacts due to Bridge Construction

312. The Hatikamrul-Rangpur road alignment will necessitate construction of two major bridges longer than 100 m at different locations along the road. These are at chainage 7+984 over a large water bodies at Sirajganj and 93+851 over the Karatoya River at Gaibandha. However, these bridges are within the same activities of Hatikamrul-Rangpur road construction thus there is no separate environmental impact assessment for these bridges. But detailed 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 these bridges constructions. Since construction of such bridges will involve earthwork, piling, concrete structures across rivers and over both the river-banks, river-training, 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

313. 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 be local and will last during construction only. The Rivers along the road alignment are unchartered navigation channel which must be kept clear for the movement of country cargo vessels, passenger steamers, barges, engine boats, small fishing vessels.

314. Therefore, RHD will instruct the contractor to implement the following mitigative measures during the major bridges constructions:

- Ensure that channel width at the crossing point will not be narrowed and corrective actions to mitigate the existing erosion problems will be addressed, through careful design of shore erosion prevention structures and the sizing of all structures to pass the 100-year ‘design storm’.
- Provide slope protection measures to the portion of the road alignment that will be in contact with the river channel.
- Design proper river bank protection measures at the upstream and downstream sides of the bridge crossings such that they do not narrow the channel.
- Monitor and manage river traffic to ensure that there is no obstruction of local country vessel traffic.

24. Erosion and Drainage

315. With the project area, being low elevation flood plain, erosion is not the major concern but drainage is. Nevertheless, at some locations near the bridge crossings, the banks of the major Rivers are steep and minor erosion prone. 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

316. Spillage of fuel, solvents, lubricants and paint by leakage of tanks or careless handling of disposal 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. Use of drilling mud other than that derived from the river itself, e.g., bentonite leasing to water quality degradation. If bentonite is used, a recover protocol must be in place and the contractor must demonstrate this by showing the balance between bentonite used and recovered in a daily ledger that can be checked by the Engineer at any time. Handling and storage of potential contaminants will be organized under strict conditions and preventive measures to avoid contamination during construction of the bridge. Additionally, the bridge construction activity will increase the Total Suspended Solids (TSS) level at the downstream of the construction site which will temporarily and locally. To avoid the impact; the contractor should carry out the activities during dry season when water level is lower and have to avoid the breeding and spawning period.

26. Vibration and Pile Driving Noise

317. 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 below the 70 dBA level and at the river crossing will not be relevant since the site will be in less inhabited areas. Construction work such as pile driving and operation of batch plants near the river will have a marginal impact and will contribute to the increases in noise levels within 50 m of the construction site, which will be in rural, less inhabited area.

27. Fisheries

318. 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.

319. The construct contract specifications and EMP place high emphasis on the proper environmental management and 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 these are not expected to be present in large quantities.

320. With the exception of Bridge over the Karatoya 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 sediment, but the levels are not expected to be high compared with the natural sediment load in that river.

28. River Transport

321. The use of construction and dredging barges has the potential to cause some disruption to river traffic on the rivers. 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. The following specific measures should be taken to avoid impact on river traffic due to bridge construction:

- Keep adequate space for passing the country vessels with marking the route
- Provide navigational lighting for the barges and associated vessels
- Provide appropriate lighting to all floating pipelines and buoys
- Check all navigational lights routinely to ensure that they are working properly.

H. Operation Phase

322. 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. In order 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, in order 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

323. **Impact.** No soil erosion is anticipated during the operation phase except in the situation 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 and also 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.

324. **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 the locomotives.
- Depending on the nature and magnitude of spill, appropriate land remediation measures shall be employed by the concerned authorities.

2. Noise and Vibration

325. **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 600 m 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.

326. **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

327. **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 PM_{10} pollution levels above the national/international standards, which may result in causing public health risks, nuisance and other impacts on bio-physical environment.

328. These conditions will result in the rise of vehicular emissions (CO, NOx, SOx, PM_{10}) 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.

329. **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

330. **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.

331. 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 along proposed new bypasses. This will exert stress on the availability of groundwater in the project area.

332. **Mitigation.** The following mitigation measures are proposed to attenuate 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

333. **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.

334. **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

335. **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.

336. **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

337. **Impact.** Fisheries resources will be affected due to the damage of 87 ponds, 285 ditches and disturbance to fisheries species during construction of bridge and culvert over rivers and canals to build the Hatikamrul-Rangpur 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.

338. **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

339. **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.

340. **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

341. **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.

342. **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.

10. Evaluation of Significant Impacts

343. The potential impacts due to implementation of the Hatikamrul-Rangpur 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 Hatikamrul-Rangpur 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.

344. 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

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

346. As can be observed from the checklist in Table 34, 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 35: 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	Medium	Medium term
	Land Acquisition	Adverse, Direct	Localized, Low	Short term
	Loss of Structure	Adverse, Direct	Medium	Short 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
	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, Low	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 and Safety	Adverse, Direct	Minor, Reversible	Short term
Operation Phase	Soil Erosion and Quality	Adverse, Direct	Localized, Low	Short term
	Flora	Positive, Direct	Localized	Long term
	Noise	Adverse/Positive, Direct	Localized	Persistent
	Air	Adverse/Positive, Direct	Localized	Persistent
	Water Quality	Adverse/Positive, Direct	Minor, Reversible	Persistent
	Landuse	Positive, Direct	Moderate	Long term
	Wild Life	Positive, Direct	Moderate	Long term

Project Phases	Activity Important Environmental Components	Types of Impact	Significance of Impact	Duration of Impact
	Fisheries	Adverse/Positive, Indirect	Moderate, Reversible	Medium term
	Cultural Sites	Adverse/Positive, Indirect	Localized	Persistent
	Road Safety	Adverse/Positive, Indirect	Localized, Reversible	Long term

VIII. CLIMATE CHANGE ASSESSMENT

A. Greenhouse Gas Emission

347. GHG emission 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 Asia[14], the Institute for Transportation and Development Policy and with funding from ADB. TEEMP is an excel based tool to assess the equivalent CO_2 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 CO_2 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 NOx.

348. Few assumptions were made in this software:

i. Fuel efficiency as reckoned in business as usual (BAU) and with project scenario (WPS) is given in Table 35. It is assumed that the fuel efficiency of the vehicles would increase due to improvement of the roads.

ii. 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 36). Pre Euro vehicles are assumed to be completely discarded for vehicle categories except for 3 wheelers.

Table 36: 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	

Table 37: 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%

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

[14] A 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.

Vehicle Type	Current Scenario				Post 20 Years		
	Pre-Euro	Euro I	Euro II	Euro III	Euro I	Euro II	Euro III
Bus		10%	20%	70%	10%	20%	70%
2-axle		10%	20%	70%	10%	20%	70%

349. 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).

350. Traffic forecasts were taken from Detailed Project Report and is shown in Table 37. The corresponding growth rates for different vehicle types are indicated in Table 38.

Table 38. Annual Average Daily Traffic (AADT) for Hatikamrul-Rangpur Road

Section[15]	Vehicle Type	2017	2020	2025	2030	2036
1	2-Wheelers	867	1,055	1,464	2,032	3,010
	3-Wheelers	415	506	701	973	1,442
	Car	445	542	752	1,043	1,546
	Multi-axle	638	777	1,078	1,496	2,217
	Bus	4,782	5,821	8,077	11,207	16,602
	2-axle	7,929	9,651	13,391	18,580	27,526
2	2-Wheelers	3,337	4,061	5,635	7,819	11,583
	3-Wheelers	1,232	1,500	2,081	2,887	4,278
	Car	442	538	747	1,036	1,535
	Multi-axle	630	767	1,064	1,476	2,187
	Bus	3,557	4,329	6,006	8,334	12,347
	2-axle	6,054	7,369	10,224	14,186	21,017
3	2-Wheelers	5,081	6,185	8,581	11,907	17,640
	3-Wheelers	867	1,055	1,464	2,032	3,010
	Car	553	673	934	1,296	1,920
	Multi-axle	649	790	1,096	1,521	2,254
	Bus	2,929	3,565	4,946	6,863	10,167
	2-axle	4,348	5,292	7,343	10,188	15,094

Table 39: 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%

[15] Section 1 – Hatikamrul – Bhuyangati; Section 2 – Between Kashipur (Mokamtola) – Gabindaganj, Pakurtala (km 243.512); Section 3 – N5-51, Between Mithapukur – Rangpur Modern More, Pairabond (km 316.022)

351. Input parameters as considered for all the project roads are as given in Table 39. 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 40: Input Parameters for TEEMP

No.	Particular	BAU	WPS
1	Lane width (m)	3.5	3.65
2	Lane length (km)		
	Section 1	66.6	66.6
	Section 2	70.5	70.5
	Section 3	19.8	19.8
3	Number of lanes	2	4
4	Roughness (m/km)	6	2.5
5	Induced Traffic		0.2
6	Start of Assessment Year	3	3

352. 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 40.

Table 41: 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

353. It was assumed that 2-wheelers average 5 km and 3-wheelers average 10 km for Sections 1 and 2, and 3 km for both 2 and 3-wheelers for Section 3. All other types of vehicles were assumed to cover the whole road segment. Furthermore, 2-wheelers and 3-wheelers constitute 90% each of the total local traffic, whereas car, multi-axles, bus and 2-axles constitute 40% respectively of the total local traffic.

354. 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 CO_2/km of road construction.

355. The proposed road widening and upgrading resulting to surface roughness and road capacity improvements have implications in CO_2 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.

356. The project road section-wise CO_2 emission intensity is provided in Table 41. The design life of the road is 20 years. Total CO_2 emission at business-as-usual, project without induced traffic, and project with induced traffic were estimated as 22,862,356 tons, 10,627,776 tons, and 13,559,956 tons, respectively. CO_2 emission from construction phase was estimated at 1,726 tons.

357. Emissions from PM and NOx were likewise shown in Table 41. 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 42: 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	22,862,356	10,627,776	13,559,956
	PM	2,205	2,396	2,851
	NOx	76,812	83,504	99,342
Output Intensity (tons/year)	CO_2	1,143,117.78	531,475.11	678,084.07
	PM	110.25	119.81	142.53
	NOx	3,840.62	4,175.22	4,967.08

358. In terms of intensity, total CO_2 emissions at business-as-usual, with-project (without induced traffic) and with project (with induced traffic) scenarios were estimated at 1,143,117.78 tons/year, 531,475.11 tons/year and 678,084.07 tons/year, respectively. These values are significantly above the 100,000 tons CO_2e/year threshold[16] 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 Change Risks and Vulnerabilities

359. The Bangladesh Climate Change Strategy Action Plan[17] (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.

360. 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

[16]Page 38, Appendix I, footnote 10 of SPS 2009

[17] A publication by Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, Sep. 2009; http://www.climatechangecell.org.bd/Documents/climate_change_strategy 2009.pdf

river flow during dry periods; and (6) sea level rise and increased salinity intrusion.[18] Similarly a working paper[19] 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".

361. **Precipitation.** Although various literature sources have differing projections on precipitation, yet all agree to an increased intensity and frequency. Spatial pattern of average annual rainfall shows that rainfall is significantly increasing in all regions of Bangladesh. Trend analysis of wet and dry months in Bangladesh show that the number of wet months is increasing and the number of dry months is decreasing in most parts of the country. Heavy rainfall days (>200mm/day) in Bangladesh have increased significantly by an amount of 1.2 days/decade. This leads to say that the increased severe monsoon wet months can trigger more rain related flooding throughout Bangladesh.

362. **River Water Level and Flooding.** The frequency of abnormal floods in Bangladesh has increased substantially in the past decade. By the trend in flood events in last fifty-five years in Bangladesh, it has been indicated that flood severity and frequency has increased in the spatial as well as depth of inundation in Bangladesh.

363. **Temperature.** 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. 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 (Shahid 2010d).

364. **Tropical Cyclones.** In the past century (1901–2000), the rate of tropical storms striking the Bangladesh coast was one storm per year. Since 1950, the rate of land falling tropical storms has increased by 1.18 per year. A hydrodynamic model predicts more intensified surge heights at the coasts of Bangladesh due to climate change. They also predicted that flooded area, flooding depth and surge intrusion length will be substantially larger under intensified surge conditions.

365. **Sea Level Rise.** 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 (where the lower bound corresponds to the lower estimate for the lowest emissions scenario, and the higher bound corresponds to the upper estimate for the highest scenario).

366. **Salinity in River Water.** A study on changes in salinity of coastal rivers between 1967 and 1997 by the Soil Resources Development Institute (SRDI, 1998) shows that salinity in some parts of the coastal region of Bangladesh has increased by 124% in the last 30 years. One of the major impacts of sea level rise on water resources will be the reduction of fresh water availability by salinity intrusion. It is reported that the reduction in rainfall and low river flow during the dry season may aggravate the salinity levels in the coastal rivers of Bangladesh.

[18] Vulnerability of the power sector of Bangladesh to climate change and extreme weather events; Regional Environmental Change, 12(3): 595-606, Shahid, S. (2012)
[19] http://climatechange.worldbank.org

C. Climate Change Adaptation Measures

367. **Design Flood Level.** As a structural measures, to counter the increase in flood levels due to the effects of climate change, the design flood level incorporates an adaptation allowance of 0.37 m above limits generated by general engineering considerations.

368. **Road Embankment.** The design of the road embankment of the Hatikamrul – Rangpur road project has taken into consideration an additional 102.4 cm increase from the existing road surface. This corresponds to a freeboard of 0.9 to 1.0 m (depending on the road stretches) above the existing road surface and is consistent with the 2011 hydrological study, where an extreme value analysis HFL plot for a 50-year flood frequency was estimated to be about 0.85 m above the 20-year HFL.

369. **Bridge Design.** As an adaptation measure recommended by the EIA reports, the design of bridges in the project area advocates a 37 cm increase from existing HFL in line with the envisaged increase in flood level under a changed future climate. The climate change adaptation concept for bridges in the project area thus 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).

370. **Drainage Capacity Design.** 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.

371. **Construction Materials Policy Adaptation.** The Government of Bangladesh has recently adopted a policy to encourage construction of roadway embankments with river sand rather than clayey agricultural soil. River sand is a good fill material with higher California Bearing Ratio (CBR) value. The EIA reports point that river sand 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. The design of embankments for new carriageways on these sub-projects have based on the use of river sand with a CBR value estimated as 10% or greater than clayey agricultural soil.

372. **Adaptation to High Temperature.** 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. 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.

D. Climate Change Adaptation Costs for Hatikamrul – Rangpur Road

373. 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 $45.9 million was allocated for engineering measures as climate change adaptation costs. These cover increase in road embankment height by 37 cm for 157 km length of the Elenga-Hatikamrul road; increase in bridge height by 37 cm for 17 bridges with a total length 1,113 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.

IX. ENVIRONMENTAL MANAGEMENT PLAN

A. General

374. This section describes an Environmental Management Plan (EMP) for the Hatikamrul-Rangpur road project. It aims to provide environmental management guidance by delineating compliance requirements, accountabilities and performance objectives, and contains practical recommendations to reduce the potential environmental impacts which may occur as a result of the project activities. Since, HR road project is comprised of development of existing 156+900 km road which has both positive and negative environmental impacts at the pre-construction, construction and operational period. Potential negative impacts of the project as per the Environmental Impact Assessment (EIA) ratings are classified as insignificant, moderate and significant; localized or widespread and temporary or persistent. It is, therefore, necessary to manage the environmental issues timely with proper manner with the help of Environmental Management Plan (EMP) in compliance with the ADB safeguard policy statement 2009 and Department of Environment (DoE) environmental guidelines. The purpose of this EMP is to protect the environmental values of the project areas by facilitating mitigation measures and management plan of potential adverse impacts arising from the project implementation.

B. Objective of EMP

375. The EMP is necessary on the grounds that it will manage the environment by off-setting the negative impacts with possible mitigation measures and enhancing the positive impacts within the allocated fund from the project. Thus, the main objectives of the EMP for the construction of the Hatikamrul-Rangpur road project are:

(i) Define the responsibilities of the project proponents in accordance with the three project phases (design, 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 of 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) Providing a cost estimate for all proposed EMP actions.

C. Environmental Management Plan (EMP)

376. On the basis of identification of the environmental impacts and recommended mitigation measures linked with the Hatikamrul-Rangpur 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 and 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**.**

Table 43: Environmental Management Plan for Hatikamrul-Rangpur Road

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
DESIGN/PRE-CONSTRUCTION STAGE								
P01EMP	Topography	▪ Change in topography due to construction-related structures such as bridges, embankments, etc.; and ▪ Visual changes to topography.	Provision for tree plantation in the design (see Appendix G for tree plantation plan).	Transport route and worksite cleared of any dust/mud	Compliance with National guideline for land use policy.	Throughout the project areas	Design Consultants (DC)	RHD
P02EMP	Removal of Trees	Cutting of 105339 trees of different species.	▪ Minimize the tree cutting by selecting road widening option based on technical and tree laws consideration. ▪ Trees should not be cut prior the permission from Forest Department. ▪ Afforestation shall be done at the ratio of 1:2 ▪ A total of 215000 sapling trees will be planted (see Appendix G for tree plantation plan). ▪ For social forestry afforestation ratio shall	• No of tree felled; • No. of afforested seedlings; • No. of indigenous tree species planted; • Compensatory plantation site identified	Compliance with guidelines on tree cutting and afforestation from the Forest Department	Throughout the project areas	DC	RHD

[20] P- Pre-construction; C – Construction; O - Operation

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
			be as per the consultation with tree owner. ▪ Raised Median will be planted with grasses and shrubs which may not attain height more than two meters. This planting could provide an effective protection against night glare besides beautifying the area; ▪ The compact plantation will be done on both sides; ▪ The indigenous trees most suited to the tract will be planted; ▪ If a tree of rare species is growing within the ROW and is required to be removed, it will not be felled but uprooted and transplanted in close consultation with the Forest Department; ▪ An awareness campaign targeted on the neighbourhood farmers will be carried to popularize the planting of trees, and saplings should be					

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
			provided on subsidized costs					
P03EMP	Land Acquisition	▪ Loss of 184.43 hectares of land of different types; ▪ Resettlement of Affected Persons (APs).	▪ All efforts shall be made in finalization of alignment to reduce productive land requirement ▪ Careful alignment and route selection by the designer to minimize resettlement; ▪ Developing proper judicious compensation package for affected persons; ▪ Prior to site works, payment of fair compensation to affected people based on the Land Acquisition and Resettlement Plan shall be made.	• Land substitution • Cash compensation of properties acquired.	Compliance with Resettlement Plan	Throughout the project areas	RHD/DC	RHD
P04EMP	Loss of Structures (Dwellings, Commercial Buildings and Industrial Structures)	▪ A few numbers of homesteads have to be acquired throughout the road alignment. ▪ Some markets and shops will	▪ Need 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).	• Number of public grievances re-resettlement and compensation; • Number of complaints from sensitive receptors	Compliance with Resettlement Plan	Throughout the project areas (Refer to Table 4.15 and Appendix E)	RHD/DC	RHD

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
		also be relocated.						
P05$_{EMP}$	Educational Institution, Religious Structure, Culturally Sensitive Structures	Educational, religious, and cultural institutions in the PIA will be directly and indirectly affected from the project activities.	▪ 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). ▪ 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.	• Records of chance finds • Temporary access provision; • Permanent access restored	Compliance with Resettlement Plan	Throughout the project areas. (Refer to Table 4.15 and Appendix E)	RHD/DC	RHD
P06$_{EMP}$	Public Utility	Inconvenience caused by disruption of public utilities	▪ Provision in the design and budget for the relocation of the existing utility infrastructures wherever required; and ▪ All public utilities (e.g. water pipes, power/ telephone lines likely to be affected by the	• Number of complaints from sensitive receptors • Nos of electric poles relocated; • Temporary power supply	Compliance with Resettlement Plan and Emergency Response plan	Throughout the project areas	RHD/DC	RHD

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
			proposed project road expansion will be relocated well ahead of time before the actual commencement of the construction work.					
CONSTRUCTION STAGE								
C01EMP	Hydrologic Regime	▪ Temporary drainage blockage, especially at small bridges, culverts, service areas, and construction sites. ▪ Increased flood risk from more rapid and higher levels of runoff	▪ Provision of drains to take design flows; ▪ Wastes should not be disposed near any water body. All waste depending on its characteristics, should be disposed of in a controlled manner.	• Designs of both Cross and side drains; • No of culverts; • Number and size of pipes	• Compliance with Design report	Bridge and culvert sites	Contractor	RHD / Supervision Consultants (SC)
C02EMP	Drainage	▪ Drainage congestion due to waste/sediment disposal and construction of road embankment;	▪ Regular cleaning of channels to avoid choking.	• Designs of both Cross and side drains; • Number of culverts; • Number and size of pipes	• Compliance with Design report	Drainage structure sites	Contractor	RHD / SC

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
		▪ Erosion and subsequent deposition in the adjacent crop fields.						
$C03_{EMP}$	Soil Erosion and Siltation	▪ Soil erosion due to construction activities, earthworks, cut and fill operations and from stockpiles	▪ Adopt good construction practices. ▪ Replanting with native varieties of trees and shrubs ▪ Construction schedule for bridges during non-monsoon 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 stone pitching or riprap at appropriate places especially around overpasses, bridges, culverts.	• Complaint regarding sediment loss or water turbidity. • Bridge locations; • Retaining walls; • Number of any non-compliance reports	• Compliance with national and international guideline limits for soil quality	The full length of the road alignment	Contractor	RHD / SC
$C04_{EMP}$	Soil Compaction	▪ Compaction of soil due to	▪ Construction vehicles, machinery, and	• Number of any non-	• Compliance with	Construction sites along	Contractor	RHD/SC

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
	and Contamination	movement of vehicles and equipment's ▪ Contamination of soil due to leakage/spillage of oil, bituminous and non-bituminous debris	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 ▪ 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.	compliance reports • Maintenance of temporary passages;	National/International guideline limits for soil quality	the full length of the project		
C05$_{EMP}$	Topsoil	▪ 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	▪ 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.	• Number of non - compliances observed/ reported	• Compliance with National/International guideline limits for soil quality	Various construction sites throughout the road alignment	Contractor	RHD/SC

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
		project works. 3.	▪ 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.					
C06EMP	Air Quality	▪ Dust Generation due to construction activities and transport of construction materials. ▪ Emissions from vehicles, equipment	▪ Vehicles transporting construction material to be covered ; ▪ Construction equipment to be maintained to a good standard and idling of engines discouraged. ▪ Machinery emitting visible smoke to be banned from construction sites; ▪ Contractor to prepare a dust suppression	• Location of stockpiles; • Number of complaints from sensitive receptors; • Heavy equipment and machinery with air pollution control devices;	• Compliance with DoE and National guideline limits for Air at sensitive receptors. Certification that vehicles are compliant with air	Construction sites along the full length of the project	Contractor	RHD/SC/DOE

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
		and machinery.	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. (Refer to Appendix E for locations of these). Clearance should be at least 500 m and take into account 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	• Ambient air quality found beyond the national standards; • Levels of SOx, NOx, CO, PM_{10}, $PM_{2.5}$,	quality standards.			

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
			▪ Air quality monitoring to be carried out as per the schedule in the environmental monitoring plan.					
$C07_{EMP}$	Noise and Vibration	▪ Noise from construction vehicles, equipment and machinery. ▪ Vibration caused by construction activities.	▪ Use of modern plant and equipment with appropriate muffling devices. ▪ All powered mechanical equipment and machinery to be fitted with noise abating gear 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 (Refer to Appendix E for locations)	• Number of complaints from sensitive receptors; • Noise measurement data • Use of silencers in noise-producing equipment and sound barriers;	• Equivalent day and night time noise levels • Compliance with DoE and National guideline limits for Noise at sensitive receptors.	Construction sites along the full length of the project	Contractor	RHD/SC/DOE

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
			▪ 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.					
C08EMP	Topography and Landscape	▪ Land degradation due to careless excavation from borrow area	▪ 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 completion of work as per the written direction of the landowner.	• 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	• Compliance with National guideline for land use policy. • Compliance with Waste management plan	Borrow areas	Contractor	RHD/SC

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
			▪ Construction wastes to be used in construction activities.	cleared of any dust/mud				
$C09_{EMP}$	Construction Camps, Workshops and Processing Facilities	▪ Loss of plantation and vegetation. ▪ Permanent physical and visual impact on the area. ▪ Social disturbance for nearby community	▪ Construction camps and workshops to be located away from sensitive areas and not within 500 metres of existing settlements (Refer to Appendix E) unless agreed to after consultation with local people. ▪ 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	• 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	• Compliance with Waste management plan	Construction sites along the full length of the project	Contractor	RHD/SC

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
			(Refer to Appendix E for locations); ▪ Construction material storage areas not to be located in sensitive areas and to be sheltered or sited within hoardings; ▪ 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	▪ Loss of surface water bodies and impact on fish	▪ 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	Effectiveness of water management measures	All water bodies likely to be affected along the project road (Refer to Appendix E)	Contractor	RHD/SC

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
C11$_{EMP}$	Surface Water Quality	▪ Contamination of surface water by disposal of construction waste. ▪ Pollution of domestic water supplies	▪ 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 cope with the rain water and oil spills. ▪ 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	• Areas for stockpiles, storage of fuels and lubricants and waste materials; • Number of silt traps installed along trenches leading to water bodies • Records of surface water quality inspection; • Levels of pH, TOC, PO_4, TSS, DO, oil and grease	• Compliance with National guideline limits for Surface water.	Construction sites along the full length of the project particularly beel / lowland / pond / ditch areas (Refer to Appendix E)	Contractor	RHD/SC/DOE

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
			according to the determined sampling 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 approve disposal sites.					
$C12_{EMP}$	Groundwater Quality	▪ Contamination of underground water table from leachate of construction waste.	▪ 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. ▪ Water reserves to be protected from contamination such as construction and oily waste.	• Monitoring in accordance with monitoring program. • No breaches of Material Safety Data Sheet (MSDS) for hazardous substances. ▪ Levels of pH, $CaCO_3$, Cl^-, Mn, As, Fe, total coliform, fecal coliform	• Compliance with National guideline limits for Ground water.	Construction sites along the full length of the project	Contractor	RHD/SC/DOE

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
C13$_{EMP}$	Waste Pollution	▪ Unhygienic conditions, health risk to workforce and general public at the camp site.	▪ 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.	• Air (PM_{10}) and noise level measurements ; • Dust pollution; • Number of non-compliances observed/ reported	• Compliance with Waste management plan	Construction sites along the full length of the project	Contractor	RHD/SC/DOE
C14$_{EMP}$	Dredging and Dredged Materials	▪ 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	▪ 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	• Air (PM10) and noise level measurements ; • Dust pollution and complaint of local residents • Number of non-compliances observed/ reported	• Compliance with Waste management plan	Dredging sites	Contractor	RHD/SC

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
		in dredged material	▪ 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 project, the contractor may collect filling materials from that area through proper contract and dredging guidelines. ▪ Dredged material from the river bank to be tested for presence of heavy metals and other pollutants before its use. Note – some areas were tested during the preparation of EIA (refer to Table 4.2).					
C15$_{EMP}$	Flora	▪ Loss of habitat due to tree cutting ▪ Vegetation loss due to site preparation and	▪ Trees suited to the tract to be planted (see Appendix G for tree plantation plan); ▪ Flowering and fruiting shrubs to be planted along the RoWs to beautify the landscape;	• Number of complaints from sensitive receptors on disturbance of vegetation. • Illegal felling of trees • PMO and PIU to report in	• Compliance with Tree management plan	Construction sites along the full length of the project	Contractor	RHD/SC/FD

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
		construction activities	▪ 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. However if such type of land is not available, it must be ensured that vegetation clearing is minimised and minimum damage is caused to the trees, undergrowth and crops.	writing the number of trees cut and planted if tree-cutting will be required (to be determined during detailed design stage)				
C16EMP	Wildlife	Hunting of wildlife and	▪ Wildlife Department to check and confirm that no hunting occurs;	• Number of complaints from sensitive	Compliance with National/Intern	Along the road alignment	Contractor	RHD/SC/DOE

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
		birds during construction.	▪ New and good condition machinery with low noise generation characteristics to be used in construction; ▪ Construction work not to be carried out at night. ▪ Borrow pits to be fenced to protect animals.	receptors on disturbance of poaching. • Illegal hunting	ational guideline for wildlife			
C17$_{EMP}$	Fisheries	▪ Impact on fishing activity (production, spawning and breeding grounds) ▪ Disturbance to aquatic life including migration of fish due to bridge construction	▪ 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.	• 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 beel/lowland/ pond/ditch/river areas (Refer to Appendix E)	Contractor	RHD/SC
C18$_{EMP}$	Land use	▪ Land disputes, soil erosion, loss of potential cropland and vegetation, landscape	▪ 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	• Number of complaints from sensitive receptors; • Records of sources of materials	Compliance with National/International guideline	Borrow areas, access roads, bypasses	DC, Contractor	RHD/SC

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
		degradation, and damage to road embankments. ▪ Land use change due to borrowing of earth. ▪ Land use change and loss of productive top soil.	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; ▪ 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;					
$C19_{EMP}$	Traffic	▪ Traffic jams causing inconvenience to the people	▪ Provision to be made for passing traffic during construction ▪ Traffic management shall be undertaken in coordination with the	• Traffic route during construction works including number of	Compliance with Traffic management plan	Construction sites along the full length of the project	Contractor	RHD/SC

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
			local traffic police department.	permanent signage, barricades and flagmen on worksite; • Number of complaints from sensitive receptors; • Number of signages placed at project location; • Number of walkways, signage, and metal sheets placed at project location				
$C20_{EMP}$	Cultural Sites	▪ Noise and dust pollution and movement of the people to the nearby schools, colleges, mosques, and graveyards etc.	▪ 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 so as to maintain proper clearances from the cultural sites.	No complaints from sensitive receptors	• Compliance with National guideline limits for Noise and dust.	Along the road alignment (Refer to Table 4.15 and Appendix E)	Contractor	RHD/SC

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
C21$_{EMP}$	Income and Employment	▪ Income loss due to the loss of agricultural lands, private structures and common property resources and rehabilitation of the households.	▪ 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.	Employment records.	Compliance to Bangladesh Labor Law of 2006 and other applicable standards	Along the road alignment	Contractor	RHD/SC
C22$_{EMP}$	OHS - Workers	▪ Health risks due to unsafe working conditions	▪ 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 made available for workers; ▪ Appropriate personal protective equipment (hearing protection, safety glasses, helmets, protective	• Equipped first-aid stations • Medical insurance coverage for workers • Number of accidents • Records of supply of uncontaminated water • Condition of eating areas of workers	Compliance to emergency response plan	Construction sites along the full length of the project	Contractor	RHD/SC

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
			footwear and gloves, high visibility vests and other protective clothing) to be provided to all workers; ▪ 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.	• 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				
C23EMP	OHS - Community	▪ Safety risks due to construction works	▪ The labour works with different transmittable diseases should be restricted within the construction site. ▪ Drivers operating construction vehicles	• Number of accidents; • Number of permanent signage, barricades and flagmen	Compliance to emergency response plan	Construction sites along the full length of the project	Contractor	RHD/SC

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
			to be trained in road safety awareness; ▪ Close consultation with local communities to identify optimal solutions for diversions to maintain community integrity and social links; ▪ 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.	on worksite as per Traffic Management Plan; • 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.				
OPERATION STAGE								
O01EMP	Soil	▪ Erosion due to damage of embankment and during transportatio	▪ Turfing of embankment shall be maintained. ▪ Surveillance to protect the embankment from	No complaints from sensitive receptors	• Compliance with National/ International guideline limits for soil	Along the road alignment particularly at erosion prone area	RHD	RHD

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
		n of sand by sand miners along river ▪ Soil contamination due to accidental spillage from vehicular movement.	unauthorized accesses. ▪ 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; ▪ 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.					
O02EMP	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.	▪ According to 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;	No complaints from sensitive receptors	• 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

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
			▪ Monitoring to protect the trees.					
$O03_{EMP}$	Air Quality	Increased traffic levels and congestion will lead to air pollution levels.	▪ 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; ▪ Regular vehicle check to control/ensure compliance with air quality standards; ▪ Enforcement and penalties against traffic rules violators.	• No complaints from sensitive receptors; • Levels of SOx, NOx, CO, $PM_{2.5}$, PM_{10}	• Compliance with National guideline limits for Air quality.	Along the road alignment particularly in the major road intersections and densely settlement areas	RHD	RHD/DOE
$O04_{EMP}$	Water Quality	▪ Contamination of water bodies from runoff from the roads containing oils and grease; ▪ Groundwater may get polluted due to contaminated road runoff	▪ 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;	▪ No visible degradation to nearby drainages, khals or water bodies due to construction activities; ▪ Levels of pH, TOC, PO_4, TSS, DO, oil and grease (surface water)	• Compliance with National guideline limits for Surface and Ground water.	Throughout the road alignment particularly in khal/lowland/rivers/pond/ditch areas (Refer to Appendix E)	RHD	RHD/DOE

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
		on earthen shoulders and embankments planted with grasses.	▪ Retention basins with reedbeds 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.	▪ Levels of pH, $CaCO_3$, Cl^-, Mn, As, Fe, total coliform, fecal coliform (groundwater)				
$O05_{EMP}$	Land Use	Development of commercial establishments, educational institutes etc., which may affect the land value	▪ 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; ▪ The bridge site may also be developed as tourist spot with further beautification;	• Number of complaints from sensitive receptors	Compliance with National/International guideline	Along the road alignment particularly in the urban and densely settlement areas	RHD	RHD

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
			▪ The designated RoW shall be maintained free of any encroachment.					
O06EMP	Wildlife	Killing of animals in road accidents	▪ 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.	• Number of complaints from sensitive receptors on disturbance of poaching. • Illegal hunting	Compliance with National/International guideline for wildlife	Along the road alignment	RHD	RHD/DOE
O07EMP	Fisheries	The damage of 44 ponds, 189 ditches and disturbance to fisheries species during construction of bridge and culvert over rivers and canals to build the road embankment.	▪ 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.	• 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

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
O08EMP	Cultural Sites	Noise, vibration and whistling near to cultural sites like school, college, madrasa, health complex, temple, etc.	▪ Proper rehabilitation of the affected people and the religious and cultural monuments and structures; ▪ Noise problem can be mitigated through plantation of trees along the boundary of the cultural sites; ▪ Avoid unnecessary whistling at sensitive cultural sites.	No complaints from sensitive receptors	• Compliance with National guideline limits for Noise and dust.	Along the road alignment	RHD	RHD
O09EMP	Road Safety	Increase in the number of road accidents and animals kills	▪ 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,	• Number of accidents; • Number of complaints from sensitive receptors; • Number of speed limit violations • Installation of road safety signages	Compliance with road safety regulations	Along the road alignment particularly at road intersections	RHD	RHD

EMP Code[20]	Environmental Activity	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Approximate Location	Institutional Responsibility	
							Implementation	Monitoring/ Supervision
			habitat areas for safe crossing of the roads ▪ Proper lighting shall be provided along the project road.					

D. EMP Implementation Schedule

377. 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 in table 42. Monitoring Plan has been separately suggested for pre-construction, construction and operation phase.

E. Environmental Monitoring Plan

1. General

378. 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).

2. Objectives

379. 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:

- Monitor the actual impact of the works on physical, biological and socioeconomic receptors within the project corridor for indicating the adequacy of the EIA;
- Recommend mitigation measures for any unexpected impact or where the impact level exceeds that anticipated in the EIA;
- Ensure compliance with legal and community obligations including safety on construction sites;
- Monitor the rehabilitation of borrow areas and the restoration of construction campsites as described in the EMP;
- Ensure the safe disposal of excess construction materials.
- 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;
- Evaluate the effectiveness of the mitigation measures proposed in the EMP and recommend improvements, if and when necessary;
- Compile periodic accident data to support analyses that will help minimize future risks; and
- Monitor the survival rate of avenue plantations.

Table 44: EMP Implementation Schedule

Environmental Issue	EMP	Time Line																									
		Pre-Const'n (6 months)		Construction Phase (36 months)												Operation Phase (36 months)											
Technical Support	Updation of environmental guidelines and performance indicators	■		■	■																						
Flora	Tree cutting along the RoW	■	■	■	■	■																					
	Compensatory afforestation (Minimum 1:2)						■	■	■	■	■	■	■	■	■	■	■	■	■								
Drainage Congestion	Provision of adequate opening			■	■	■	■	■	■	■	■	■	■	■	■												
	Monitoring analysis of drainage congestion			■	■	■	■	■											■				■				■
Erosion, Sedimentation and Soil	River bank protection measures			■	■	■	■	■	■	■	■	■	■	■	■												
	Soil conservation			■	■	■	■	■	■	■	■	■	■	■	■												
	Monitoring of soil erosion																		■				■				■
Land	Compensation against land acquisition	■	■	■	■																						
	Landscaping on approach road and service areas						■	■	■	■	■	■	■	■	■	■	■										
Slope/ Embankment protection at approach Road	Turfing of embankment with grasses and herbs			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■								
	Embankment protection of the approach road			■	■	■	■	■	■	■	■	■	■	■	■												
Water and Drinking Water Supply	Monitoring of Surface Water Quality		■				■				■				■				■				■				■
	Monitoring of Ground Water Quality and Levels		■				■				■				■				■				■				■
	Installation of oil and grease traps at construction sites			■	■	■	■	■	■	■	■	■	■	■	■												
	Construction of soak pits at construction and rehabilitation sites			■	■	■	■	■	■	■	■	■	■	■	■												
	Ensuring arsenic free drinking water for construction camps			■	■	■	■	■	■	■	■	■	■	■	■												
Air Quality and Dust Management	Monitoring of Ambient Air Quality		■				■				■				■				■				■				■
	Water Spraying/ Watering			■	■	■	■	■	■	■	■	■	■	■	■												
Construction Safety	Provision of PPEs			■	■	■	■	■	■	■	■	■	■	■	■												
Health Issues	Health Check-up Camps			■	■	■	■	■	■	■	■	■	■	■	■												
	Monitoring of Noise and Vibration		■				■				■				■				■				■				■

Environmental Issue	EMP	Time Line																													
		Pre-Const'n (6 months)		Construction Phase (36 months)												Operation Phase (36 months)															
Noise Quality and Barriers	Monitoring of Tree Felling and Plantation																														
	Maintenance of tree																														
	Provision of Noise Barriers																														
Establishments	Construction Stage																														
Training	Environmental training and Awareness																														
Management Information System																															

F. Components to be monitored

380. Monitoring has two components:

- Compliance monitoring, which checks whether prescribed actions have been carried out, usually by visual observation and by the use of checklists.
- 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.

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

1. Pre-Construction stage compliance monitoring

382. 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 with 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.

383. The detailed program of monitoring of various components is given in table 45.

2. Construction stage compliance monitoring

384. 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.

385. 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.

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

- 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).

- 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.
- 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.
- 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.

3. Operation stage monitoring

387. 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, for monitoring with respect to air quality, water, noise and traffic.

- 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 NO_2, SO_2 and particulate matters will be monitored and necessary measures will be taken to keep them within the limits set by government.
- 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.
- 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.
- 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).

G. Monitoring Program

389. Monitoring points have been selected based on the sensitivity of the location with respect to sensitive receptors.

390. 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

391. 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

392. 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

393. 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

394. 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.

395. 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

396. 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 and 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 45: 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), Cromium (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, Total Phosphate, 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, 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
$P07_{EMoP}$	Tree felling	▪ Monitoring activities outlined in RP; ▪ Check whether proper compensation as mentioned in RP is	Inspection	ROW along the alignment	During tree felling and site clearing operations	Contractor/ NGOs/RHD	RHD/CSC

EMoP Code	Environmental Components	Parameters/ Units	Standards/ Guidelines	Location	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
						Implementation	Supervision
		received by PAPs.					
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 3 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 inhabited locations and sensitive areas	2/year per site for 3 years	Contractor	RHD\CSC
$C04_{EMoP}$	Water Quality	Surface water: pH, TOC, Total Phosphate, TSS, Oil and Grease, and DO	Water quality standard by MoEF, Bangladesh	Surface water near project site	2/year per site for 3 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 ground water near project site	2/year per site for 3 years	Contractor	RHD\CSC
$C06_{EMoP}$	Soil Erosion	Visual check for Soil erosion and siltation		All major water bodies	Once during rainy seasons of the construction period.	Contractor	RHD\CSC
$C07_{EMoP}$	Drainage congestion	▪ Check drainage plan implemented correctly ▪ Conduct regular inspection	Monitoring	Construction site	Weekly during monsoon	Contractor	RHD\CSC

EMoP Code	Environmental Components	Parameters/ Units	Standards/ Guidelines	Location	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
						Implementation	Supervision
$C08_{EMoP}$	Soil Pollution	▪ 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
$C10_{EMoP}$	Fisheries	Impact on fish productivity , breeding and spawning		All major water bodies	Once in a year	Contractor	RHD\CSC
$C11_{EMoP}$	Waste	▪ Check storage, transportation, disposal, handling of hazarders waste ▪ Waste and effluents to be collected and disposed safely from all camps. ▪ Wastes and garbage from bridges construction sites to be disposed safely	Monitoring	Construction Yard, dumping site	Weekly	Contractor	RHD\CSC
$C12_{EMoP}$	Health and Safety	▪ Check quality of food and 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;	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
		▪ First Aid Box with required tools and 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 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
$O02_{EMoP}$	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	1site/year for 3 years	RHD	RHD\DOE
$O03_{EMoP}$	Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Major Road Intersections and inhabited locations and sensitive areas	1site/year for 3 years	RHD	RHD\DOE
$O04_{EMoP}$	Water Quality	Surface water: pH, TOC, Total Phosphate, TSS, Oil and Grease, and DO	Water quality standard by DOE, Bangladesh	Surface water near project site	1site/year for 3 years	RHD	RHD\DOE

EMoP Code	Environmental Components	Parameters/ Units	Standards/ Guidelines	Location	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
						Implementation	Supervision
$O05_{EMoP}$		Groundwater: pH, Mn, As, Fe, Cl^-, Total hardness, TC, FC		Groundwater near project site	1site/year for 3 years	RHD	RHD\DOE
$O06_{EMoP}$	Accident and Public Safety	Record of accidents, different level of disabilities/fatalities.	None Specific	Thought out the project section	----------	RHD	RHD
$O07_{EMoP}$	Soil Erosion	Visual check for soil erosion and siltation		All major water bodies	After first precipitation	RHD	RHD
$O08_{EMoP}$	Soil Quality	Heavy metals		At each construction camp post restoration of construction camp site	Once at each construction site	RHD	RHD\DOE
$O09_{EMoP}$	Wildlife	Wildlife habitat and movement	None Specific	Areas alongside the road alignment	Quarterly	RHD	RHD\DOE
$O10_{EMoP}$	Fisheries	Impact on fish productivity , breeding and spawning		All major water bodies	End of First year of Operation	RHD	RHD\DOE

H. Environmental Budget

397. 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:

- 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.

398. The total budget is estimated as US$ 1.42 million.

Table 46: Environmental Budget for Hatikamrul-Rangpur Road

Component	Item	Unit	Quantity	Rate (in BDT)	Amount (million BDT)
PRE-CONSTRUCTION STAGE					
Technical Support	Updating 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.	6	15,000	0.09
Flora	Clearing of Roadside plantation	No. of tree	215000	Covered in Eng. Cost	--
Water Quality	Surface water quality measurement	No.	2	20,000	0.040
	Groundwater quality measurement	No.	2	20,000	0.040
Land acquisition and resettlement	Compensation against land acquisition	Covered in R and R Budget			--
	SUB TOTAL (PRE-CONSTRUCTION STAGE)				**0.83**
CONSTRUCTION STAGE					
Air Quality	Measuring air quality	No.	12	60,000	0.72
Noise	Measuring ambient noise level	No.	36	15,000	0.54
	Provision for additional tree plantation / Noise Barriers	No.	Covered in Engineering Cost		--
Flora / tree plantation	Clearing of roadside plantation	No.	Covered in Engineering Cost		--
	Compensatory afforestation (Minimum 1:2) (Plantation and maintenance for three years)	No.	215000	300/tree	64.5
Water Quality	Surface water quality measurement	No.	36	20,000	0.72
	Groundwater quality measurement	No.	36	20,000	0.72

Component	Item	Unit	Quantity	Rate (in BDT)	Amount (million BDT)
	Installation of oil and grease traps at construction sites @ 1 per site and 1 site per construction package (6)	No.	25	60,000	1.50
	Construction of soak pits at construction sites @ 2 per construction camp and 1 camp per package	No.	20	30,000	0.60
Agriculture	Institutional support for enhancing agricultural productivity (Development of demonstration plots for change in cropping pattern for cash crop or high yield variety)	Plots	20	1,00,000	2.00
	Technical Support to farmers	Lump sum	-	20,00,000	2.00
Fisheries	Conversion of derelict pond into culture ponds and other support (fisheries seed distribution, demonstration ponds, technical support)	Lump sum	-	20,00,000	2.00
Drainage Congestion	Provision of adequate opening	Covered in Engineering Cost			
Erosion and 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	-	80,00,000	8.00
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	-	8,00,000	0.80
Health	Health check-up camps for construction workers	Camps	Camps/year	5,00,000	1.50
Environmental Monitoring in construction phase	Monitoring Tree Felling and Plantation	Lump sum	-	20,00,000	2.00
	Fisheries	Lump sum	-	8,00,000	0.80
	SUB TOTAL (CONSTRUCTION STAGE)				**88.4**
OPERATION STAGE					
Air Quality	Monitoring air quality	No.	3 (1/year)	60,000	0.18

Component	Item	Unit	Quantity	Rate (in BDT)	Amount (million BDT)
Noise	Monitoring ambient noise level	No.	6 (1/year)	15,000	0.09
Water	Monitoring surface water quality	No.	6 (1/year)	20,000	0.12
	Monitoring ground water quality and levels	No.	6 (1/year)	20,000	0.12
Fisheries	Maintenance of Derelict Ponds or rehabilitation of Borrow Areas	Lump Sum	-	20,00,000	2.00
Tree survival	Provision of additional tree plantation (Plantation and maintenance for two year)	No. of trees	21500	100/tree	2.15
Monitoring of performance indicators	Monitoring tree felling and plantation	Lump sum	-	8,00,000	0.80
	Fisheries	Lump sum	-	8,00,000	0.80
	Monitoring of waste disposal and management	Lump Sum	-	8,00,000	0.80
	SUB TOTAL (OPERATION STAGE)				**7.06**
ESTABLISHMENT and TRAINING					
Establishment	Construction stage	Per month	36	1,00,000	3.60
	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 and awareness	Lump sum	As per training details	30,00,000	3.0
Management Information System		Lump sum	-	8,00,000	0.80
SUB TOTAL (ESTABLISHMENT and TRAINING)					**8.66**
SUB TOTAL (Pre-construction, Construction, Operation, establishment and training)					**104.95**
CONTINGENCIES @ 10 % on total Environmental Costs					**10.49**
GRAND TOTAL (in BDT)					**115.44**
GRAND TOTAL IN MILLION US$ (@ 1 US $ = 81.5 BDT)					**1.42**

X. INSTITUTIONAL ARRANGEMENT, CAPACITY BUILDING AND GRIEVANCE REDRESS MECHANISM

A. Institutional Arrangement

399. 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.

400. The organizational structure of RHD is given in Figure 7.1. 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.

401. 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.

402. 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.

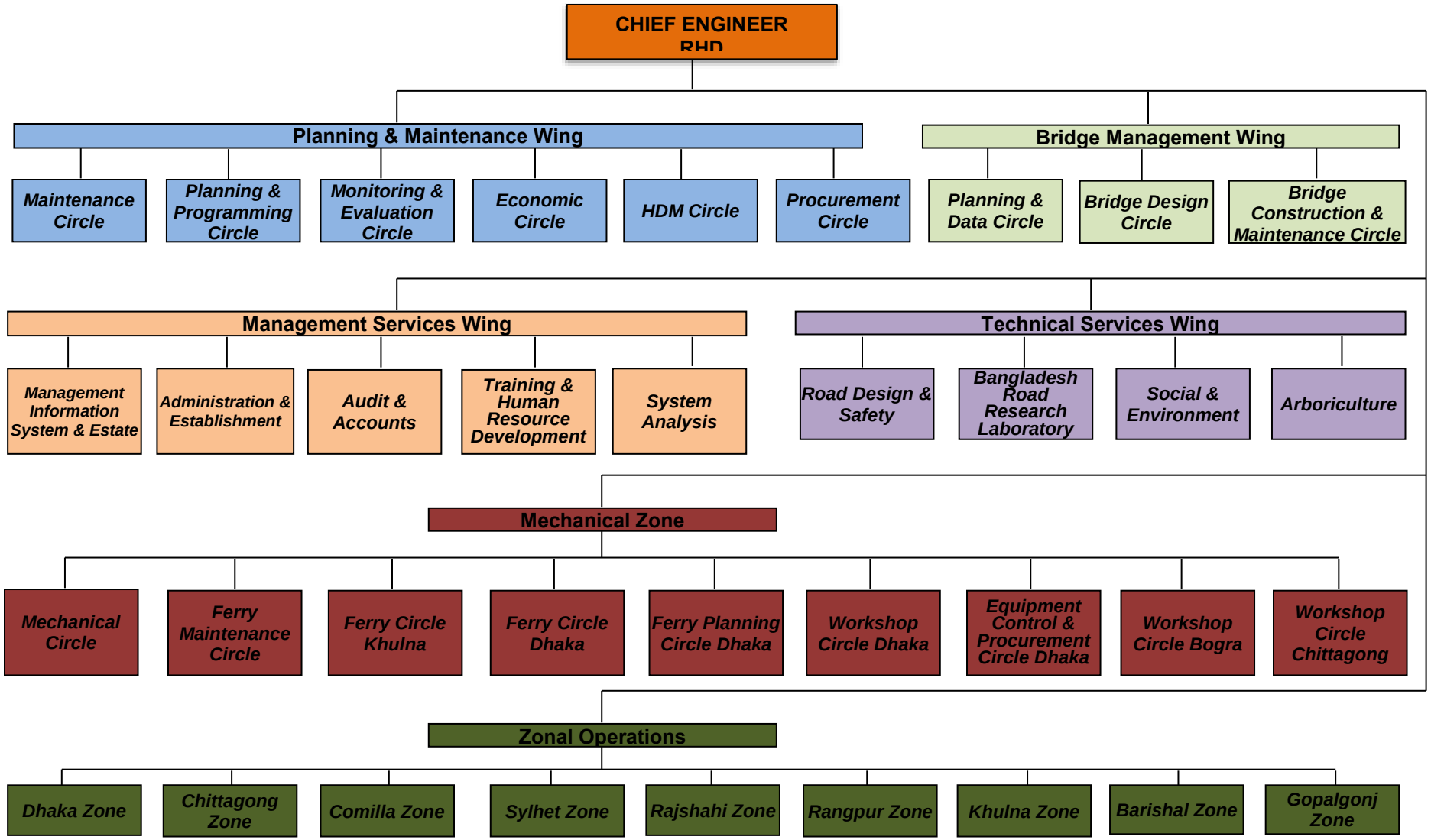


Figure 25: Organisation Structure of RHD

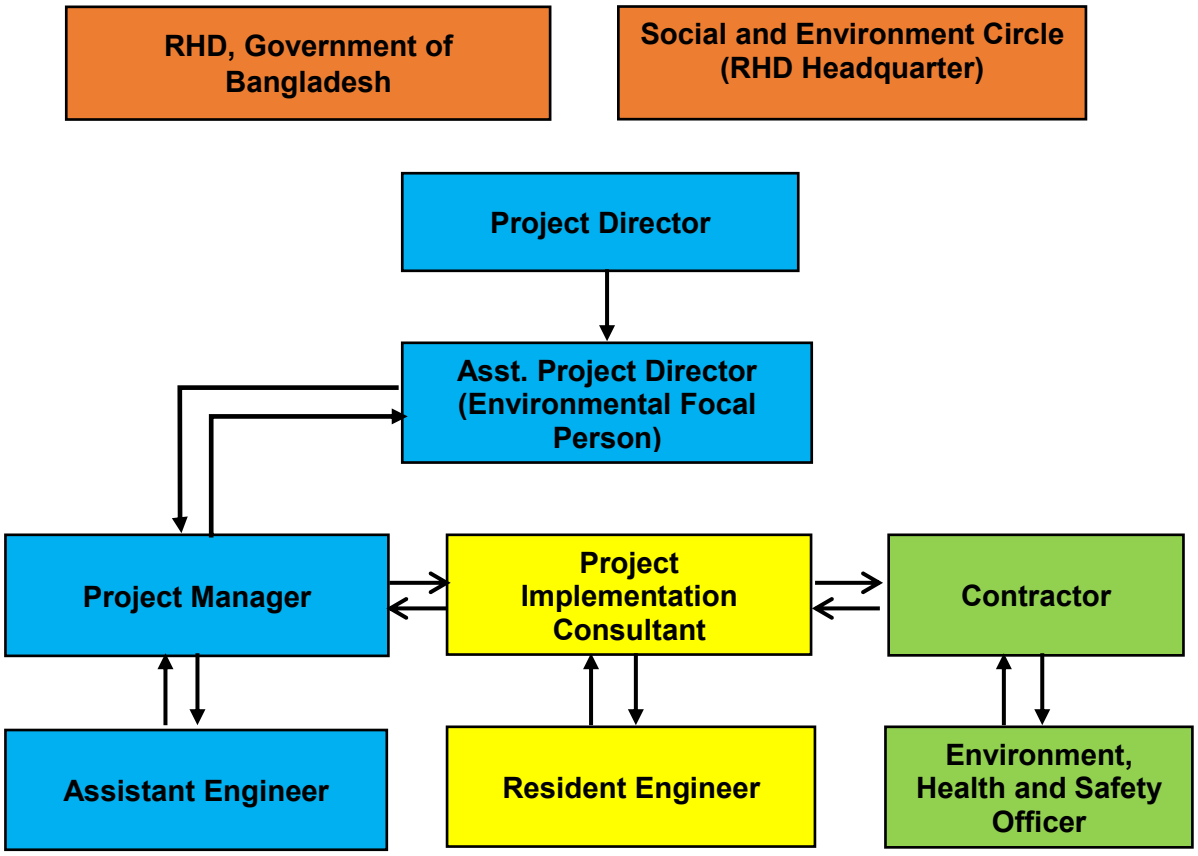


Figure 26: Proposed Organisation Structure of RHD for Hatikamrul-Rangpur Road Project[21]

[21] - Roads and Highways Department (RHD); - Project Implementation Unit; - Project Implementation Consultant; - Contractor

B. Institutional Roles and Responsibilities

403. 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.

404. Two Project Implementation Units (PIU) will be responsible for implementing phase 1 (Joydepur–Chandra–Tangail–Elenga)22 and phase 2 (Elenga–Hatikamural–Rangpur)23 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 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.

405. 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.

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

1. RHD

407. 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 Cell)

408. The RHD Environment and Social Cell (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.

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

[23] A new PIU for phase 2 has just been established

- 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)

409. 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)

410. 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)

411. 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 elating 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

412. 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

413. 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 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.

414. 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 47: 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 and 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	Lectures, Workshops and Seminars	Before the construction begins

Target Group	Subject(s)	Method	Time Frame
	awareness and land acquisition and resettlement issues		
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
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	Wild life protection and environmental protection awareness programme	Signage, workshops,	Construction and operation stage

415. 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

416. 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.

417. 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.

418. 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.

419. 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.

420. 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.

421. 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.

422. 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.

423. 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.

424. 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.

425. 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.

426. 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).

XI. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

A. Background

427. 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.

428. 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

429. 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 representative, NGO's and general public. All those stakeholders had different types of stakes according to their professions.

C. Information Disclosed

430. 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.

431. Stakeholder consultations were held during the different site visits in January 2014 for the EIA report preparation. 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.

432. Issues were discussed in depth with the government officials and while in case of the people those issues were touched upon which are relevant to them. To begin with, they 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 points:

- 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
- The consultation process was undertaken after studying the project design and identifying the possible impacts due to the project 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.

433. 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

434. 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

435. 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 following section.

F. Government Officers' Comment

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

Table 48: Details of Consultation with Government Authorities for Hatikamrul-Rangpur Road Project

Department	Name and Designation of the Government Official	Comments	Suggestions
Roads and Highways Department (RHD)	Rowshan Ara Khanam Superintending Engineer A. K. M. Mozammel Haque Executive Engineer	• Priority Roads are priority. • Department will be open to incorporate feasible environmental protection measures in road design.	• Mitigative measures shall be simple and implementable. • RHD is open for the implementable ideas for institutional capacity building
Department of Environment (DOE)	Md. Shahjahan Additional Director General Sayed Nazmul Ahsan Deputy Director (Environmental Clearance) Md. Monirul Islam Assistant Director Md. Samsuzzaman Sarker Assistant Director	• 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.	• 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.
Department of Agriculture Extension (DAE)	Kalyan Kumar Sarker Upazilla Agriculture Officer Shajahanpur, Bogra Ummey Habiba Upazilla Agriculture Extension Officer Shajahanpur, Bogra Md. Shahidul Islam Upazilla Agriculture Extension Officer Royganj, Sirajganj Md. Sowkat Usman Upazilla Agriculture Officer Polashbari, Gaibandha Md. Khorshed Alam Upazilla Agriculture Officer Govindoganj, Gaibandha Dr. Md. Sorwarul Haque Upazilla Agriculture Officer Mithapukur, Rangpur	• 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 and Air pollution will be increased during bringing heavy machinery at the stage of construction.	• Avoid agricultural land as much as possible. • 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.
	Md. Ferdous Ali		

Department	Name and Designation of the Government Official	Comments	Suggestions
Department of Fisheries (DoF)	Upazilla Fisheries Officer Shajahanpur, Bogra Md. Zillur Rahman Upazilla Fisheries Officer Sherpur, Bogra Md. Khalekuzzaman Sarker Upazilla Fisheries Officer Royganj, Sirajganj Dr. Md. Aftab Hossain Senior Upazilla Fisheries Officer Polashbari, Gaibandha Md. Harun-ar-Rashid Assistant Fisheries Officer Pirganj, Rangpur Depok Kumar Paul Senior Fisheries Officer Mithapukur, Rangpur	• Small water channels/ watercourses may be abandoned due to non-availability of passages across the road.	• Adopt measures to minimise dust, smoke, and noise pollution, and to control spillages from construction machinery • 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)	Md. Ahsan Kabir Upazilla Engineer Govindoganj, Gaibandha	• 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.	• 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

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. Conservator of Forests, Wild Life and Nature conservation circle, advised to preserve the old tree. He indicated that Govt. plans to declare the old tree as heritage but the proposed tree conservation act yet not finalised. He also emphasize that though there is no specific law governing number of tree to be planted against the number of tree cut but he highlighted that adequate number of tree shall be planted preferably on 1:2 ratio. He also highlighted on not to keep empty places during tree plantation. The evaluation and calculation of tree cutting and plantation should be done in association with forest department.

439. Officials from Bangladesh Forest Department also highlighted that the tree within ROW belongs to RHD even if these are old and RHD is free to cut these tree if so required. In reserved forests area no activity can be undertaken without permission.

440. 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.

G. Focus Group Discussions

441. 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 13 FGDs were held starting from 18th January 2014 to 24th January 2014 and 21 to 22 March 2017. Approximately 174 participants, including several women, from different locations have taken part in those consolations. The schedules, venues and the participant's lists are given in Appendix L.

442. 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.

443. Most of the people told that the local air quality has been degraded from the emission of brickfields, 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 told 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.

444. 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 told that there is no Environmental Protected Area in the project area. Finally, they answered that all of them are in favour of the project.

445. **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.

Photograph 12: Photos of Focus Group Discussion at Various Locations

H. Local People's Comments

446. A number of informal public consultations were held along the priority roads. In all the places, respondents mostly welcomed the project. However, they did point out few issues of concern noise and air pollution, accident hazard along with loss of land and compensation issues. In the time of field survey 33 local people were interviewed (See Appendix I).

Table 49: Details of Consultation with Public in Hatikamrul-Rangpur Road Sections

Comments	Suggestions
• Good news • Very welcome step from Govt. • Improved road is essential and we welcome the road. • Commuting will be fast which will help improve business environment. • Difficult to cross the road due to heavy traffic, accident prone • Construction stage will create some inconvenience to people but that is tolerable. • Accident prone area due high traffic and substantial movement of people in the business areas. • Increased traffic may cause air and noise pollution. • Local people will be benefited economically due to more employment opportunities.	• Road should be straight as it is sharply turning at this place or road ROW should be reduced. • Footpath and over-bridge should be constructed in appropriate and convenient (heavily used) locations so that common people may use it to avoid accident during road crossing. • Provide underpass at this location to facilitate easy movement of people who are moving in large number currently. • Require safe passage being a growth centre. • Make appropriate measures in road design for safe passage. • Speed-breakers should be constructed near schools, hospitals and religious places. • Tree shall be planted wherever there is space available. • Tree should be planted in 1:2 ratio. • Water should be sprayed 2-3 times in a day to reduce the dust pollution.

447. 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 crossing due to increasing traffic. They have strongly demanded provision of foot over bridge and speed breaker. They also demanded for traffic management near big towns.
- Local people are of strong opinion for the early implementation of the project.

Photograph 13: Individual Interviews at Different Locations along the Road

I. Integration of Comments

448. 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.

449. 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 study 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.

XII. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

450. 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

451. 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.

452. This EIA study was carried out when the Hatikamrul-Rangpur Road Subproject 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 in order to complete the environmental impact assessments and recommend suitable mitigation measures.

453. The potential environmental impacts were assessed in a comprehensive manner. The EIA report assesses the potential environmental impacts associated with the Hatikamrul-Rangpur Road Subproject, and suitable mitigation measures have been recommended. In the event that any design details of the Hatikamrul-Rangpur Road Subproject are changed, the EIA and EMP shall be reviewed and revised accordingly and submitted to DOE and ADB for acceptance.

B. Environmental Gains Due to Proposed Work Justifying Implementation

454. 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 Bangabandhu Bridge to Dhaka and the southeast road corridor (to Chittagong). (ii) This will 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 at related air pollution due to idling of the vehicles due to widening as well as provision of flyovers and underpasses.

C. Potential Impacts, Mitigation, Management and Monitoring

455. The Hatikamrul-Rangpur Road Subproject 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 Hatikamrul-Rangpur Road Subproject will mostly take place during the construction stage 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 Hatikamrul-Rangpur Road

Subproject or associated activities that also require environmental assessment and environmental permits under the environmental laws of Bangladesh.

456. The finding of EIA indicates that the project is unlikely to cause any significant adverse environmental impacts. The project proposed 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.

457. While some of the impacts are negative, there are many bearing benefits to the area. Most of the impacts are likely to occur during construction stage and are temporary in nature. Some impacts require design consideration and are suitably addressed. The road alignment does not pass through or near to any ecologically sensitive/protected area. No archeologically protected monument either located in any of the project vicinity. 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.

458. 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. Many 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.

459. 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.

D. Post EIA Surveillance and Monitoring

460. 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.

461. 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.

462. 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.

E. Recommendations

463. 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.

464. 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.

465. 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.

466. 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 ENVIRONMENTAL IMPACT ASSESSMENT OF ROAD DEVELOPMENT PROJECTS UNDER SUBREGIONAL TRANSPORT PROJECT (SRTP)

A. Background

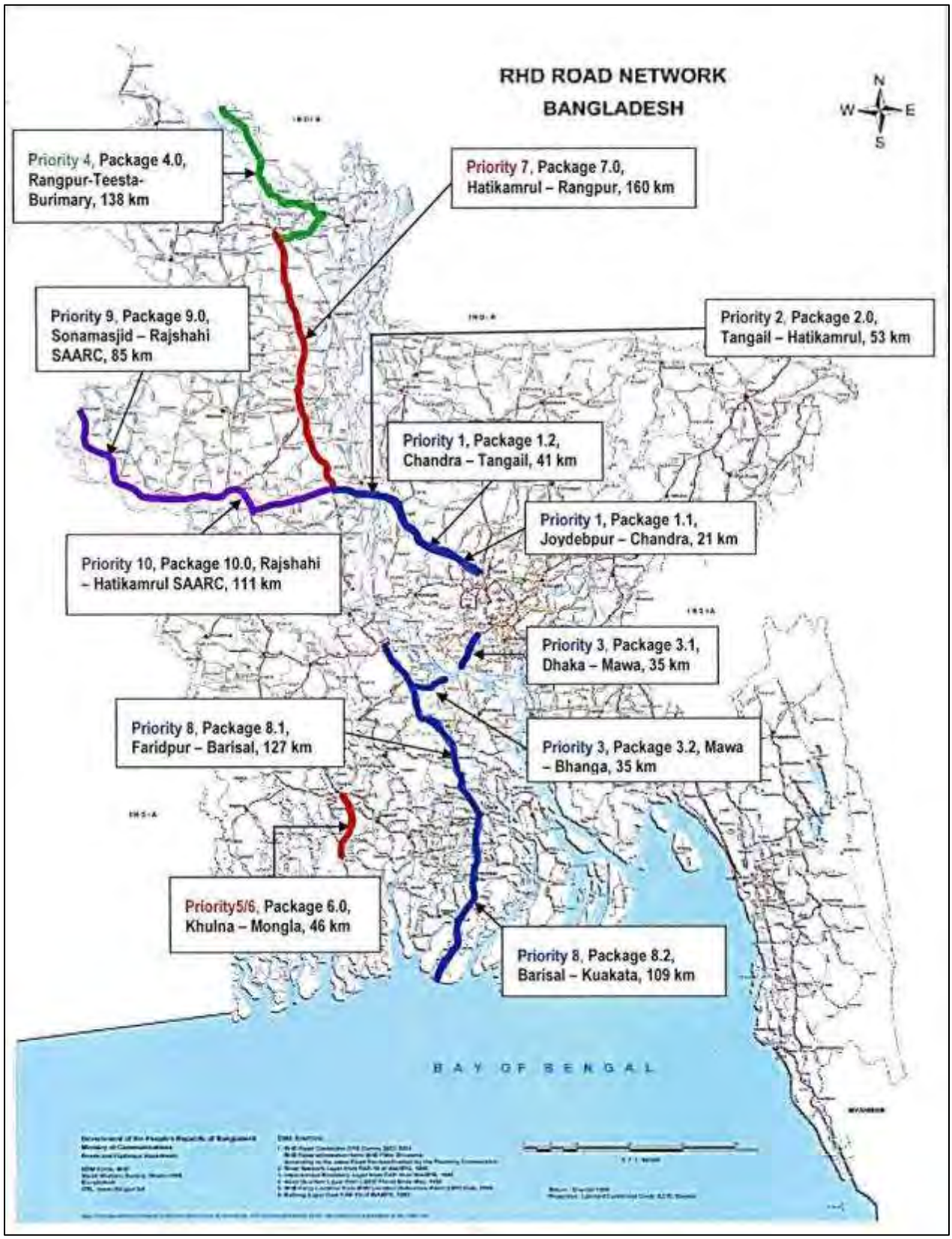
1. The Government of Bangladesh (GoB) has received a loan from Asian Development Bank (ADB) for the Subregional Transport Project Preparatory Facility under Technical Assistance for Subregional Road Transport Project Preparatory Facility (ADB Loan 2688-BAN). GoB has resolved to apply a portion of the 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 carryout 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 1.


RHD ROAD NETWORK
BANGLADESH
N
W
E
S
Priority 4, Package 4.0, Rangpur-Teesta-Burimary, 138 km
Priority 7, Package 7.0, Hatikamrul – Rangpur, 160 km
Priority 9, Package 9.0, Sonamasjid – Rajshahi SAARC, 85 km
Priority 2, Package 2.0, Tangail – Hatikamrul, 53 km
Priority 1, Package 1.2, Chandra – Tangail, 41 km
Priority 1, Package 1.1, Joydebpur – Chandra, 21 km
Priority 10, Package 10.0, Rajshahi – Hatikamrul SAARC, 111 km
Priority 3, Package 3.1, Dhaka – Mawa, 35 km
Priority 8, Package 8.1, Faridpur – Barisal, 127 km
Priority 3, Package 3.2, Mawa – Bhanga, 35 km
Priority5/6, Package 6.0, Khulna – Mongla, 46 km
Priority 8, Package 8.2, Barisal – Kuakata, 109 km
BAY OF BENGAL

C. Project Components

5. The SRTP consists of the following roads are being considered for upgrading:

(i) Design Package No. 1 – Joydevpur-Chandra-Tangail road section in N4 and N405 (70km)
(ii) Design Package No. 2 – Tangail-Hatikamrul (40km)
(iii) Design Package No. 3 – Dhaka-Mawa-Bhanga road section in N8 (70km)
(iv) Design Package No. 4 – Upgrading of Rangpur-Teesta-Burimari Road into 4-lane highway (138km)
(v) Design Package No. 5 – Construction of a bridge over the river Mongla at Mongla on Khulna-Mongla Road
(vi) Design Package No. 6 – Upgrading of Khulna-Mongla Road into 4-lane highway with link to Dhigraj to Mongla Ferry Ghat (46km)
(vii) Design Package No. 7 – Upgrading of Hatikamrul-Rangpur National Highway into 4-lane highway (160km)
(viii) Design Package No. 8 – Faridpur-Barisal-Kuakata road section in N8 (236km)
(ix) 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)
(x) 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.

D. 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.

E. 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.

b. 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.

c. 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.

10. 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, PM_{10}, CO, CO_2, NOx, SOx, O_3 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.

2. Detailed Field Investigation to Screen Environmental Impacts

a. Field Investigation and Analysis of Results

11. 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.

12. 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.

3. Anticipated Environmental Impacts and Mitigation Measures

13. 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.

4. Environmental Management Plan

14. 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.

5. Institutional Arrangement, Capacity building and Grievance Redress Mechanism

15. 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.

16. 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.

6. Information Disclosure, Consultation, and Participation

17. 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.

7. Conclusion and Recommendation

18. This section will provide the conclusions drawn from the assessment and present the recommendations.

F. EIA Study Team

19. The EIA team has been included in the following team:

1. National Environmental Specailist-1	08 months
2. National Environmental Specailist-2	12 months
3. Junior Environmental Specialist-1	17 months
4. Junior Environmental Specialist-2	07 months

20. 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.

G. Work Program and Personal Schedule

21. 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.

H. EIA Report Structure

22. 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.doe-bd.org
Head Office, Paribesh Bhaban
E-16 Agargaon, Dhaka-1207

Memo No: DoE/Clearance/5195/2013/ ১১৭ Date: ৩০ 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. Socio-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.

1/2

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 maid 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 (NOC's) 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 (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

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 many villages and towns and few community resources like temple, mosque and graveyards 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 10km of the project area that might me directly affected because of the project.
▪ Wetland	✓		There are small ponds, beels and Khals link to certain rivers. However none of them are protected or rich in biodiversity.
▪ Mangrove		✓	None
▪ Estuarine		✓	None
▪ Buffer zone of protected area		✓	None
▪ Special area for protecting biodiversity		✓	None
B. Potential Environmental Impacts Will the Project cause…			

Screening Questions	Yes	No	Remarks
▪ Encroachment on historical/cultural areas; disfiguration of landscape by road embankments, cuts, fills, and quarries?	✓		No encroachment on historical but some cultural 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.
▪ Encroachment on precious ecology (e.g. sensitive or protected areas)?		✓	The project road does not pass through any National Park/Wildlife Sanctuary.
▪ Alteration of surface water hydrology of waterways crossed by roads, resulting in increased sediment in streams affected by increased soil erosion at construction site?	✓		There are significant numbers of bridges with the existing road and those bridges will be reconstructed. The bridge construction may temporally increase the sedimentation level in the river around bridge construction site. However this would be temporary and short term in nature. 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.
▪ Deterioration of surface water quality due to silt runoff and sanitary wastes from worker-based camps and chemicals used in construction?	✓		Suitable siltation prevention measures such as silt fencing is included in the EMP. Adequate measures for sanitary and construction related waste such as chemicals shall be taken to prevent contaminating local water resources.
▪ Increased local air pollution due to rock crushing, cutting and filling works, and chemicals from asphalt processing?	✓		Local air pollution level is likely to be increased for short duration during construction period particularly due to earth work. Appropriate distance from settlement area and wind direction will be taken into account to locate air polluting facility like stone crushing unit etc. if required.
▪ 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.

Screening Questions	Yes	No	Remarks
▪ Noise and vibration due to blasting and other civil works?	✓		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 are few noise sensitive locations especially schools, mosque, shrine etc. close to the alignment that will be affected adversely. 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.
▪ Dislocation or involuntary resettlement of people?		✓	There will be minimal resettlement impacts. Further details are provided in the Resettlement Plan.
▪ Dislocation and compulsory resettlement of people living in right-of-way?		✓	
▪ Disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups?		✓	
▪ 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 was wet spraying, covering of trucks, location of hot mix plants and other stationary equipment's away from settlement areas and others.
▪ 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.
▪ 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.
▪ 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.

Screening Questions	Yes	No	Remarks
▪ 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 and proper traffic signage system at sensitive places will ensure smooth traffic flow which will reduce accidental risk
▪ 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.
▪ 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.
▪ 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.
▪ 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.
▪ 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.
▪ 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**
• 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. Required design measures for adapting to future flooding events the result of climate change have been recommended to this EIA as well.

▪ Could changes in temperature, precipitation, or extreme events patterns over the Project lifespan affect technical or financial sustainability (eg., 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 it is expected that the road will be able to withstand with future changes of various climatic parameters.
▪ Are there any demographic or socio-economic aspects of the Project area that are already vulnerable (eg., 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.
▪ 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)?		✓	The project will significantly reduce the GHG emissions due to better road condition.

Note: Hazards are potentially damaging physical events.

APPENDIX D: SURFACE WATER QUALITY TEST RESULTS

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	6.86	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	82.34 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	5.06 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	3.67 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

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Form No. QSF-22 Revision No. 08 Revision Date: 24 June, 2016

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Certificate No: T-1676

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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

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*The results relate only to the items tested.

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Laboratories/Institute/Center: Institute of National Analytical Research & Service (INARS)

ANALYSIS REPORT

ASC Ref No	Mar2017001193	Unit (Lab/Inst.) Ref No	INS-454
Lab/Sample ID	A-217	Number of Sample	1
Sample Description	Test of Surface water (Oil and Grease)-SW 01	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-217	Surface water (SW-01)	Oil and Grease	18.2 mg/L	5520.B

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Laboratories/Institute/Center: Institute of National Analytical Research & Service (INARS)

ANALYSIS REPORT

ASC Ref No	: Mar2017001194	Unit (Lab/Inst.) Ref No	: INS-455
Lab/Sample ID	: A-218	Number of Sample	: 1
Sample Description	: Test of Surface water (Oil and Greese)-SW 02	Test Commencement date	: 21/03/2017
Client's Details	: Tahsin-Uz-Zaman ENRAC House#464/C (Ground Floor), Khilgaon, Dhaka-1219	Test Completion date	: 04/04/2017

Details:

Lab ID	Particulars of supplied Sample	Parameters	Concentration	Test Method (APHA)
A-218	Surface water (SW-02)	Oil and Grease	5.20 mg/L	5520.B

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ANALYSIS REPORT

ASC Ref No	: Mar2017001195	Unit (Lab/Inst.) Ref No	: INS-456
Lab/Sample ID	: A-219	Number of Sample	: 1
Sample Description	: Test of Surface water (Oil and Greese)-SW 03	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-219	Surface water (SW-03)	Oil and Grease	5.40 mg/L	5520.B

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ANALYSIS REPORT

ASC Ref No	: Mar2017001196	Unit (Lab/Inst.) Ref No	: INS-457
Lab/Sample ID	: A-220	Number of Sample	: 1
Sample Description	: Test of Surface water (Oil and Greese)-SW 04	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-220	Surface water (SW-04)	Oil and Grease	7.60 mg/L	5520.B

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ANALYSIS REPORT

ASC Ref No	: Mar2017001197	Unit (Lab/Inst.) Ref No	: INS-458
Lab/Sample ID	: A-221	Number of Sample	: 1
Sample Description	: Test of Surface water (Oil and Greese)-SW 05	Test Commencement date	: 21/03/2017
Client's Details	: Tahsin-Uz-Zaman ENRAC House#464/C (Ground Floor), Khilgaon, Dhaka-1219	Test Completion date	: 05/04/2017

Details:

Lab ID	Particulars of supplied Sample	Parameters	Concentration	Test Method (APHA)
A-221	Surface water (SW-05)	Oil and Grease	4.00 mg/L	5520.B

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ANALYSIS REPORT

ASC Ref No	: Mar2017001198	Unit (Lab/Inst.) Ref No	: INS-459
Lab/Sample ID	: A-222	Number of Sample	: 1
Sample Description	: Test of Surface water (Oil and Greese)-SW 06	Test Commencement date	: 21/03/2017
Client's Details	: Tahsin-Uz-Zaman ENRAC House#464/C (Ground Floor), Khilgaon, Dhaka-1219	Test Completion date	: 06/04/2017

Details:

Lab ID	Particulars of supplied Sample	Parameters	Concentration	Test Method (APHA)
A-222	Surface water (SW-06)	Oil and Grease	3.40 mg/L	5520.B

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ANALYSIS REPORT

ASC Ref No	: Mar2017001199	Unit (Lab/Inst.) Ref No	: INS-460
Lab/Sample ID	: A-223	Number of Sample	: 1
Sample Description	: Test of Surface water (Oil and Greese)-SW 07 (50m Up Stream)	Test Commencement date	: 21/03/2017
Client's Details	: Tahsin-Uz-Zaman ENRAC House#464/C (Ground Floor), Khilgaon, Dhaka-1219	Test Completion date	: 06/04/2017

Details:

Lab ID	Particulars of supplied Sample	Parameters	Concentration	Test Method (APHA)
A-223	Surface water, SW-07 (Up Stream)	Oil and Grease	9.60 mg/L	5520.B

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6th of April 2017 08:00 AM

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বাংলাদেশ বিজ্ঞান ও শিল্প গবেষণা পরিষদ (বিসিএসআইআর)

Laboratories/Institute/Center: Institute of National Analytical Research & Service (INARS)

ANALYSIS REPORT

ASC Ref No	: Mar2017001201	Unit (Lab/Inst.) Ref No	: INS-462
Lab/Sample ID	: A-225	Number of Sample	: 1
Sample Description	: Test of Surface water (Oil and Greese)-SW 08	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-225	Surface water (SW-08)	Oil and Grease	16.0 mg/L	5520.B

06/04/2017
Analyst
Mohammad Mojedul Haque
Scientific Officer
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BCSIR, Dhanmondi, Dhaka.

06/04/17
Supervisor
Shamim Ahmed
Senior Scientific Officer
Institute of National Analytical Research & Service (INARS)
BCSIR, Dhaka

6.4.17
Director/Officer In-Charge

Note:

a. The results reported here is based only on the supplied sample's in this laboratory
b. Any complain about test report will not be acceptable after one month from the date of issuing of the said report.
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Analytical Service Cell (ASC)
Dr. Qudrat-I-Khuda Road, Dhanmondi, Dhaka-1205,Bangladesh
Telephone:9671108,Fax: 880-02-9671108 E-mail:asc@bcsir.gov.bd

4th of April 2017 02:33 PM

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Laboratories/Institute/Center: Institute of National Analytical Research & Service (INARS)

ANALYSIS REPORT

ASC Ref No	: Mar2017001202	Unit (Lab/Inst.) Ref No	: INS-463
Lab/Sample ID	: A-226	Number of Sample	: 1
Sample Description	: Test of Surface water (Oil and Greese)-SW 09	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-226	Surface water (SW-09)	Oil and Grease	16.0 mg/L	5520.B

06/04/2017
Analyst
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06/04/17
Supervisor
Shamim Ahmed
Senior Scientific Officer
Institute of National Analytical Research & Service (INARS)
BCSIR, Dhaka.

6.4.17
Director/Officer In-Charge

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4th of April 2017 02:38 PM

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Laboratories/Institute/Center: Institute of National Analytical Research & Service (INARS)

ANALYSIS REPORT

ASC Ref No	: Mar2017001208	Unit (Lab/Inst.) Ref No	: INS-469
Lab/Sample ID	: A-232	Number of Sample	: 1
Sample Description	: Test of Surface water (Oil and Greese)-SW 10 (50m Up Stream)	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-232	Surface water, SW-10 (Up Stream)	Oil and Grease	6.00 mg/L	5520.B

06/04/2017
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BCSIR, Dhaka.

6.4.17
Director/Officer In-Charge
ড. সালমিনা আহমেদ
পরিচালক (ভারপ্রাপ্ত)
ইন্সটিটিউট অব ন্যাশনাল এনালাইটিক্যাল
রিসার্চ এন্ড সার্ভিস (আইএনএআরএস)
বিসিএসআইআর, ঢাকা।

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5th of April 2017 07:54 AM

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Laboratories/Institute/Center: Institute of National Analytical Research & Service (INARS)

ANALYSIS REPORT

ASC Ref No	: Mar2017001204	Unit (Lab/Inst.) Ref No	: INS-465
Lab/Sample ID	: A-228	Number of Sample	: 1
Sample Description	: Test of Surface water (Oil and Greese)-SW 10 (50m Down Stream)	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-228	Surface water, SW-10 (Down Stream)	Oil and Grease	10.0 mg/L	5520.B

06/04/2017
Analyst
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Supervisor
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Director/Officer In-Charge

Note:
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"[illegible]"
জীবনের জন্য বিজ্ঞান

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Laboratories/Institute/Center: Institute of National Analytical Research & Service (INARS)

ANALYSIS [illegible]ORT

ASC Ref No	: Mar2017001205	Unit (Lab/Inst.) Ref No	: INS-466
Lab/Sample ID	: A-229	Number of Sample	: 1
Sample Description	: Test of Surface water (Oil and Greese)-SW 11	Test Commencement date	: 21/03/2017
Client's Details	: Tahsin-Uz-Zaman ENRAC House#464/C (Ground Floor), Khilgaon, [illegible]		

Details:

Lab ID	Particulars of supplied Sample	Parameters	Concentration	Test Method (APHA)
A-229	Surface water (SW-11)	Oil and Grease	9.60 mg/L	5520.B

06/04/2017
Analyst
Mohammad Majedul Haque
Scientific Officer
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06/04/17
Supervisor
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ড. শামিমা আহমেদ
পরিচালক (চলতি দায়িত্ব)
[illegible]

Note:

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5th of April 2017 07:26 AM

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Laboratories/Institute/Center: Institute of National Analytical Research & Service (INARS)

ANALYSIS REPORT

ASC Ref No	: Mar2017001206	Unit (Lab/Inst.) Ref No	: INS-467
Lab/Sample ID	: A-230	Number of Sample	: 1
Sample Description	: Test of Surface water (Oil and Greese)-SW 12	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-230	Surface water (SW-12)	Oil and Grease	6.80 mg/L	5520.B

06/04/2017
Analyst

06/04/17
Supervisor
Shamim Ahmed
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5th of April 2017 07:39 AM

BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH (BCSIR)

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Laboratories/Institute/Center: Institute of National Analytical Research & Service (INARS)

ANALYSIS REPORT

ASC Ref No	: Mar2017001203	Unit (Lab/Inst.) Ref No	: INS-464
Lab/Sample ID	: A-227	Number of Sample	: 1
Sample Description	: Test of Surface water (Oil and Greese)-SW 10 (50m Up Stream)	Test Commencement date	: 21/03/2017
Client's Details	: Tahsin-Uz-Zaman ENRAC House#464/C (Ground Floor), Khilgaon, Dhaka-1219	Test Completion date	: 05/04/2017

Details:

Lab ID	Particulars of supplied Sample	Parameters	Concentration	Test Method (APHA)
A-227	Surface water, SW-13 (Up Stream)	Oil and Grease	7.40 mg/L	5520.B

06/04/2017
Analyst
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BCSIR, Dhaka

Director/Officer In-Charge

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Laboratories/Institute/Center: Institute of National Analytical Research & Service (INARS)

ANALYSIS REPORT

ASC Ref No	: Mar2017001207	Unit (Lab/Inst.) Ref No	: INS-458
Lab/Sample ID	: A-231	Number of Sample	: 1
Sample Description	: Test of Surface water (Oil and Grease)-SW 13 (50m Down Stream)	Test Commencement date	: 21/03/2017
Client's Details	: Tahsin-Uz-Zaman ENRAC House#464/C (Ground Floor), Khilgaon, Dhaka-1219	Test Completion date	: 05/04/2017

Details:

Lab ID	Particulars of supplied Sample	Parameters	Concentration	Test Method (APHA)
A-231	Surface water, SW-13 (Down Stream)	Oil and Grease	11.4 mg/L	5520.B

06/04/2017
Analyst
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Supervisor
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Director/Officer In-Charge
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ইন্সটিটিউট অব ন্যাশনাল এনালাইটিক্যাল
রিসার্চ এন্ড সার্ভিস (আইএনএএস)
বিসিএসআইআর, ঢাকা।

Note:
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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 Greese)-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

06/04/2017
Analyst
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BCSIR, Dhaka

6-4-17
Director/Officer In-Charge

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5th of April 2017 08:00 AM

APPENDIX E: GROUNDWATER QUALITY TEST RESULTS

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Mohakhali, Dhaka-1212
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Fax : +880-2-9827062
Web : http://www.icddrb.org

Environmental Microbiology Laboratory

Test Report

Lab. ID No.2017031011
Receipt No: MAR1708298

Date of Reporting: 20.03.2017
Date of Sample Tested: 15.03.2017
Date of Sample Received: 15.03.2017

Particular of Sample: Drinking Water

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.

Dr. Zahid Hayat Mahmud
Associate Scientist and Head
Environmental Microbiology Lab, LSSD, icddr,b

Tested By (Code No.): 7, 8
EM.FM.007.01 Effective Date 30/03/2016

Checked By (Code No.): 2
End of the Report

icddr,b
Centre for Food and Waterborne Diseases
Mohakhali, Dhaka-1212
Phone : +880-2-9827001-10/2405
Fax : +880-2-9827062
Web : http://www.icddrb.org

Environmental Microbiology Laboratory

Test Report

Lab. ID No.2017031010
Receipt No: MAR1708299

Date of Reporting: 20.03.2017
Date of Sample Tested: 15.03.2017
Date of Sample Received: 15.03.2017

Particular of Sample: Drinking Water

Client Address: ENRAC GW 03, Sherpur Bazar.

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.

Dr. Zahid Hayat Mahmud
Associate Scientist and Head
Environmental Microbiology Lab, LSSD, icddr,b

Tested By (Code No.): 7, 8
EM.FM.007.01 Effective Date 30/03/2016

Checked By (Code No.): 2

End of the Report

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Web : http://www.icddrb.org

Environmental Microbiology Laboratory

Test Report

Lab. ID No.2017031002

Receipt No: MAR1708300

Date of Reporting: 20.03.2017
Date of Sample Tested: 15.03.2017
Date of Sample Received: 15.03.2017

Particular of Sample: Drinking Water

Client Address: ENRAC GW 04, Ariabazar.

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.

Dr. Zahid Hayat Mahmud
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Tested By (Code No.): 7, 8
EM.FM.007.01 Effective Date 30/03/2016

Checked By (Code No.): 2

End of the Report

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Environmental Microbiology Laboratory

Test Report

Lab. ID No.2017031003
Receipt No: MAR1708301

Date of Reporting: 20.03.2017
Date of Sample Tested: 15.03.2017
Date of Sample Received: 15.03.2017

Particular of Sample: Drinking Water

Client Address: ENRAC GW 05, Bogra Rail.

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	24	0	0	Membrane Filtration
2	Faecal coliforms	CFU /100mL	16	0	0	Membrane Filtration

Comment: The supplied water sample is contaminated with total coliforms and faecal coliforms.

N.B: This report is valid only for particular sample tested and cannot be used for publicity.

Dr. Zahid Hayat Mahmud
Associate Scientist and Head
Environmental Microbiology Lab, LSSD, icddr,b

Tested By (Code No.): 7, 8
EM.FM.007.01 Effective Date 30/03/2016

Checked By (Code No.): 2

End of the Report

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Environmental Microbiology Laboratory

Test Report

Lab. ID No.2017031004

Receipt No: MAR1708302

Date of Reporting: 20.03.2017
Date of Sample Tested: 15.03.2017
Date of Sample Received: 15.03.2017

Particular of Sample: Drinking Water

Client Address: ENRAC GW 06, Matidhali, Biman Mor.

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.

Dr. Zahid Hayat Mahmud
Associate Scientist and Head
Environmental Microbiology Lab, LSSD, icddr,b

Tested By (Code No.): 7, 8
EM.FM.007.01 Effective Date 30/03/2016

Checked By (Code No.): 2

End of the Report

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Web : http://www.icddrb.org

Environmental Microbiology Laboratory

Test Report

Lab. ID No.2017031005
Receipt No: MAR1708303

Date of Reporting: 20.03.2017
Date of Sample Tested: 15.03.2017
Date of Sample Received: 15.03.2017

Particular of Sample: Drinking Water

Client Address: ENRAC GW 07, Polashbari Chowmatha.

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.

Dr. Zahid Hayat Mahmud
Associate Scientist and Head
Environmental Microbiology Lab, LSSD, icddr,b

Tested By (Code No.): 7, 8
EM.FM.007.01 Effective Date 30/03/2016

Checked By (Code No.): 2
End of the Report

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Fax : +880-2-9827062
Web : http://www.icddrb.org

Environmental Microbiology Laboratory

Test Report

Lab. ID No.2017031009
Receipt No: MAR1708305

Date of Reporting: 20.03.2017
Date of Sample Tested: 15.03.2017
Date of Sample Received: 15.03.2017

Particular of Sample: Drinking Water

Client Address: ENRAC GW 08, Mithipur Union Pourashava.

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	15	0	0	Membrane Filtration
2	Faecal coliforms	CFU /100mL	5	0	0	Membrane Filtration

Comment: The supplied water sample is contaminated with total coliforms and faecal coliforms.

N.B: This report is valid only for particular sample tested and cannot be used for publicity.

Dr. Zahid Hayat Mahmud
Associate Scientist and Head
Environmental Microbiology Lab, LSSD, icddr,b

Tested By (Code No.): 7, 8
EM.FM.007.01 Effective Date 30/03/2016

Checked By (Code No.): 2

End of the Report

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Web : http://www.icddrb.org

Environmental Microbiology Laboratory

Test Report

Lab. ID No.2017031008
Receipt No: MAR1708306

Date of Reporting: 20.03.2017
Date of Sample Tested: 15.03.2017
Date of Sample Received: 15.03.2017

Particular of Sample: Drinking Water

Client Address: ENRAC GW 09, Mithapukur

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.

Dr. Zahid Hayat Mahmud
Associate Scientist and Head
Environmental Microbiology Lab, LSSD, icddr,b

Tested By (Code No.): 7, 8
EM.FM.007.01 Effective Date 30/03/2016

Checked By (Code No.): 2
End of the Report

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Centre for Food and Waterborne Diseases
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Web : http://www.icddrb.org

Environmental Microbiology Laboratory

Test Report

Lab. ID No.2017031006

Receipt No: MAR1708307

Date of Reporting: 20.03.2017
Date of Sample Tested: 15.03.2017
Date of Sample Received: 15.03.2017

Particular of Sample: Drinking Water

Client Address: ENRAC GW 10, Asshotpur, Parker Mor, Rangpur

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.

Dr. Zahid Hayat Mahmud
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Environmental Microbiology Lab, LSSD, icddr,b

Tested By (Code No.): 7, 8
EM.FM.007.01 Effective Date 30/03/2016

Checked By (Code No.): 2
End of the Report

Form No. QSF-22 Revision No. 08 Revision Date: 24 June, 2016
ISO/IEC 17025:2005 Certified
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

25-05-2016

Sig and Name of the Validator
Md. Aminul Ahsan
Principal Scientific Officer
Institute of National Analytical Research & Service (INARS)

*The results relate only to the items tested.

Dr. Qudrat-I-Khuda Road, Dhanmondi, Dhaka-1205, Tel.: 88-02-8621741, 9664959, Fax: 880-2-8613022;
PABX: 8611057-61, 8625038-9, 8626034-5, 8626032, Ext/325, E-mail: directorbi@yahoo.com, bcsir@bangla.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-113, Date : 20-03-2017 | Unit (Lab/Inst.) Ref. No. : 113, Date : 21-03-2017

Lab / Sample ID : SE - 536 | Number of Sample : 09

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	66.5 ppm
SE 536-04	GW 05	6.95	0.383 ppm	6.64 ppb	0.059 ppm	26.79 ppm	86.8 ppm
SE 536-05	GW 06	6.66	0.564 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
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6.4.17

Director / Officer-In-Charge
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Director (Addl.-Charge)
BCSIR Laboratories, Dhaka
Dr. Qudrat-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)
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APPENDIX F: AIR QUALITY IMPACTS ASSESSMENT OF PROPOSED HIGHWAY CORRIDOR OF HATIKAMRUL-RANGPUR

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 PM_{10} 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 PM_{10} 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 PM_{10}.

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 is the dominating vehicles category (33%) along the road corridors.

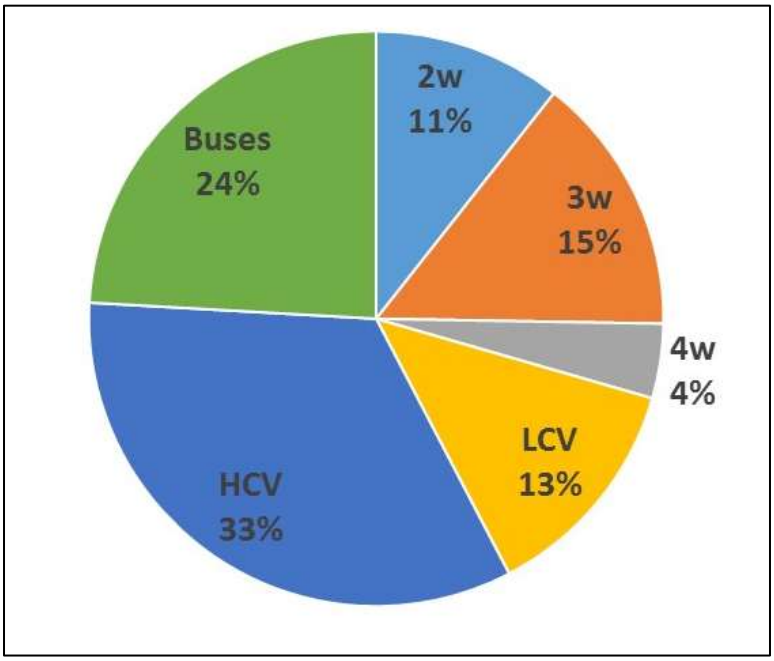


Figure F-1: Traffic Fleet on the proposed Highway Corridor

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

Road Section	Years	Motor Cycles (2W)	Auto Rickshaw (3W)	Car (4W)	Light Commercial Vehicles (LCV)	HCV	Bus	Total
Hatikamrul-Bhuyangati	2016	396	389	417	1147	7172	4479	14000
	2020	518	509	546	1545	12843	5871	21832
	2025	694	681	731	2069	17186	8406	29767
	2030	928	912	978	2767	23000	11248	39833
	2035	1242	1220	1309	3704	30779	15053	53307
	2040	1663	1633	1751	4956	41190	20144	71337
Sherpur-Sherpur	2016	2281	3474	698	3366	6129	4562	20510
	2020	2989	4554	916	4520	11196	5981	30156
	2025	4000	6094	1225	6048	14983	8563	40913
	2030	5353	8155	1640	8093	20051	11460	54752
	2035	7164	10914	2194	10831	26832	15336	73271
	2040	9587	14605	2936	14494	35907	20523	98052
Bogra 2nd By pass-Sultanganj, Banani,	2016	2814	8321	1638	2879	6297	5271	27220
	2020	3688	10908	2147	3900	11472	6909	39024
	2025	4935	14597	2874	5220	15352	9893	52871
	2030	6605	19534	3846	6985	20544	13239	70753
	2035	8838	26141	5146	9348	27492	17717	94682
	2040	11828	34982	6887	12510	36791	23709	126707
Kashi pur(Mokamtola)-Gabin	2016	1175	1154	414	1989	4645	3331	12708
	2020	1541	1513	542	2688	8788	4365	19437
	2025	2062	2025	726	3597	11759	6250	26419

Road Section	Years	Motor Cycles (2W)	Auto Rickshaw (3W)	Car (4W)	Light Commercial Vehicles (LCV)	HCV	Bus	Total
	2030	2759	2710	971	4813	15737	8363	35353
	2035	3692	3626	1300	6441	21059	11191	47309
	2040	4941	4853	1739	8620	28182	14977	63312
Palashbari-Pirganj, Ekberpur	2016	626	216	223	987	2679	1719	6450
	2020	820	283	292	1325	5183	2254	10157
	2025	1097	379	391	1774	6935	3227	13803
	2030	1468	507	523	2373	9280	4319	18470
	2035	1965	679	701	3176	12419	5780	24720
	2040	2630	908	937	4250	16621	7735	33081
Pirganj-Mithapukur	2016	583	73	227	741	2753	1668	6045
	2020	765	96	298	1002	5301	2186	9648
	2025	1023	128	399	1341	7094	3130	13115
	2030	1370	171	533	1794	9493	4188	17549
	2035	1833	229	714	2401	12703	5605	23485
	2040	2453	307	955	3213	16999	7501	31428
Mithapukur-Rangpur Modern More, Pairabond	2016	2607	812	518	1591	3409	2743	11680
	2020	3418	1064	678	2148	6325	3597	17230
	2025	4574	1424	908	2875	8464	5149	23394
	2030	6121	1906	1215	3848	11327	6891	31308
	2035	8191	2551	1626	5149	15158	9222	41897
	2040	10961	3414	2176	6890	20285	12340	56066

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 PM_{10} 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 PM_{10} 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 PM_{10}, 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 PM_{10} is 0.3 g/VKT
sL = road surface silt loading (g/m^2) = 0.531 g/m^2 (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 PM_{10} 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	7.72	1.48	3.21
2020	7.68	1.61	3.34
2025	7.67	1.61	3.35
2030	7.67	1.61	3.35
2035	7.67	1.61	3.35
2040	7.67	1.61	3.35

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.

TableF-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	^{0}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).

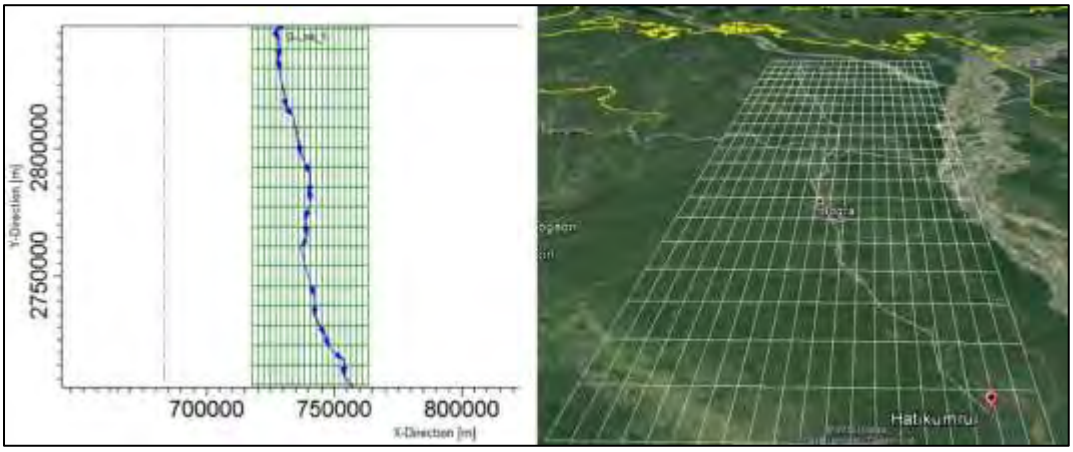


Figure F-2: Road alignment and receptor grid representation in Model and Google Earth view

D. Results

10. The model has been setup and run to predict hourly average CO, $PM_{2.5}$ and PM_{10} 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 50-60% of total concentration at receptor locations.

Table F-5: Monitored and Predicted Concentration at selected location (kerb) along the road

Parameter	Concentrations					
	Monitored			Predicted		
	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	CO (ppm)	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	CO (ppm)
Hatikamrul	27.77	65.78	0	18	29	0.1
Elenga – Gaibandha Rangpur Intersection	30.88	70.07	0	13	26	0
Pirganj Bus Stand	40.32	93.75	0	18	29	0
Rangpur Parker Mor	37.63	66.66	0	15	28.6	0

11. The predicted hourly average concentration of CO, $PM_{2.5}$ and PM_{10} during peak traffic hour are shown in table 6. The graphical representation of hourly average pollutant concentrations on both side of the road sections shown in figures 3 – 5 at different locations.

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	0.1		0.1	0	0	0	0	0	0
$PM_{2.5}$ ($\mu g/m^3$)	0.00	1.80	3.60	7.20	12.60	16.56	18.00		13.00	9.10	7.80	3.90	2.60	0.00	0.00
PM_{10} ($\mu g/m^3$)	1.11	2.90	5.80	11.60	20.30	26.68	29.00		22.00	15.40	14.30	6.60	6.60	2.20	1.12

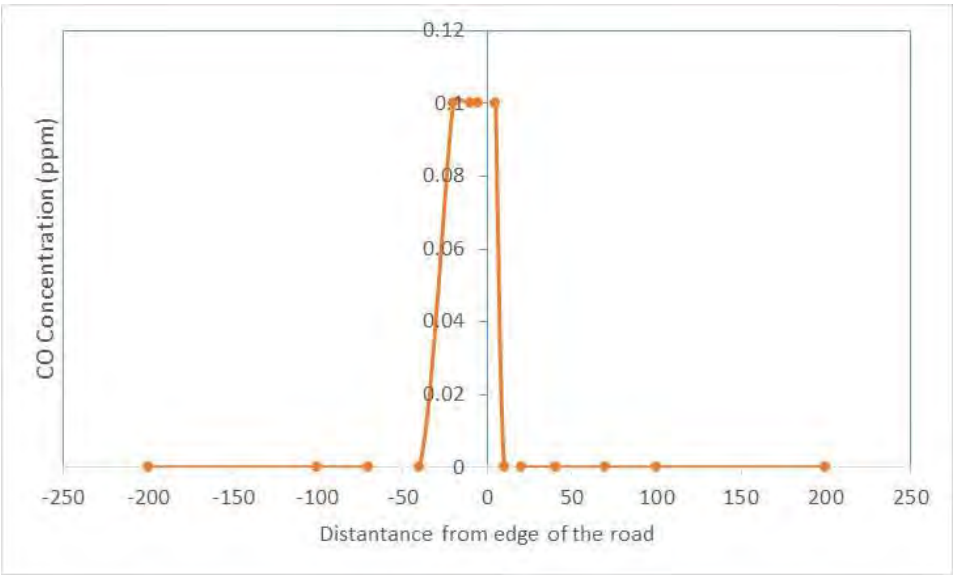


Figure F-3: CO predicted concentrations (ppm) along the proposed highway corridor (Left Side is of graph represent downwind side)

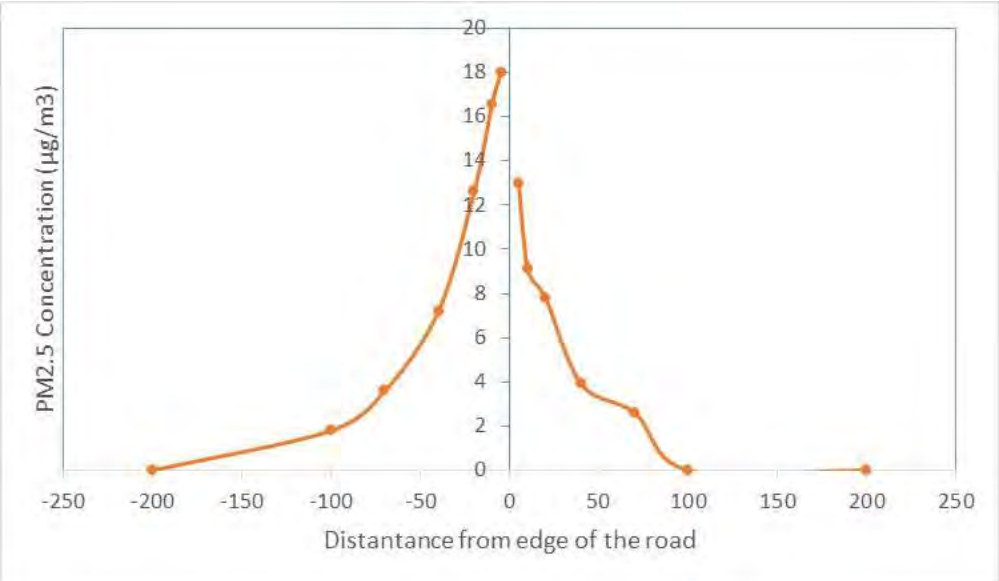


Figure F-4: $PM_{2.5}$ predicted concentrations (µg/m^3) along the proposed highway corridor (Left Side is of graph represent downwind side)

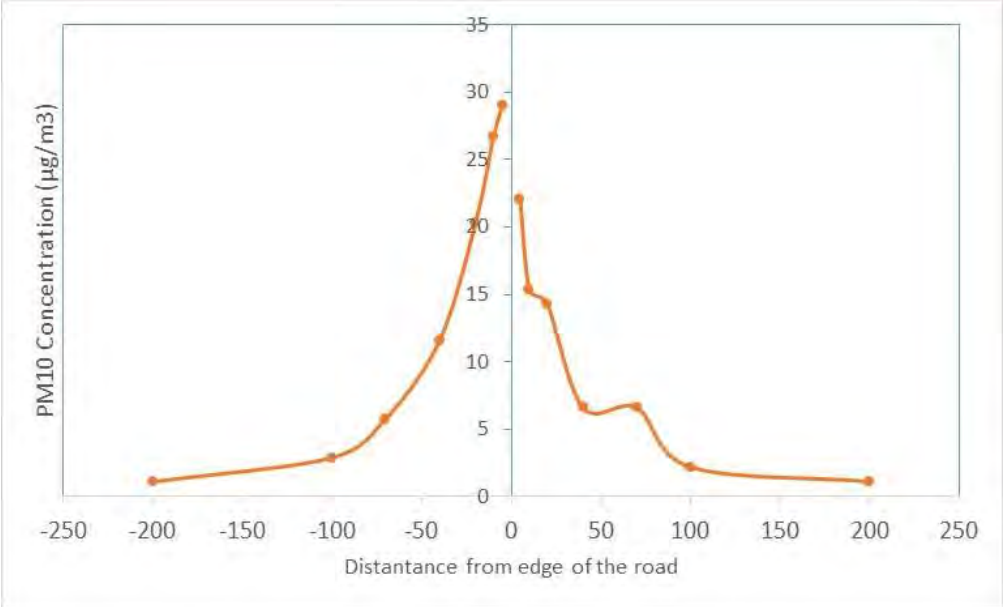
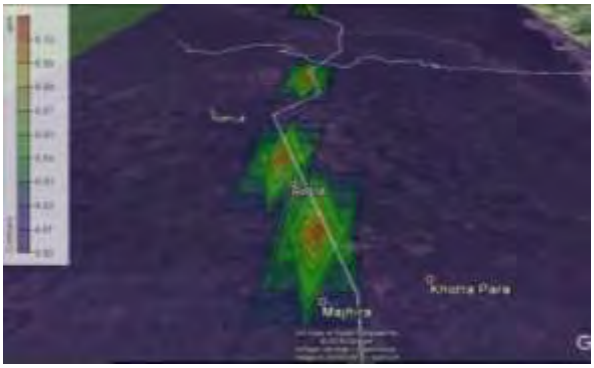


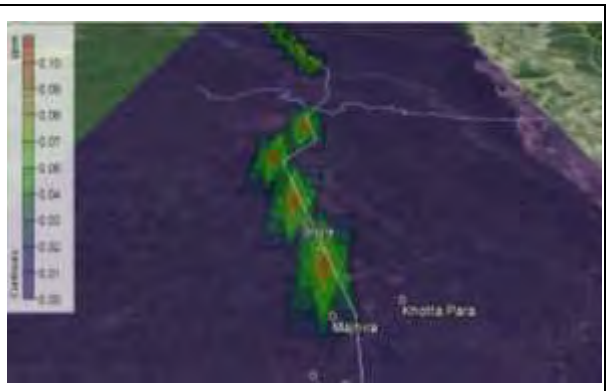
Figure F-5: PM_{10} predicted concentrations (µg/m^3) along the proposed highway corridor (Left Side is of graph represent downwind side)

12. In addition, the spatial distribution of hourly average predicted CO, $PM_{2.5}$ and PM_{10}, 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.

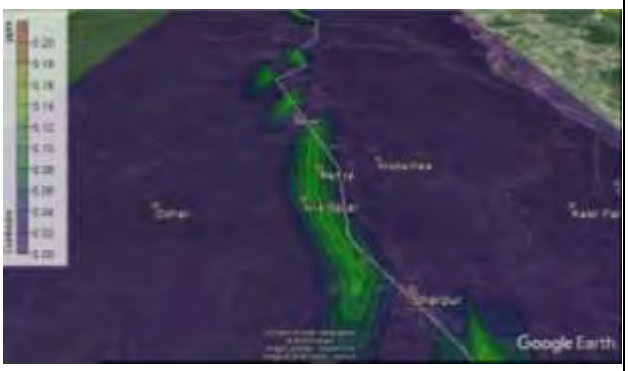
Figure F-6: Spatial distribution of CO concentrations



Year 2016



Year 2020



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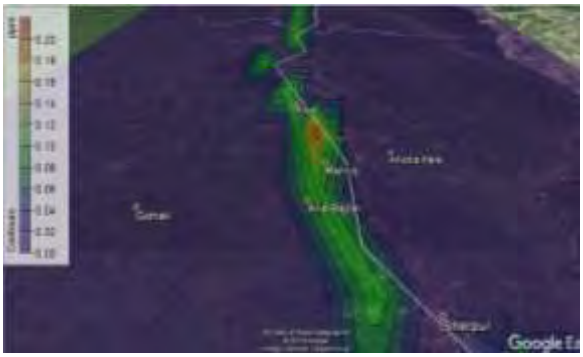
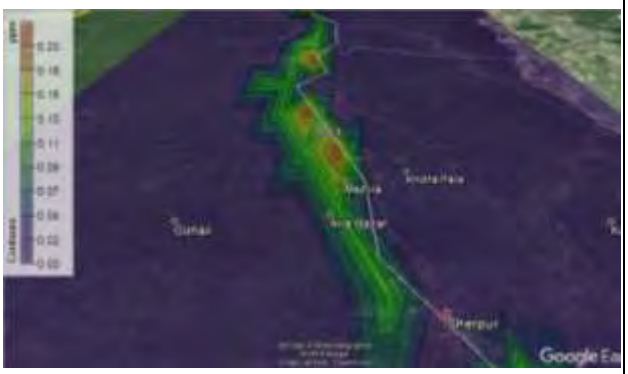
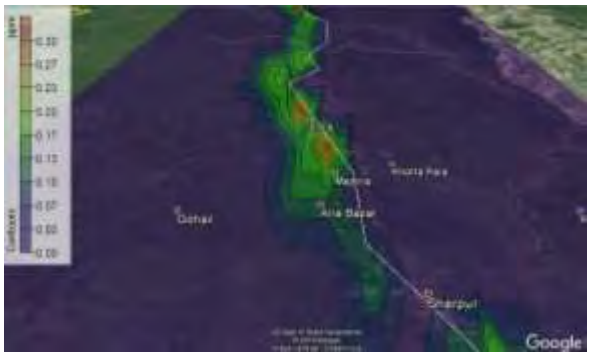


Year 2030

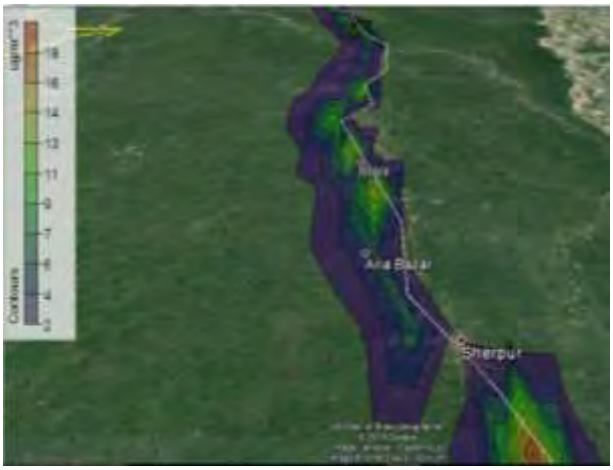


Year 2035



Year 2040

Figure F-7: Spatial distribution of $PM_{2.5}$ concentrations

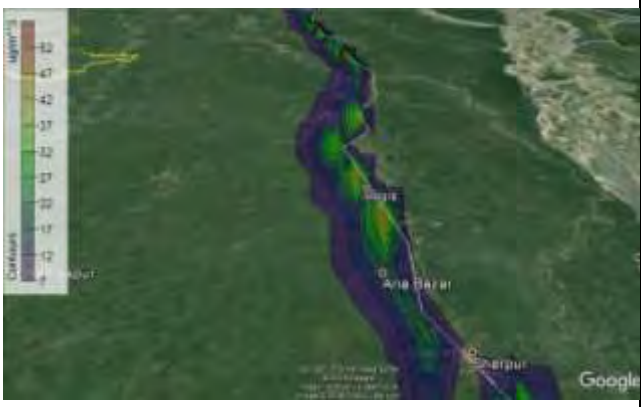


Year 2016

Year 2020

Year 2025

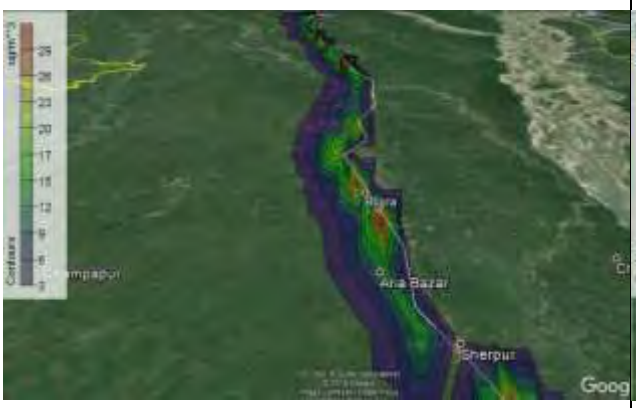
Year 2030



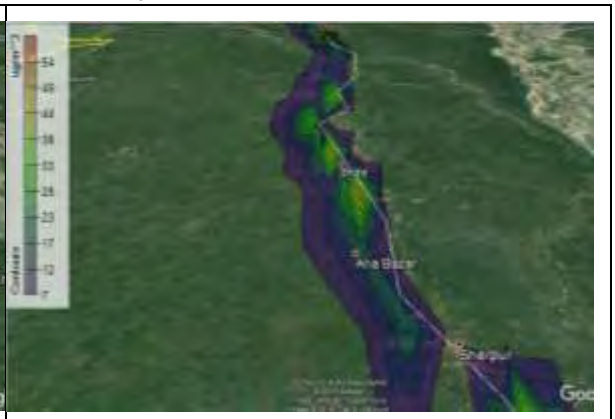
Year 2035

Year 2040

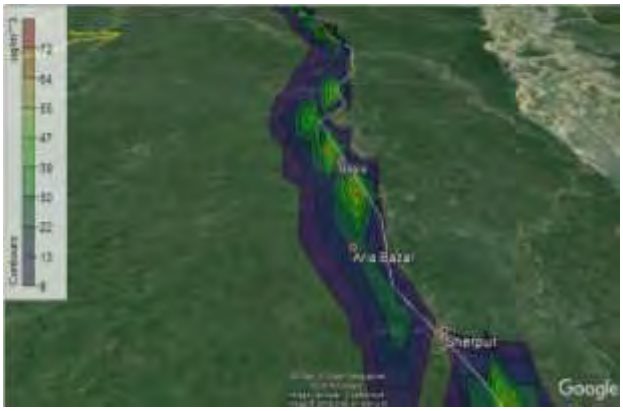
Figure F-8: Spatial distribution of PM_{10} concentrations



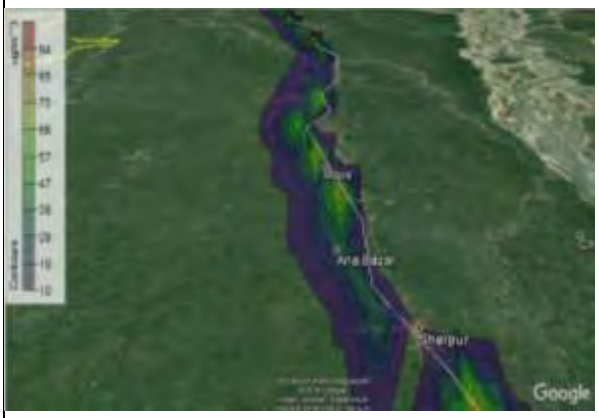
Year 2016



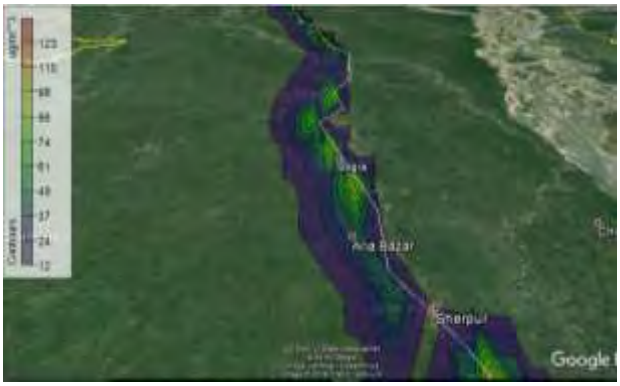
Year 2020



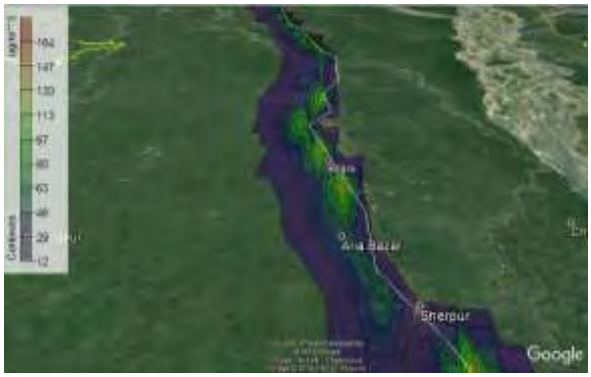
Year 2025



Year 2030



Year 2035



Year 2040

13. The summary of maximum GLC of CO, $PM_{2.5}$ and PM_{10} at kerb side of road in downwind side are described in Table 7.

Table F-7: Maximum GLC of CO, $PM_{2.5}$ and PM_{10} at kerb side of road in downwind side

Year	CO	$PM_{2.5}$	PM_{10}
2016	0.1	18	29
2020	0.1	25	54
2025	0.2	32	72
2030	0.2	40	94
2035	0.2	52	123
2040	0.3	75	164

Reference:

- 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 CORRIDOR
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.

A. 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.

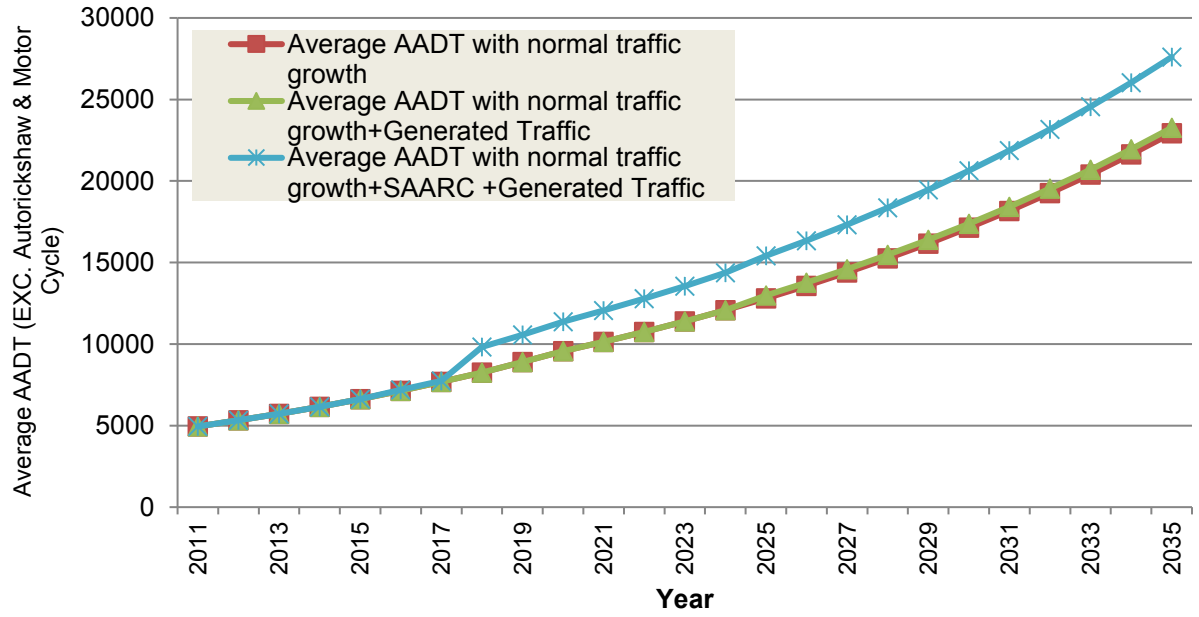


Figure G-1: Traffic Forecast of Rangpur-Hatikamrul Road
(Source: STPPF (Road Component - Package 1) –Traffic Forecast Report – Feb 2014)

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. withZ-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

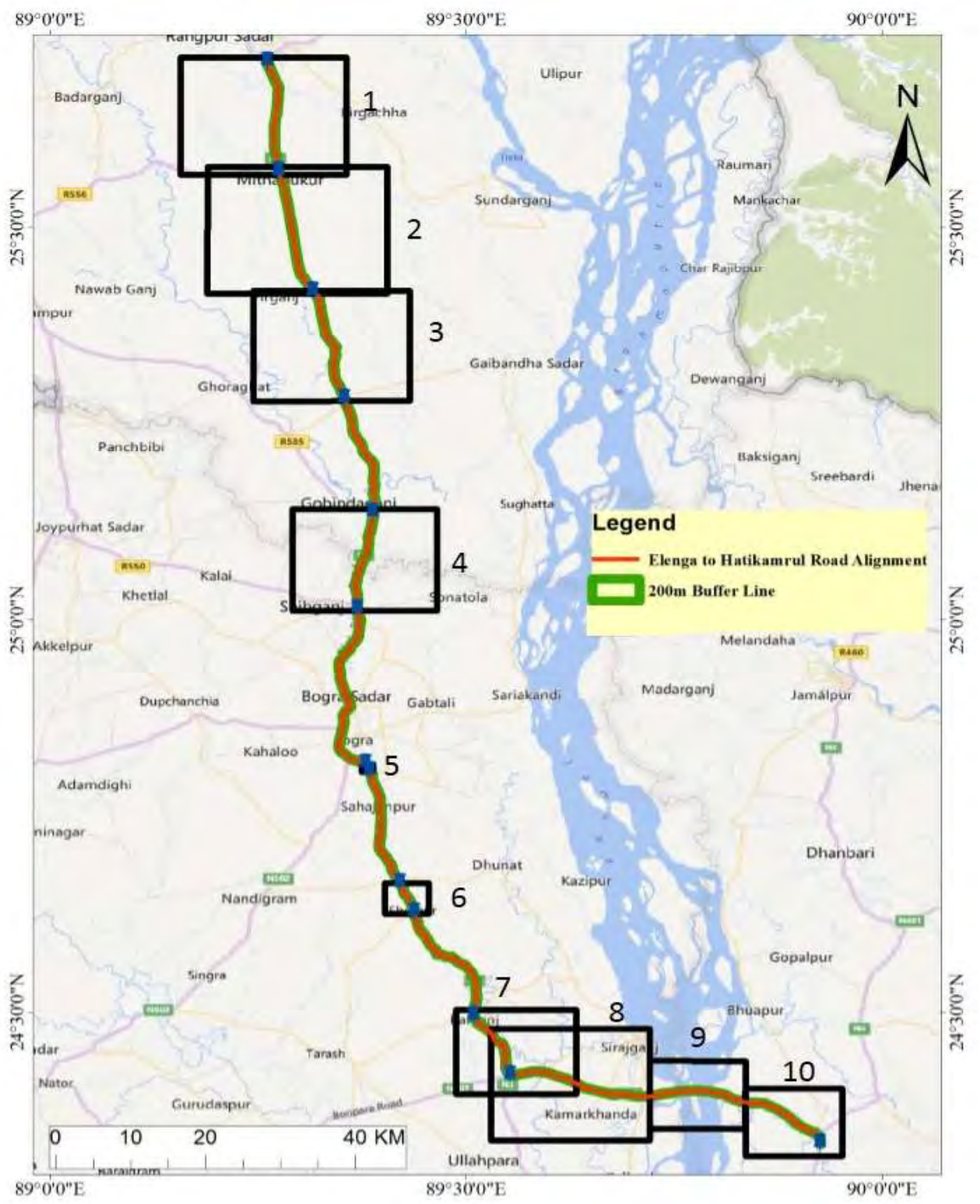


Figure G-2: The different road sections in which noise emission modeling has been performed. Boxes 1 – 10 are delineated in the figure to highlight the road sections (see Table 1 for details) in which noise simulations were made.

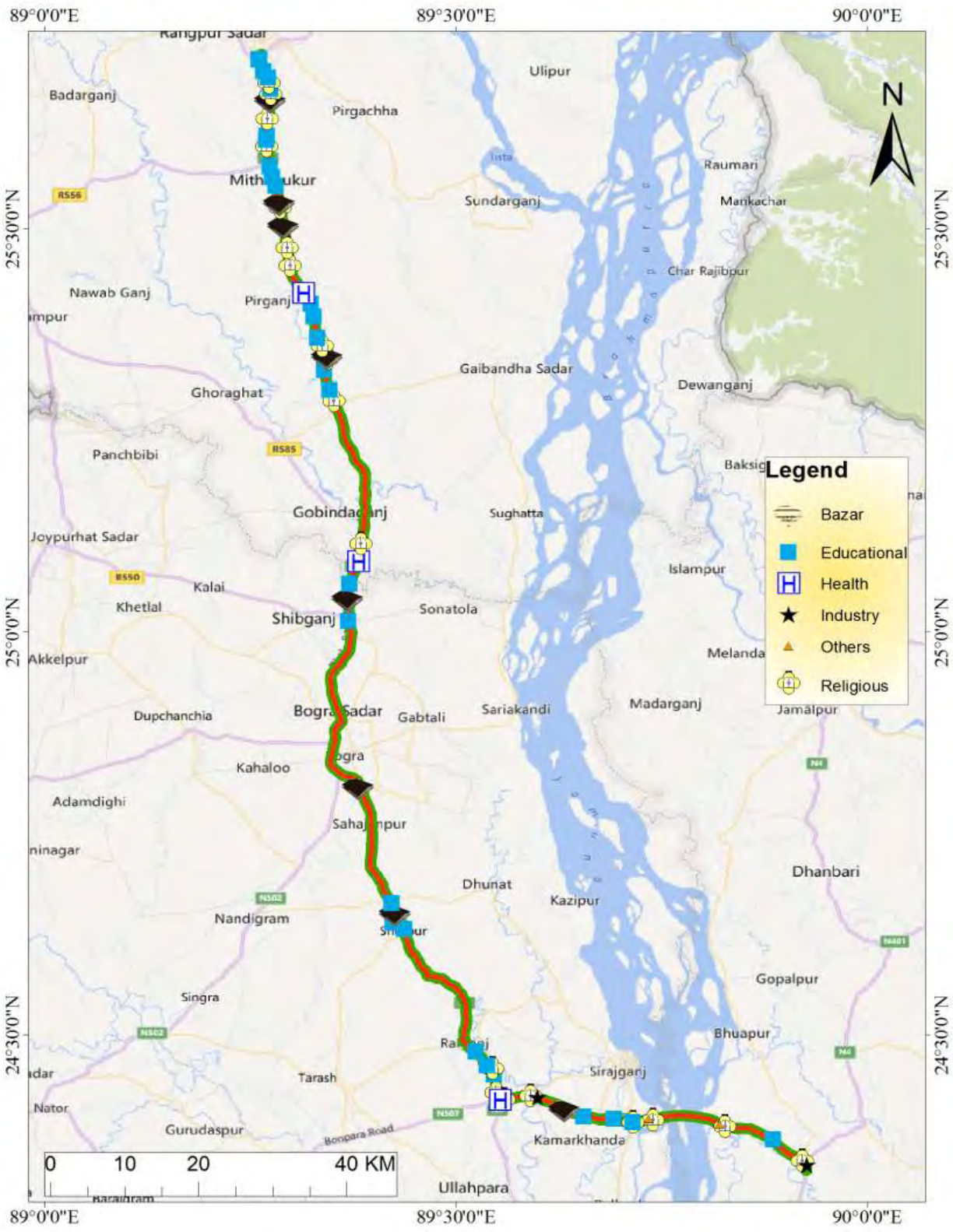


Figure G-3: Location of sensitive noise receptors where baseline noise measurements were carried out along the Elenga- Hatikamrul-Rangpur route

B. Identification of Sensitive Noise Receptors in the Road Network

4. 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 (Leq)[24] 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.

C. Noise Impact on Roadside Environment

5. 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

6. 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.

[24] The 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-the measurement interval and L_i is the mid-point of that interval

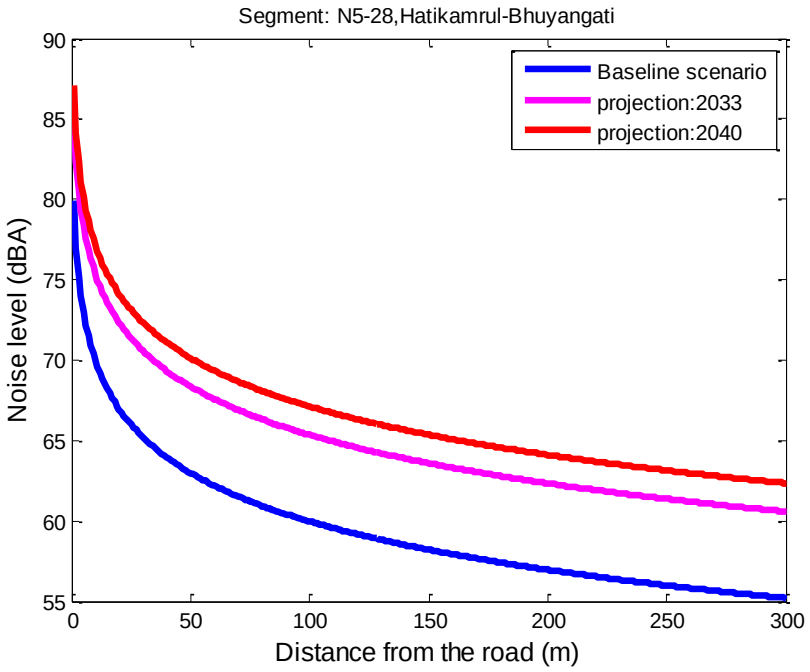


Figure G-4 (a): Noise Prediction under different scenarios as a function of the distance from the road in the Hatikamrul-Bhuyangati segment

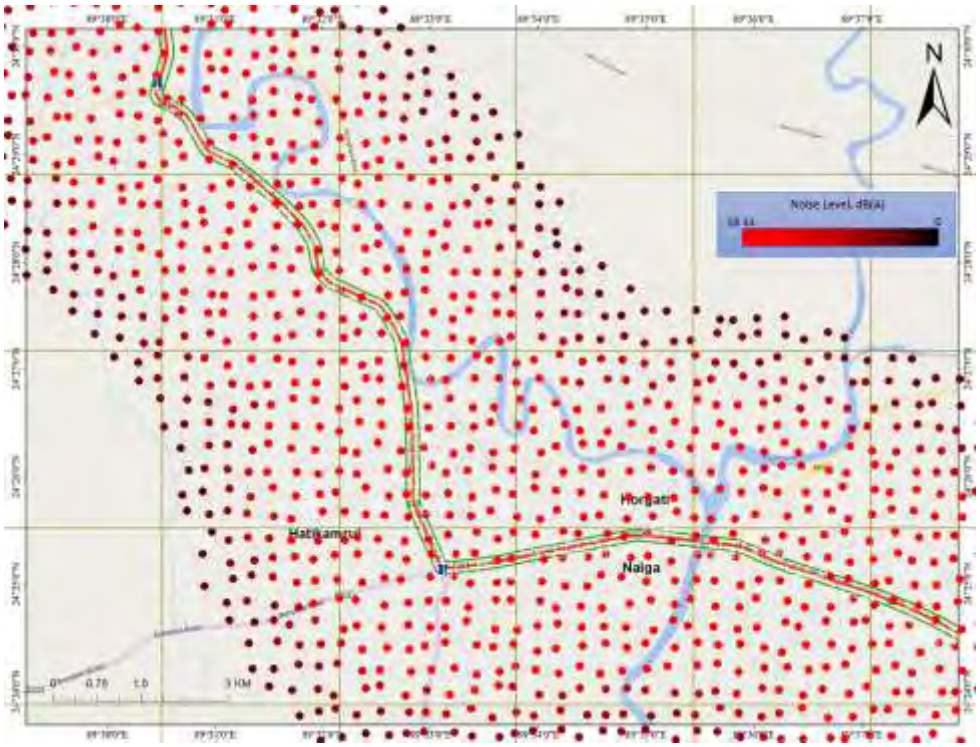


Figure G-4 (b): Spatial noise intensity map of the Hatikamrul-Bhuyangati segment (Box 7)

Table G-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)

7. 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.

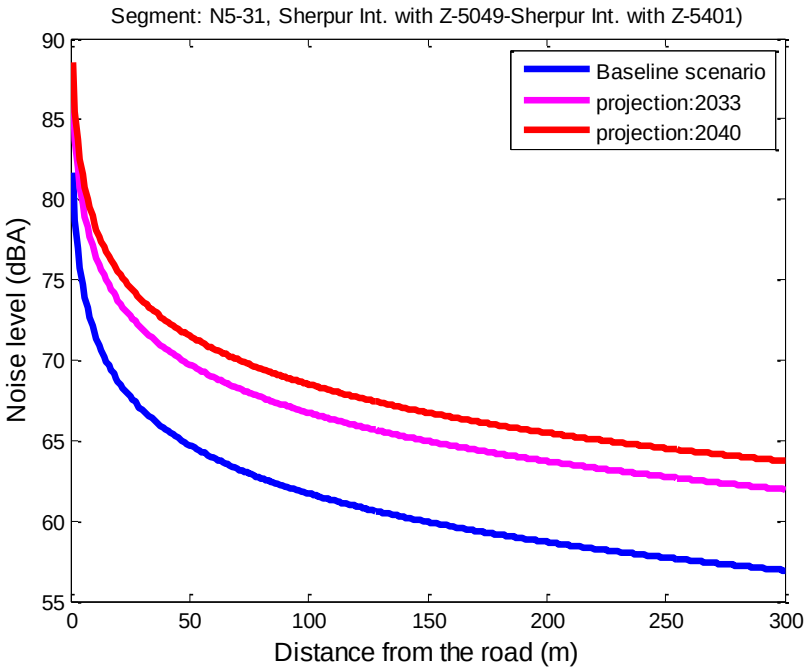


Figure G-5 (a): Noise Prediction under different scenarios as a function of the distance from the road in the N5-31, Sherpur Int. with Z-5049)-Sherpur (Int. with Z-5401)

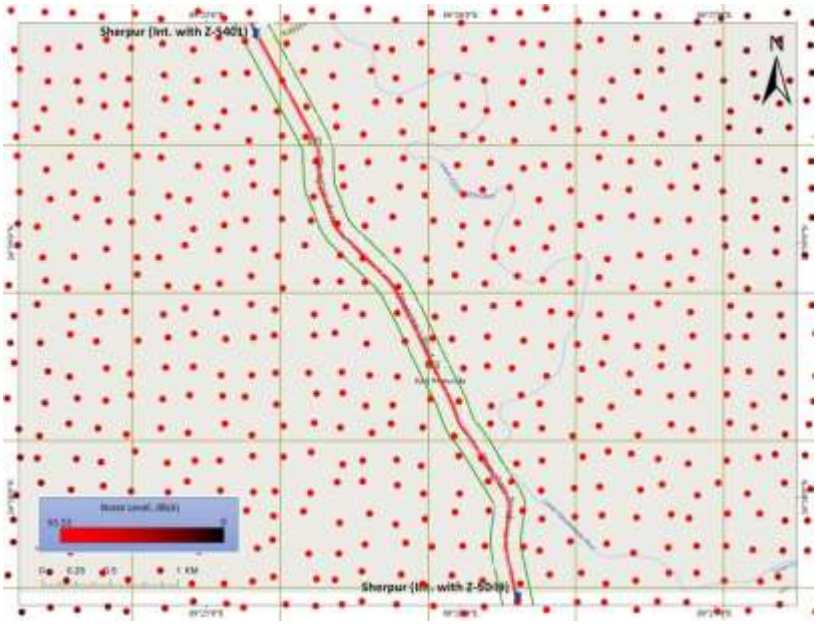


Figure G-5 (b): Spatial noise intensity map of the N5-31, Sherpur Int. with Z-5049)-Sherpur (Int. with Z-5401) (Box 6)

Table G-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**

3. N5-33, between Int. with Bogra 2nd By pass-Sultanganj, Banani

8. 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

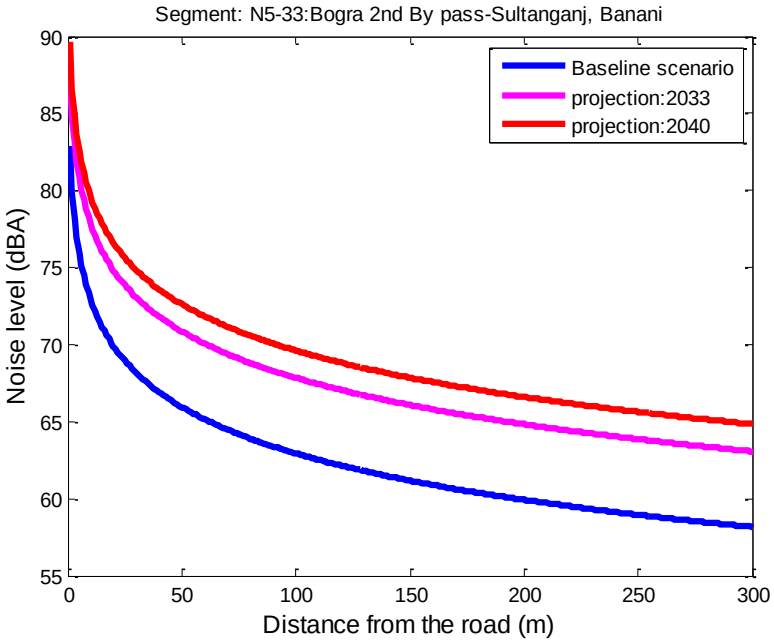


Figure G-6 (a): Noise Prediction under different scenarios as a function of the distance from the road in the N5-33, between Int. with Bogra 2nd By pass-Sultanganj, Banani

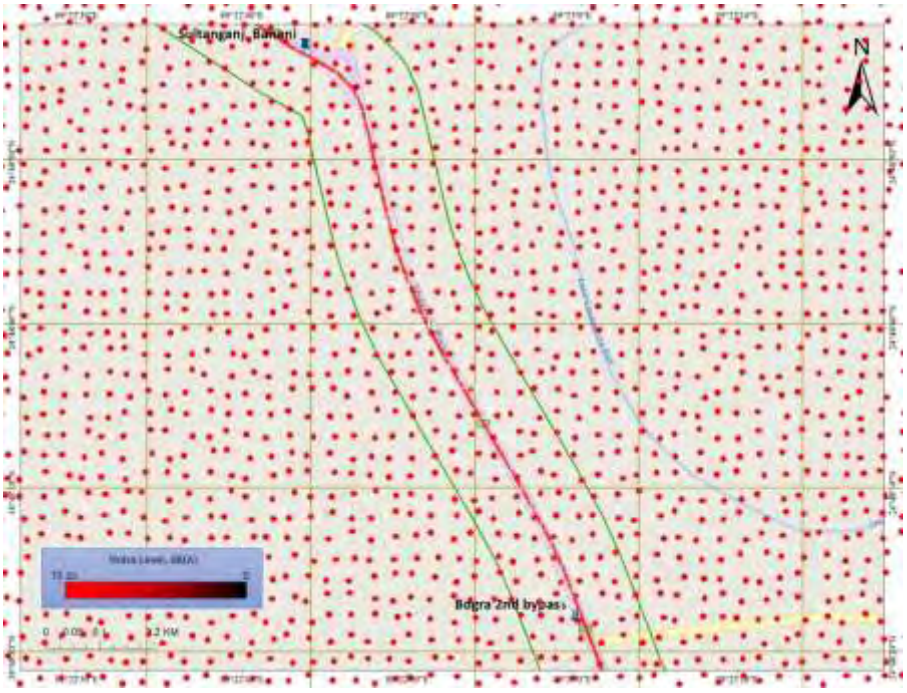


Figure G-6 (b): Spatial noise intensity map of the N5-33, between Int. with Bogra 2nd Bypass-Sultanganj, Banani (Box 5)

4. N5-45, between Kashipur (Mokamtola)-Gabindaganj, Pakurtala

9. 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.

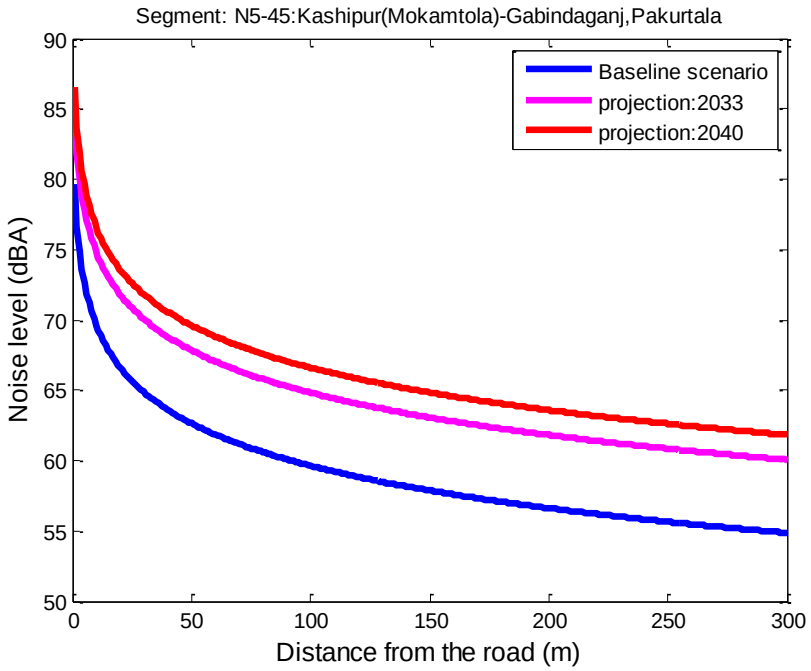


Figure G-7(a): Noise Prediction under different scenarios as a function of the distance from the road in the N5-45, between Kashipur (Mokamtola)-Gabindaganj, Pakurtala

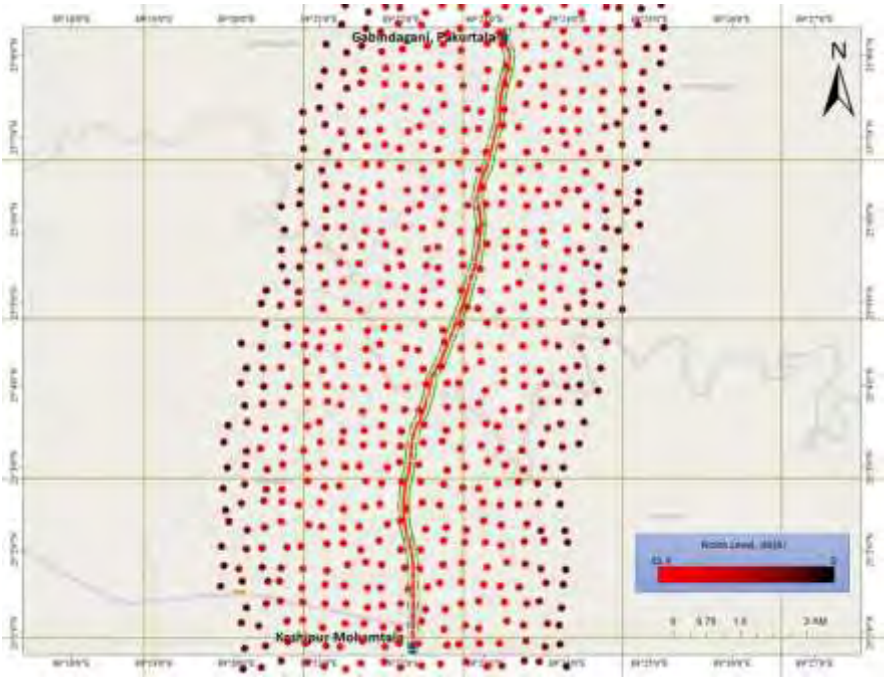


Figure G-7(b): Spatial noise intensity map of the N5-45, between Kashipur (Mokamtola)-Gabindaganj, Pakurtala (Box 4)

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

5. N5-48, between Palashbari-Pirganj, Ekberpur

10. 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.

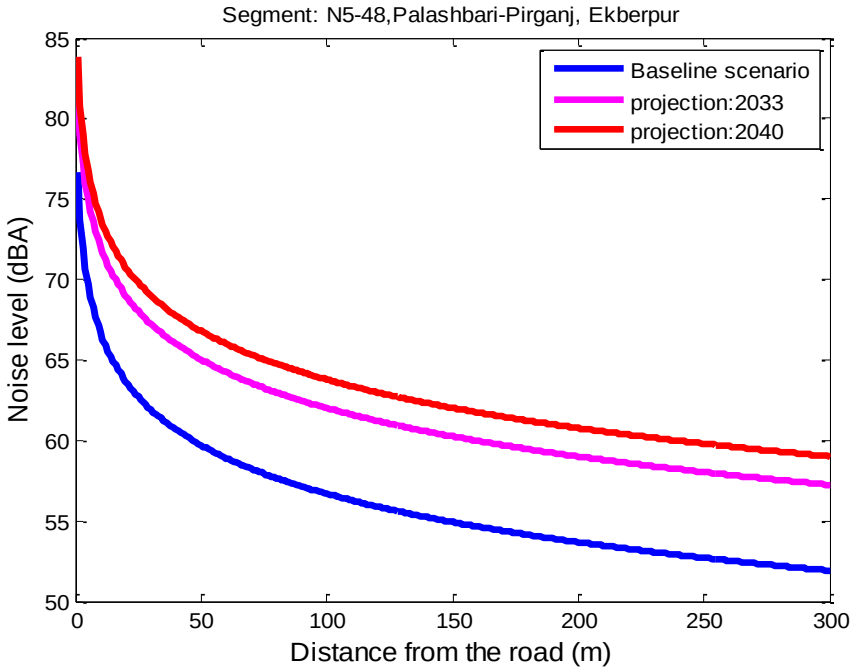


Figure G-8 (a): Noise Prediction under different scenarios as a function of the distance from the road in the N5-48, between Palashbari-Pirganj, Ekberpur

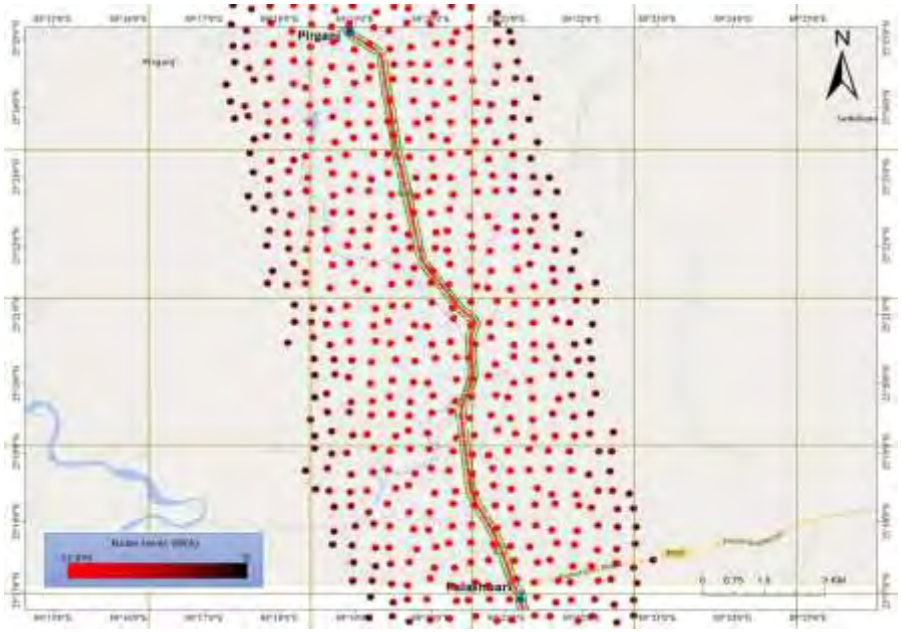


Figure G-8 (b): Spatial noise intensity map of the N5-48, between Palashbari-Pirganj, Ekberpur (Box 3)

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

6. N5-48, between Pirganj, Ekberpur -Mithapukur

11. 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

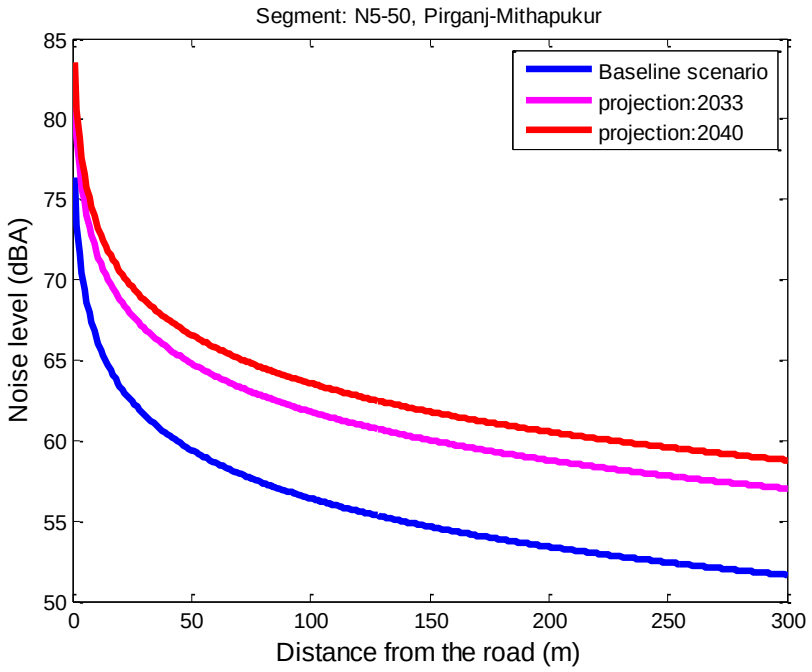


Figure G-9 (a): Noise Prediction under different scenarios as a function of the distance from the road in the N5-50, between Pirganj-Mithapukur

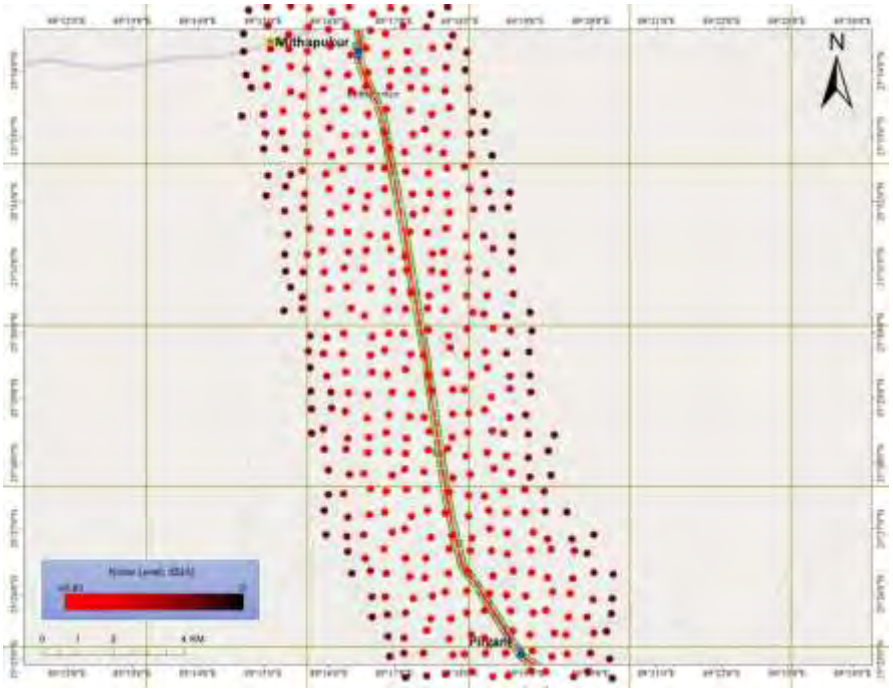


Figure G-9 (b): Spatial noise intensity map of the N5-50, between Pirganj-Mithapukur (Box 2)

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

7. 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.

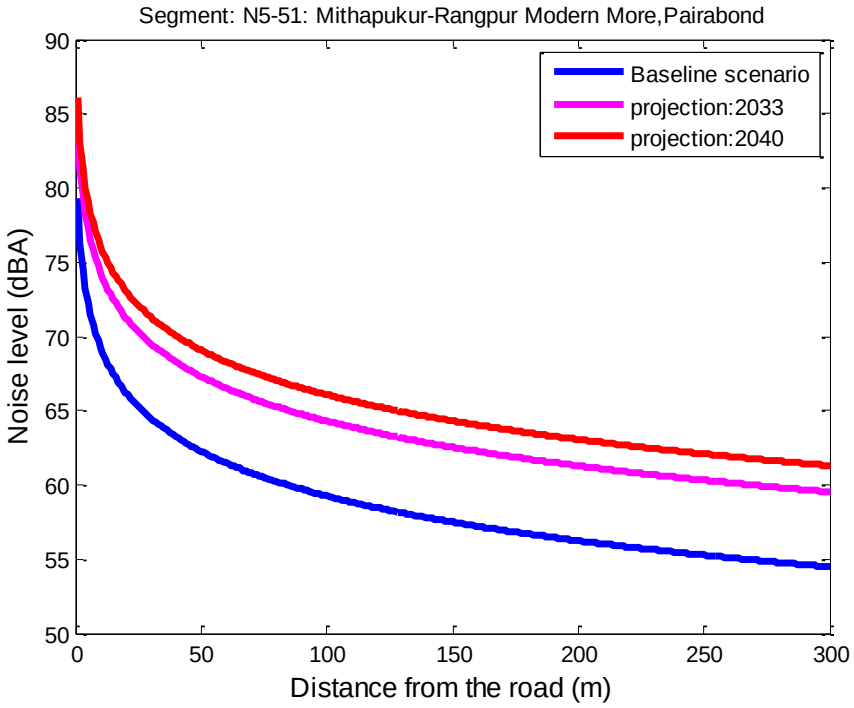


Figure G-10(a): Noise Prediction under different scenarios as a function of the distance from the road in the N5-51, between Mithapukur-Rangpur Modern More, Pairabond

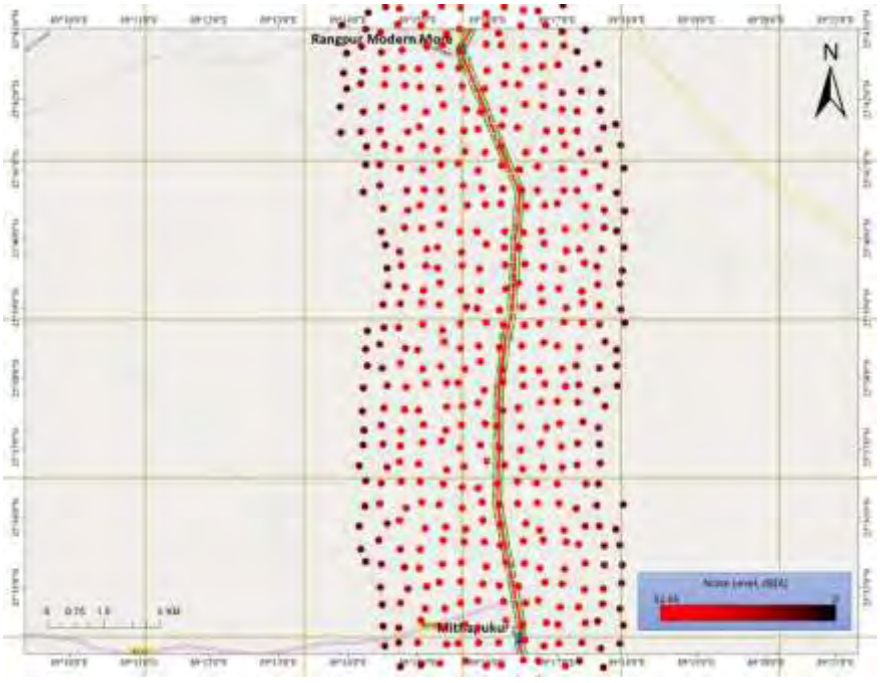


Figure G-10(b): Spatial noise intensity map of the N5-51, between Mithapukur-Rangpur Modern More, Pairabond (Box 1)

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 -Rangpur Modern More, Pairabond, km 316.022	Mithapukur Autistic School	Educational	25.57818	89.27351	67.2	70.1	**Increase**
	Batason 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**

8. 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.

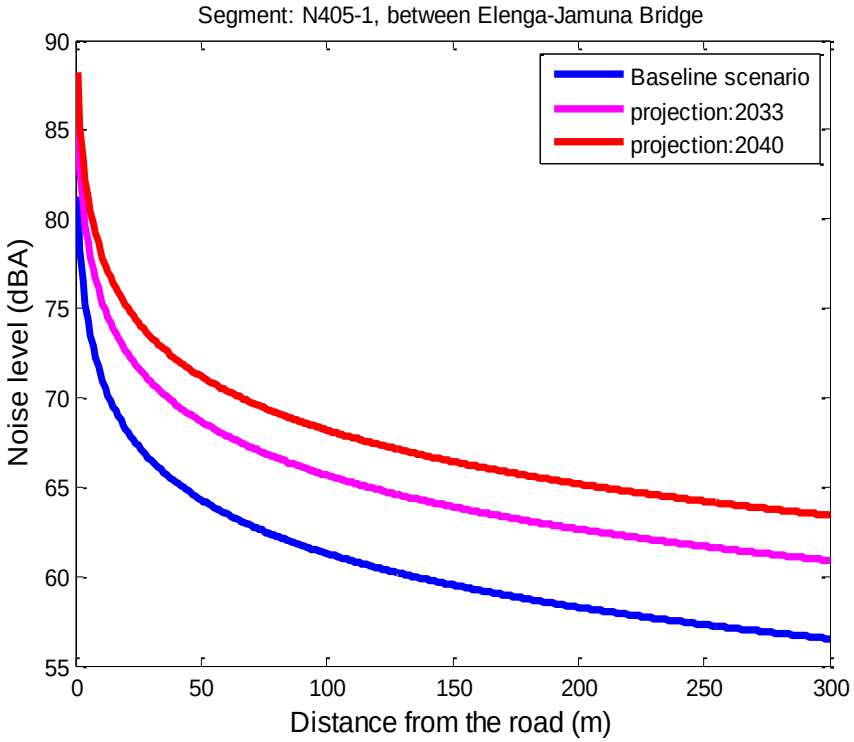


Figure G-11(a): Noise Prediction under different scenarios as a function of the distance from the road in Tangail (Elenga)-Hatikamrul Road segment

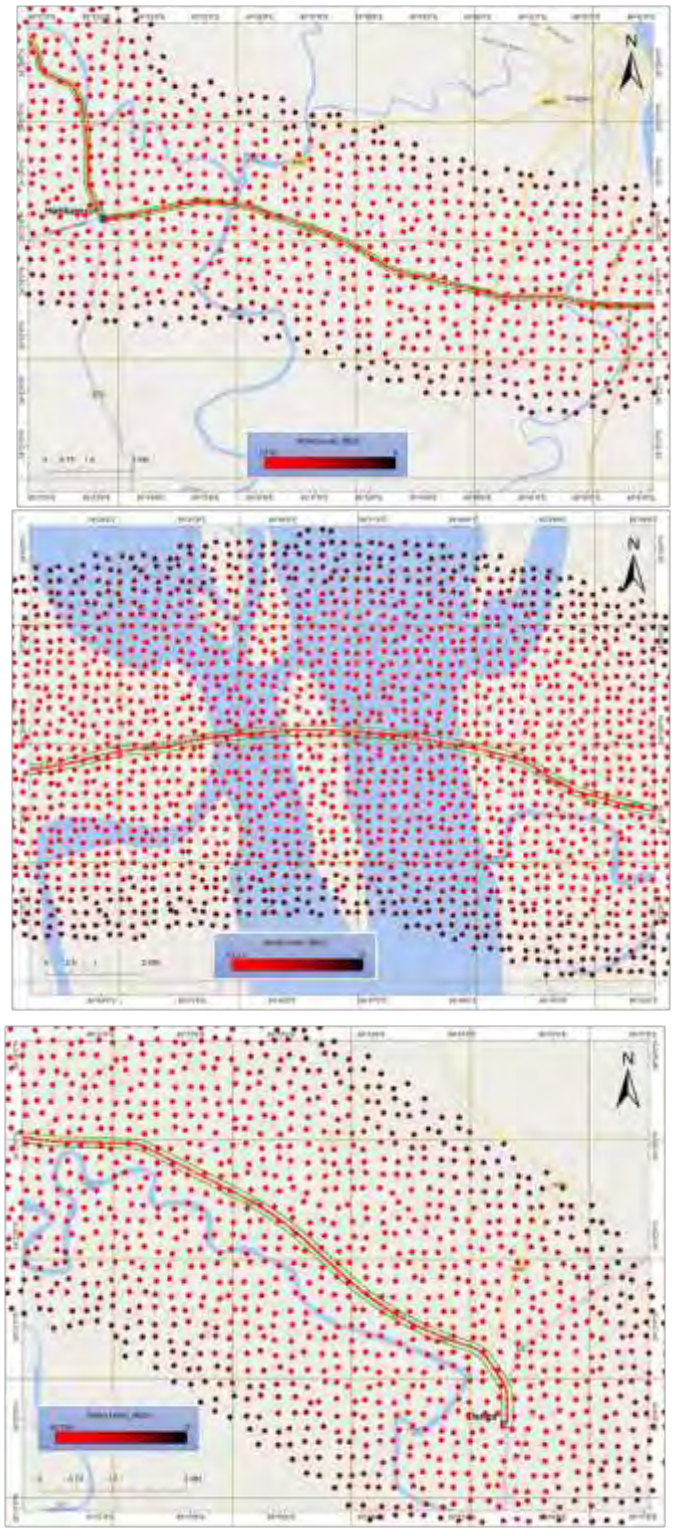


Figure G-11(b): Spatial noise intensity map of the Tangail (Elenga)-Hatikamrul Road (Box 8, 9 and 10)

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
	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**

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 ore 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.

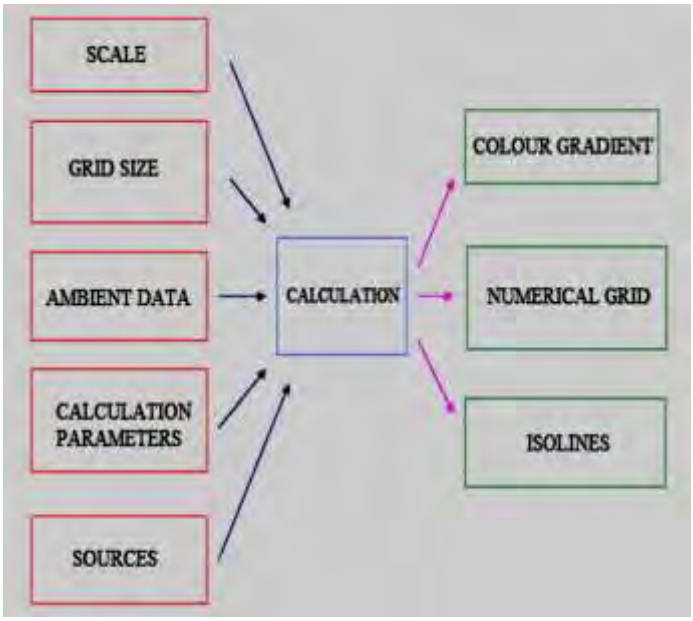


Figure 1: Input and output data arrangements in CUSTIC 3.2

Figure 2: A typical noise intensity output in CUSTIC 3.2 for a typical road using line noise source.

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

$$\boldsymbol{L_{eq} = LW - 20\times \log(r) - 11\times dB(A)}$$

Where **r** is the distance and LW the source power.

4. However, for an industrial complex, the following equation will be used:

$$\boldsymbol{L_{eq} = L_i + 10\times \log(S) - 20\times \log(r) - 14\times dB(A)}$$

Where $\boldsymbol{S}$ is the external surface and $\boldsymbol{L_i}$ is the internal noise power.

5. 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,

$$\boldsymbol{L_{eq} = 68\times dB(A) + 30\log(v/50) + 10\times \log(N/1000) - 10\times \log(r/10)}$$

6. 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

$$\boldsymbol{L_i = 10\times \log(a/180)}$$

Where **a** is the angle of the small road size (degrees).

7. To obtain the total noise level, we add the different $\mathbf{L_i}$ values following the equation

$$\boldsymbol{L_{eq} = 10\times \log[\sum_i 10^{(L_i/10)}]}$$

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.

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, 2004.CanarinaAlgorithosNumericos, 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

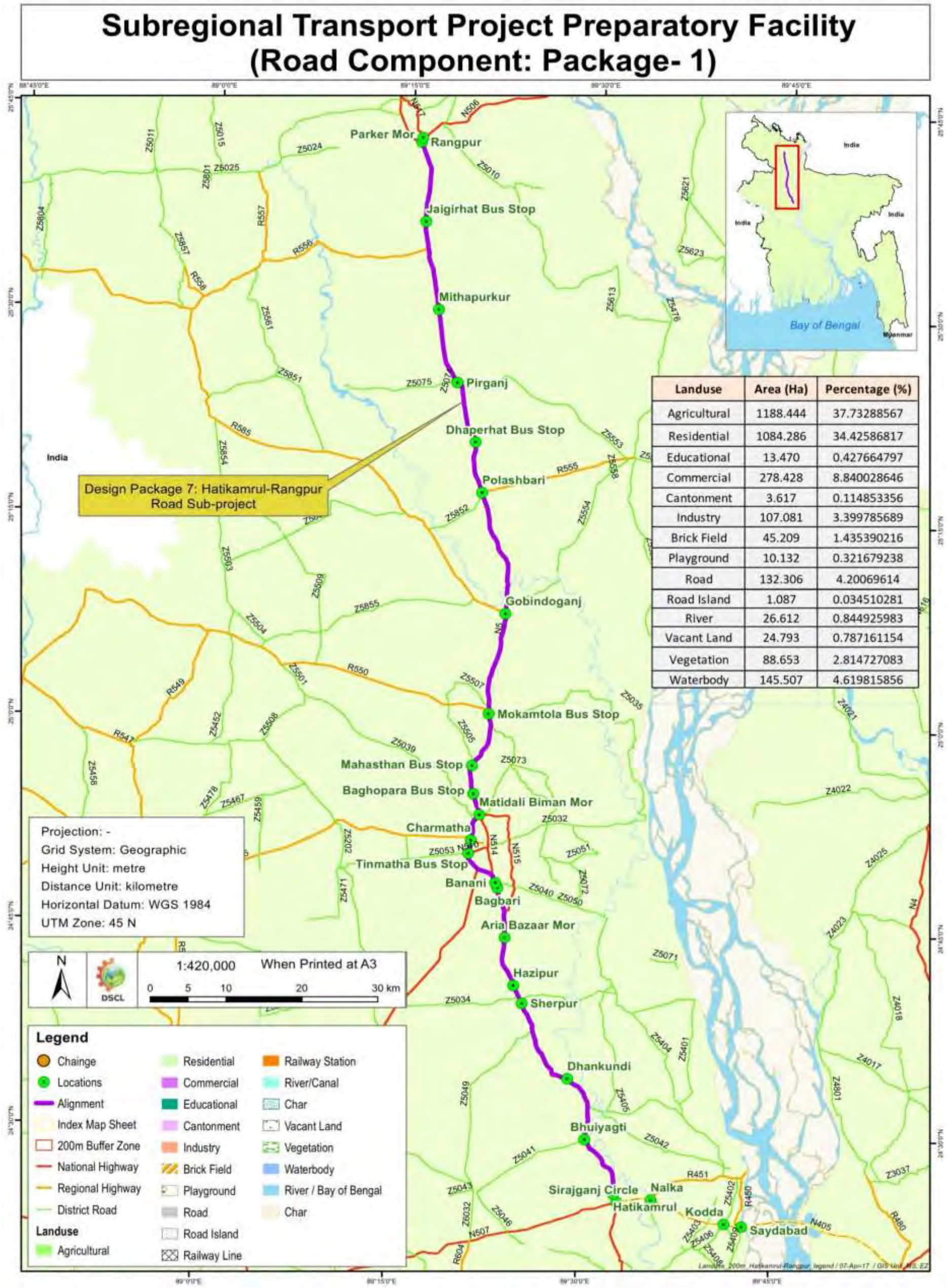
Note: For acceptable indoor noise levels for residential, institutional, and education settings refer to WHO (1999).

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



Landuse	Area (Ha)	Percentage (%)
Agricultural	1188.444	37.73288567
Residential	1084.286	34.42586817
Educational	13.470	0.427664797
Commercial	278.428	8.840028646
Cantonment	3.617	0.114853356
Industry	107.081	3.399785689
Brick Field	45.209	1.435390216
Playground	10.132	0.321679238
Road	132.306	4.20069614
Road Island	1.087	0.034510281
River	26.612	0.844925983
Vacant Land	24.793	0.787161154
Vegetation	88.653	2.814727083
Waterbody	145.507	4.619815856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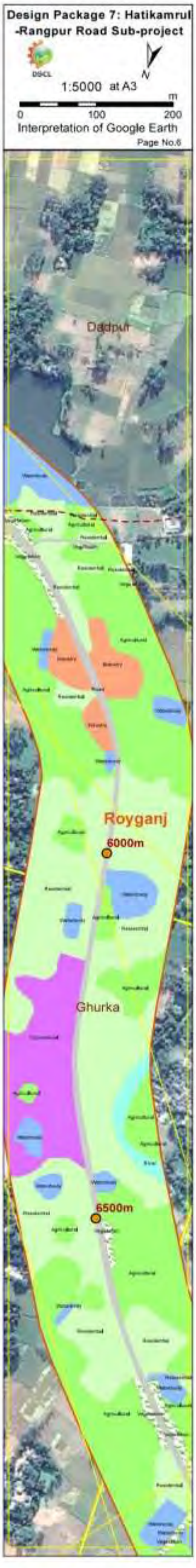
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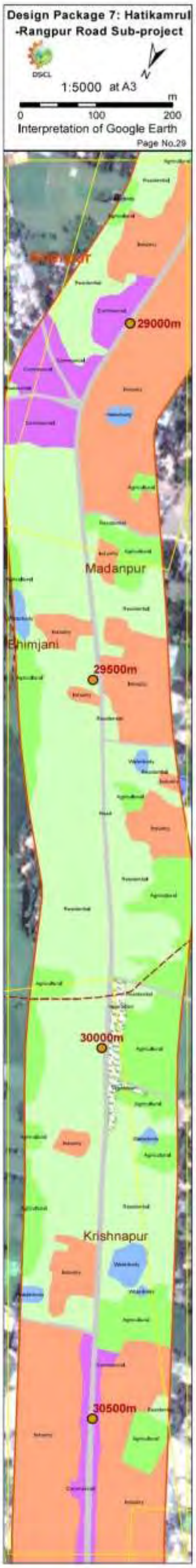
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Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.30
Madanpur
30000m
Krishnapur
30500m
Sherpur
31000m
Serua (Part)
31500m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.31
Krishnapur
31500m
Sherpur
Serua (Part)
32000m
Khondakartala


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.32
31500m
Serua (Part)
32000m
Sherpur
Sherpur
32500m
33000m
Khondakartala


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.33
33000m
Khondakartala
33500m
Sherpur
34000m
34500m
Ban Maricha (Part)


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.34
34500m
Ban Maricha (Part)
35000m
Sherpur
Hazipur
Hajipur (Part)
35500m
Mahipur


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.35
Hajipur (Part)
35500m
36000m
Mahipur
36500m
Joypur
37000m


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
DSCL
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.36
36500m
Mahipur
37000m
Sherpur
37500m
Garidaha
38000m
Kalta
Para


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.37
38000m
Kalta
Para
38500m
Jamuna
Shahajanpur
Jamalpur
39000m


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.38
Jamalpur
39500m
40000m
Shahajanpur
40500m
Bamunia
Aria
41000m


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.39
Bamunia
41000m
41500m
Aria
Shahajanpur
42000m
Aria
Bazaar Mor
42500m


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.40
42500m
Aria
Shahajanpur
43000m
43500m
44000m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.41
44000m
Shahajanpur
44500m
Majhira
45000m
45500m
Sajapur


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
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1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.42
Majhira
45500m
Shahajanpur
46000m
Sajapur
46500m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.43
46500m
47000m
Shahajanpur
Sajapur
47500m
48000m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.44
48000m
Sajapur
Betgara
48500m
Sujabad
49000m
Bagbari
Sujabad
49500m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.45
Betgara
Sujabad
49000m
Bagbari
Sujabad
Shahajanpur
Banani
50000m


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.46
Sujabad
Betgara
Sujabad
49500m
Shahajanpur
Banani
50000m
50500m
Gondagram
Shahajanpur


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.47
Betgara
Betgara
51000m
Gondagram
Bogra
Sadar
Laribpur
(Part-B)
Shahajanpur
51500m
Phul
Dighi


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.48
Gondagram
51500m
Phul
Dighi
52000m
Shahajanpur
52500m
Shakpara


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.49
Shakpara
53000m
Phul
Dighi
53500m
Bogra
Sadar
Malgram
(Part-B)
Silimpur
54000m


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.50
54000m
Silimpur
54500m
Bogra
Sadar
Belail
55000m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.51
Belai
55000m
55500m
Tinmatha Bus Stop
Puran Bogra
56000m
Bogra Sadar
Nishindara (Part-B)
Palsa
56500m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.52
56500m
Palsa
57000m
Bogra Sadar
Charmatha
57500m
Nishindara (Part-B)
58000m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.53
58500m
Nishindara (Part-B)
Kumira
59000m
Bogra Sadar
Barbakpur
59500m
60000m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.54
60000m
Barbakpur
60500m
Bogra Sadar
61000m
Matidali Biman Mor
Shakharia


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.55
Barbakpur
Shakharia
Matidali Biman Mor
61500m
Bogra Sadar
62000m
Thengamara


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
1:5000 at A3
0 100 200 m
Interpretation of Google Earth
Page No.56
Shakharia
62000m
Barbakpur
62500m
63000m
Thengamara
Bogra
Sadar
63500m


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
1:5000 at A3
0 100 200 m
Interpretation of Google Earth
Page No.57
63500m
Thengamara
Bogra
Sadar
64000m
Bagho
Para
Baghopara
Bus Stop
64500m
Mahish
Bathan
65000m
Bagho
Para


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
1:5000 at A3
0 100 200 m
Interpretation of Google Earth
Page No.58
Bagho
Para
65500m
Bogra
Sadar
Gokul
66000m
Telihara
66500m


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
1:5000 at A3
0 100 200 m
Interpretation of Google Earth
Page No.59
66500m
Telihara
67000m
Gokul
Dhawakola
67500m
Bogra
Sadar


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
1:5000 at A3
0 100 200 m
Interpretation of Google Earth
Page No.60
57500m
Gokul
Bogra
Sadar
68000m
Dhawakola
Mahasthan
Bus Stop
Mahasthangar
68500m
Shibganj
Nagarkandi
69000m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.61
Mahasthangar
68500m
69000m
Shibganj
Nagarkandi
69500m
Anantabala


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.62
69500m
Shibganj
Nagarkandi
70000m
Anantabala
Dighalkandi
Bogra Sadar
70500m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.63
Nagarkandi
Shibganj
Dighalkandi
70500m
Anantabala
Chandihara
Bujrug Majhira
71000m
Bogra Sadar
Shibganj
71500m
Chandihara
Nimai Para


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.64
Bujrug Majhira
Bogra Sadar
Chand Para
Chandihara
71500m
72000m
Nimai Para
Shibganj
72500m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.65
Nimar Para
Shibganj
Chak Para
73000m
Saulakandi
Gabtali
73500m
Shibganj
Malahar
74000m
74500m


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
1:5000 at A3
0 100 200 m
Interpretation of Google Earth
Page No.66
Malaha
74500m
Shibganj
75000m
Muradpur
Achlai
75500m
7600m
Lakshmipur


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
1:5000 at A3
0 100 200 m
Interpretation of Google Earth
Page No.67
Achlai
Muradpur
76000m
Mokamtola
Bus Stop
Lakshmipur
76500m
Shibganj
Kashipur
Shankarpur
77000m
77500m


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
1:5000 at A3
0 100 200 m
Interpretation of Google Earth
Page No.68
Shankarpur
Kashipur
77500m
78000m
Shibganj
Laskarpur
Bhaira
78500m
Laskarpur
79000m


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
1:5000 at A3
0 100 200 m
Interpretation of Google Earth
Page No.69
Bhaira
Shibganj
79000m
79500m
Krishnapur
Rahabal
80000m
Krishnapur
80500m
Rahabal


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
1:5000 at A3
0 100 200 m
Interpretation of Google Earth
Page No.70
Krishnapur
Rahabal
80500m
Rahabal
Krishnapur
Shibganj
81000m
Rahabal
81500m
Krishnapur
80500m
Rahabal
82000m
Kamardaha
Gobindaganj


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.71
Shibganj
Rahabal
82000m
Gobindaganj
82500m
Kamardaha
83000m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.72
83500m
Gobindaganj
Kamardaha
84000m
84500m
85000m
Masta


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.73
Kamardaha
85000m
Gobindaganj
85500m
Masta
86000m
Mekurai
Bagh Char
86500m
Tardaha


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.74
Masta
Bama Chandra Sekhar
Mekurai
Bagh Char
86500m
87000m
Gobindaganj
Tardaha
87500m
88000m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
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1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.75
Tardaha
88000m
Pantha Para
88500m
Gobindaganj
89000m
Buzrug Boalia
89500m


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.76
Santha Para
89500m
Gobindoganj
90000m
Buzrug Boalia
90500m


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.77
90000m
Gobindoganj
90500m
Buzrug Boalia
Gobindaganj
91000m
Boalia
91500m


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.78
Buzrug Boalia
91500m
Boalia
92000m
Khalsi Chandpur
Gobindaganj
92500m


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
DSCL
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m
0 100 200
Interpretation of Google Earth
Page No.79
Khalsi Chandpur
92500m
Boalia
93000m
Gobindagan
93500m
Hatidaha
Dighali Phulbari
Jaipur


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
DSCL
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Interpretation of Google Earth
Page No.80
Dighali Phulbari
94000m
Hatidaha
Gobindaganj
94500m
Tajpur
95000m
Sapgachhi Hatidaha


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.81
95000m
Tajpur
95500m
Chandipur
Gobindaganj
96000m
Somar Para
96500m
Chak Shibpur


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.82
Somar Para
96500m
Gobindaganj
97000m
Chak Shibpur
Chak Sinhadanga
97500m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.83
97500m
Chak Sinhadanga
98000m
Chhota Jamalpur
Gopinathpur
Chhota Jamalpur
98500m
Gobindaganj
Sinjani
99000m
Durgapur


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
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1:5000 at A3
m
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Interpretation of Google Earth
Page No.84
99000m
Sinjani
Gobindaganj
99500m
Durgapur
100000m
Darbasta
100500m
Bhagabanpur
Palashbari


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
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m
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Interpretation of Google Earth
Page No.85
Durgapur
Bhagabanpur
Palashbari
100500m
101000m
Gobindaganj
Darbasta
101500m
102000m
Abhirampur


Design Package 7: Hatikamrul -Rangpur Road Sub-project
1:5000 at A3
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Darbasta
Bhagabanpur
102500m
Palashbari
Rampur
Gobindagan
103000m
Abhirampur
Dublagari
103500m
Palashbari


Design Package 7: Hatikamrul -Rangpur Road Sub-project
1:5000 at A3
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Interpretation of Google Earth
Page No.87
Rampur
103000m
Gobindaganj
Abhirampur
Dublagari
103500m
Palashbari
104000m
Paschim Gopinathpur
104500m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
1:5000 at A3
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Interpretation of Google Earth
Page No.88
105000m
Paschim Gopinathpur
105500m
Palashbari
Bairi Harinmari
106000m
Nuniagari
Harinmari
106500m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
1:5000 at A3
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Harinmari
106500m
Jamalpur
107000m
Palashbari
Polashbari
Giridharipur
107500m
108000m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
1:5000 at A3
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Interpretation of Google Earth
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Giridharipur
108500m
Palashbari
Baskata
109000m
Maheshpur
109500m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
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1:5000 at A3
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0 100 200
Interpretation of Google Earth
Page No.91
109000m
109500m
110000m
110500m
Palashbari
Maheshpur
Ajampur
Kabilpur
Sonatola
Pirganj
Chak Solagari


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.92
110500m
111000m
111500m
112000m
Chak Solagari
Pirganj
Sadullapur
Chandipur
Ekbarpur


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.93
Chandipur
Sadullapur
Ekbarpur
112000m
112500m
113000m
Pirganj
Rasulpur
Palan Para


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.94
Rasulpur
113500m
Palan Para
114000m
Sadullapur
Dhaperhat Bus Stop
114500m
Gobindapur
Jamgani
Pirganj
115000m
Jagannathpur


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
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1:5000 at A3
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0 100 200
Interpretation of Google Earth
Page No.95
Palan Para
Sadullapur
Gobindapur
115000m
Jagannathpur
115500m
Pirganj
Sayestapur
Madarpur
116000m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
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1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.96
Jagannathpur
115500m
Madarpur
116000m
Sayestapur
Pirganj
116500m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
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m
0 100 200
Interpretation of Google Earth
Page No.97
Madarpur
117000m
Sayebpur
117500m
Pirganj
118000m
Khejmatpur
118500m
Bara Majidpur


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
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0 100 200
Interpretation of Google Earth
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Khejmatpur
119000m
Bara Majidpur
119500m
Ghola
Pirganj
120000m
Bara Ramnathpur
120500m
Bara Rajarampur
Uzirpur


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
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1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.99
Bara Rajarampur
Bara Ramnathpur
Tularam Majidpur
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Tularam Majidpur
Uzirpur
121500m
Pirganj
Tularam Majidpur
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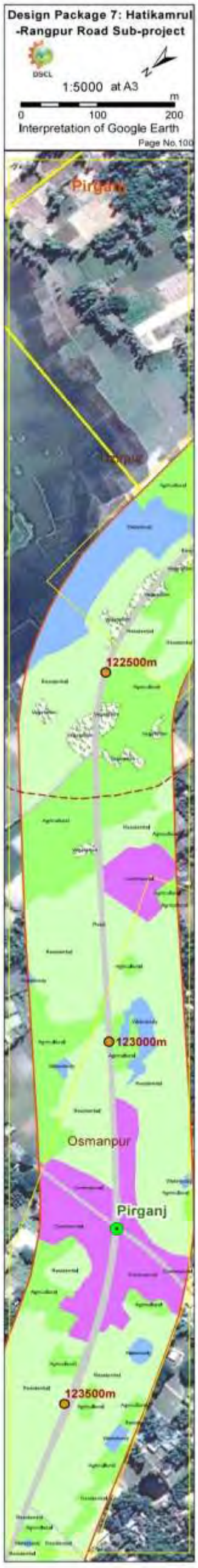
Design Package 7: Hatikamrul -Rangpur Road Sub-project
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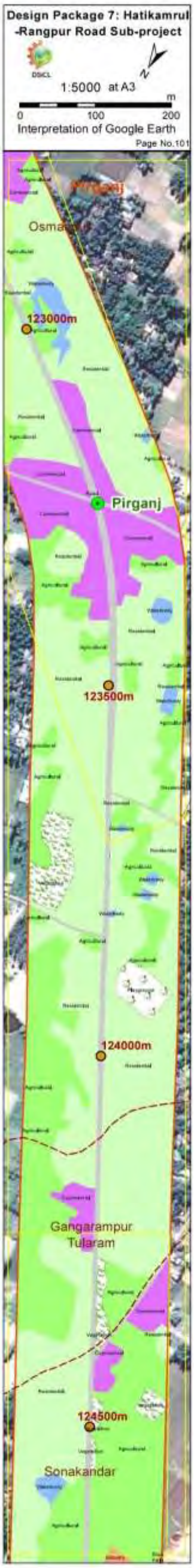
Osmanpur
Pirganj
123500m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-Rangpur Road Sub-project
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Interpretation of Google Earth
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Pirganj
123500m
124000m
Gangarampur
Tularam
124500m
Sonakandar


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
1:5000 at A3
0 100 200 m
Interpretation of Google Earth
Page No.102
Pirganj
Gangarampur
Tularam
124500m
Sonakandar
125000m
Makimpur
125500m
Fatehpur
Buzrug
126000m


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
1:5000 at A3
0 100 200 m
Interpretation of Google Earth
Page No.103
Makimpur
Pirganj
126000m
Fatehpur
Buzrug
126500m
127000m
Bajitpur


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
1:5000 at A3
0 100 200 m
Interpretation of Google Earth
Page No.104
Fatehpur
Buzrug
127000m
Bajitpur
127500m
Gobardhanpur
Pirganj
128000m
Bajitpur
Dubrajpur
128500m


Design Package 7: Hatikamrul
-Rangpur Road Sub-project
1:5000 at A3
0 100 200 m
Interpretation of Google Earth
Page No.105
128500m
Dubrajpur
129000m
Dasar
Para
Raut
Para
Pirganj
129500m
Ghoshpur
130000m
Dubrajpur
128500m
Dasar
Para


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.106
130500m
Ghoshpur
131000m
Jibanandapur
Pirganj
131500m
Bara Dargah Bhagabanpur
132000m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
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1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.107
Jibanandapur
132000m
132500m
Bara Dargah Bhagabanpur
Pirganj
133000m
Ismailpur
133500m
Mithapurkur


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.108
Mithapurkur
Ismailpur
Pirganj
134000m
Chhota Mirzapur
Shantipur
134500m
Mitha Pokur
135000m
Bara Mirzapur
Kanthali
135500m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
N
1:5000 at A3
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0 100 200
Interpretation of Google Earth
Page No.109
Bara Mirzapur
135500m
Mitha Pukur
Kanthali
136000m
136500m
Sathibari Durgapur
137000m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
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1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.110
Sathibari Durgapur
Mitha Pukur
Shitalgari
137500m
Sathibari Haripur
138000m
Dulahapur
138500m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
1:5000 at A3
0 100 200
Interpretation of Google Earth
Page No.111
138500m
Sathibari Haripur
Dulahapur
139000m
Kashipur
139500m
Mitha Pukur
140000m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
1:5000 at A3
0 100 200
Interpretation of Google Earth
Page No.112
Dulahapur
140000m
Kashipur
Chithali Dakshinpara
140500m
Mitha Pukur
141000m
Chithali Uttarpara


Design Package 7: Hatikamrul -Rangpur Road Sub-project
1:5000 at A3
0 100 200
Interpretation of Google Earth
Page No.113
Chithali Dakshinpara
141000m
Chithali Uttarpara
Mitha Pukur
141500m
Mitha Pukur
142000m
Rasidpur
Khurda Shantipur
142500m
Janakinathpur


Design Package 7: Hatikamrul -Rangpur Road Sub-project
1:5000 at A3
0 100 200
Interpretation of Google Earth
Page No.114
Khurda Shantipur
Mitha Pukur
Janakinathpur
143000m
Rasidpur
143500m
144000m
Batasan Fatehpur
Nischintapur


Design Package 7: Hatikamrul -Rangpur Road Sub-project
1:5000 at A3
0 100 200
Interpretation of Google Earth
Page No.115
Batasan Fatehpur
144500m
Nischintapur
Batasan Durgapur
145000m
Mitha Pukur
145500m
Jaigirhat Bus Stop
146000m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
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1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.116
Batasan Durgapur
146000m
Hatampur
146500m
Mitha Pukur
Abhirampur
147000m
Abhirampur Nurpur
147500m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
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m
0 100 200
Interpretation of Google Earth
Page No.117
Abhirampur
Abhirampur Nurpur
148000m
Salaipur
148500m
Mitha Pukur
149000m
Joyrampur Anwar


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
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1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.118
149500m
Joyrampur Anwar
150000m
Mitha Pukur
Lahani
150500m
Chuhar
151000m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
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1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.119
151000m
Chuhar
Islampur
151500m
Mitha Pukur
152000m
152500m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
DSCL
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1:5000 at A3
m
0 100 200
Interpretation of Google Earth
Page No.120
Islampur
Mitha Pukur
153000m
Taluk Tamphat
Taluk Dharmadas
153500m
Rangpur Sadar
154000m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
1:5000 at A3
0 100 200
Interpretation of Google Earth
Page No.121
153500m
Taluk Dharmadas
154000m
154500m
Sekh Para
Rangpur Sadar
155000m


Design Package 7: Hatikamrul -Rangpur Road Sub-project
1:5000 at A3
0 100 200
Interpretation of Google Earth
Page No.122
155500m
Taluk Dharmadas
Rangpur Sadar
156000m
156500m
Rangpur


Design Package 7: Hatikamrul -Rangpur Road Sub-project
1:5000 at A3
0 100 200
Interpretation of Google Earth
Page No.123
Sekh Para
Taluk Dharmadas
Rangpur Sadar
Rangpur
157000m
Parker Mor
157584m

APPENDIX I: LIST OF IESFS ALONG THE ROW

IECs	Within the RoW		From Boundary of the RoW to 500meter			
	Chainages (km) Right	Chainages (km) Left	Chainages (km) Right	Distance from Alignment (m)	Chainages (km) Left	Distance from Alignment (m)
Mosque	1+510, 3+050, 16+300, 18+140, 19+580, 30+090, 31+560, 40+450, 43+040, 50+430, 52+460, 61+275, 62+620 72+615, 77+390, 104+850, 116+200, 118+270, 126+010, 127+450, 133+160, 141+210	12+820, 17+190, 20+370, 21+140, 25+490, 25+910, 30+375, 32+665, 33+765, 33+950, 37+290, 38+240, 40+220, 45+860, 47+690, 49+360, 54+760, 63+150, 65+395, 66+150, 70+065, 75+810, 76+200, 80+505, 84+545, 86+700, 88+820, 94+620, 97+240, 107+600, 115+450, 118+508, 147+900	1+100, 4+430, 38+240, 44+070, 45+480, 55+530, 57+230, 59+030, 59+420, 71+120, 103+965, 106+680, 115+020, 119+580, 129+440, 140+820, 141+640, 143+800, 147+780, 150+800, 154+680, 155+170, 156+180	40, 30, 40, 30, 40, 30, 100, 40, 30, 20, 80, 40, 02, 60, 400, 30, 40, 02, 05, 70, 10, 10, 05	10+130, 16+450, 22+760, 23+335, 32+440, 33+450, 35+120, 35+740, 35+960, 39+020, 43+630, 46+690, 49+510, 51+280, 51+490, 53+350, 55+090, 55+900, 56+440, 57+320, 58+250, 62+100, 65+090, 66+915, 78+160, 88+130, 93+960, 95+295, 98+825, 99+395, 101+250, 102+380, 113+930, 116+720, 122+840, 123+460, 124+035, 129+995, 135+500, 137+190, 138+520, 144+150, 148+890, 150+550, 152+610, 152+790, 152+950, 155+335	070, 050, 030, 100, 050, 050,050, 050, 300, 150, 010, 020, 020, 030, 025, 030, 100, 030,150, 010, 080, 045, 020, 200, 080, 025, 010, 050, 006, 003, 003, 007, 030, 030, 003, 002, 004, 002, 002, 005, 002, 003, 020, 020, 060, 005, 050, 050
School	4+000, 28+770, 33+880, 35+670, 37+460, 42+120, 42+920, 49+325, 51+400, 52+790, 62+880, 78+060, 78+870, 88+670, 90+200, 133+240	22+250, 38+560, 41+980, 48+150, 71+030, 72+405, 90+450	36+210, 41+920, 57+700, 74+480, 74+800, 77+680, 84+170, 85+350, 88+880, 90+460, 91+500, 94+935, 94+980, 95+100, 95+280, 95+300, 94+780, 103+940, 119+630, 134+400, 144+930, 145+560,	70, 50, 150, 20, 20, 30, 100, 100, 150, 70, 70, 20, 50, 30, 20, 20, 250, 100, 150, 400, 70, 15, 20, 30,	0+050, 3+600, 3+600, 5+600, 7+650, 8+580, 9+230, 16+400, 19+420, 23+410, 25+400, 25+500, 26+100, 26+650, 34+360, 35+780, 35+960, 37+480, 40+370, 42+295, 44+170, 45+830, 52+670, 66+025,	100, 030, 90, 080, 150, 80, 145, 100, 030, 040, 150, 100, 045, 400, 500, 055, 300, 150, 070, 015, 025, 015, 200, 015, 100, 015, 015, 100, 450, 015, 003, 100, 003, 100, 010, 100,

IECs	Within the RoW		From Boundary of the RoW to 500meter			
	Chainages (km) Right	Chainages (km) Left	Chainages (km) Right	Distance from Alignment (m)	Chainages (km) Left	Distance from Alignment (m)
			150+770, 152+000, 156+760	20	71+365, 71+570, 71+580, 75+810, 80+600, 82+580, 83+400, 84+680, 86+820, 89+610, 90+300, 95+395, 101+480, 101+540, 102+670, 106+115, 107+415, 108+685, 109+015, 109+005, 111+810, 113+920, 115+470, 116+520, 116+765, 118+370, 121+075, 133+260, 134+605, 137+800, 140+185, 145+040	015, 010, 050, 018, 050, 003, 008, 005, 035, 035, 070, 030, 007, 075, 150, 200, 500, 200, 005, 025
College	33+900, 33+950, 51+270, 62+890, 63+260, 63+950		17+400, 84+860	40, 100	17+120, 34+300, 34+360, 38+140, 44+170, 53+200, 53+700, 62+710, 62+780, 63+135, 64+740, 65+085, 68+130, 80+850, 84+385, 90+495, 116+890, 138+800, 140+540	080, 500, 500, 030, 025, 200, 030, 015, 010, 020, 020, 012, 200, 050, 450, 100, 300, 003, 050
Madrasah	28+020, 85+020	5+880, 24+980, 45+870, 49+650, 72+405, 107+600	25+070, 26+380, 40+080, 68+900, 75+010, 78+750, 88+490, 95+440, 18+820, 124+030, 127+440, 133+440, 140+250	60, 500, 500, 150, 25, 10, 15, 30, 70, 250, 150, 400, 50	19+250, 23+330, 35+960, 48+130, 61+350, 63+425, 63+700, 108+615	015, 070, 300, 050, 050, 400, 450, 005
Training Institute					46+950, 55+520, 60+380, 61+800, 62+625, 107+385	400, 050, 450, 055, 500, 450

IECs	Within the RoW		From Boundary of the RoW to 500meter			
	Chainages (km) Right	Chainages (km) Left	Chainages (km) Right	Distance from Alignment (m)	Chainages (km) Left	Distance from Alignment (m)
Graveyard	1+490, 29+160, 34+580, 52+840, 63+070, 63+400, 64+040, 65+700, 69+070, 75+540, 90+840, 117+025	30+025, 54+800, 65+510, 65+990	4+330, 18+270, 28+400, 39+420, 41+780, 46+500, 63+440, 94+140, 98+450, 99+750 104+160, 108+750, 110+200, 115+580, 117+100, 117+570, 117+960, 138+690, 144+920, 145+190, 153+580, 153+680	30, 70, 40, 20, 50, 50, 20, 70, 60, 20, 100, 100, 10, 20, 20, 150, 100, 100, 50, 10, 70, 50,	19+350, 20+380, 32+440, 37+290, 51+160, 53+360, 62+990, 63+015, 63+360, 65+100, 65+180, 65+750, 66+085, 67+015, 71+720, 78+890, 80+445, 82+725, 86+800, 101+495, 102+590, 103+115, 115+300, 117+900, 121+130, 125+300, 125+430, 150+020, 152+830, 152+845, 153+010, 153+590, 153+630, 153+920	020, 005, 050, 020, 050, 030, 003, 050, 010, 010, 020, 005, 015, 005, 007, 006, 003, 005, 003, 004, 020, 018, 012, 013, 020, 012, 015, 040, 020, 040, 003, 050, 020, 070
Mazar	63+200, 64+400, 66+210,	64+005, 151+915, 155+300, 151+015	103+570, 133+180	50, 05,	67+650, 71+650, 85+515, 148+890	200, 005, 050, 020
Temple			17+440, 102+020, 113+730, 136+940,	70, 20, 40, 20	6+550	150
Eidgah	0+880, 39+620, 52+990, 64+930, 71+425, 80+560, 134+380, 153+640	8+200, 20+430, 26+420, 29+700, 38+285, 66+415, 70+200, 87+835, 115+445, 139+960, 144+630, 145+520	77+660, 97+260, 105+100, 121+540, 132+380, 148+840, 155+320	30, 350, 150, 06, 20, 05, 150,	22+420, 28+080, 85+515, 108+190, 126+970	150, 040, 050, 003, 016
Boddhobhumi					152+850	350
UP Office			85+070	200		
Asrom					6+190, 28+980	100, 010
Filling Station	8+660, 30+840, 34+080, 48+530, 49+040, 54+840, 55+200, 58+670, 58+850, 59+085, 61+300, 62+315, 62+360, 67+580,	1+390, 5+710, 28+490, 32+060, 39+140, 39+190, 50+470, 53+150, 56+600, 59+100, 74+970, 88+410, 107+070, 145+740,	24+880, 46+700, 46+780, 47+780, 48+970, 48+990, 49+160, 60+100, 61+100, 61+440, 61+580, 71+570,	30, 30, 20, 50, 50, 50, 50, 15, 20, 30, 30, 10, 10, 20, 07,	0+150, 37+500, 43+770, 46+620, 49+690, 57+350, 60+700, 64+020, 66+980, 90+170, 105+815, 123+605	030, 010, 050, 020, 020, 030, 010, 015, 007, 006, 003, 003

IECs	Within the RoW		From Boundary of the RoW to 500meter			
	Chainages (km) Right	Chainages (km) Left	Chainages (km) Right	Distance from Alignment (m)	Chainages (km) Left	Distance from Alignment (m)
	76+370, 83+580, 101+580, 137+320, 149+740	148+190, 155+560, 155+970, 156+540	114+920, 132+000, 141+110			
Health Complex	42+190, 63+160, 80+865,	66+205, 91+110	118+170, 140+690,	100, 100,	1+220, 33+040, 61+930, 107+150,	035, 400, 015, 050
Library					62+970	020
Park					105+370	035
Power Station	124+430		7+360, 8+850, 9+700 147+180,	30, 40, 40 30,	36+260, 53+410, 53+950, 108+135, 135+735, 108+135, 135+735	030, 025, 040, 015, 016, 015, 016
Brick filed	71+640, 71+900		11+730, 11+830, 16+050, 22+440, 22+790, 23+360, 26+920, 35+280, 64+370, 70+950, 71+260, 73+680, 78+860, 80+240, 81+540, 85+720, 102+060, 104+770, 112+110, 112+440, 134+980	30, 30, 80, 100, 30, 150, 40, 70, 30, 150, 40, 70, 100, 100, 50, 100, 50, 200, 70, 70, 70,	4+900, 10+630, 22+730, 39+520, 48+500, 70+700, 71+850, 71+195, 72+650, 73+350, 81+580, 84+940, 104+045, 111+115, 115+450, 124+385, 124+800, 128+400	200, 150, 120, 150, 100, 030, 025, 005, 050, 005, 080, 400, 003, 015, 200, 100, 500, 100
Cold Storage					76+600, 78+255	008, 048
Wooden Garden	2+040, 4+220, 8+960, 27+890, 28+050, 36+440, 36+680, 36+950, 37+520, 39+480, 39+880, 40+570, 41+500, 44+730, 48+650, 70+840, 76+740, 85+120, 86+060, 86+520, 91+860, 95+870, 100+500, 107+900, 109+300, 112+220, 113+580, 116+000,	2+220, 19+570, 92+740, 154+010	46+880, 63+660, 65+320, 67+160 90+600, 118+050, 142+680, 142+830, 142+860, 153+550, 155+500,	70, 100, 70, 50, 30, 20, 10, 20, 15, 05, 10,	38+680, 38+940, 39+690, 46+890, 47+490, 49+180, 51+850, 54+350, 62+320, 65+245, 65+450, 71+640, 72+950, 73+720, 76+100, 76+800, 80+480, 83+925, 85+05, 85+910, 92+650, 92+895, 93+700, 95+460, 95+510, 97+055, 97+595, 97+610,	030, 030, 100, 020, 020, 030, 030, 050, 060, 015, 013, 015, 080, 015, 007, 015, 005, 007, 015, 012, 005, 010, 003, 012, 010, 050, 100, 015, 015, 003, 008, 020, 018, 015, 007, 005, 006,

IECs	Within the RoW		From Boundary of the RoW to 500meter			
	Chainages (km) Right	Chainages (km) Left	Chainages (km) Right	Distance from Alignment (m)	Chainages (km) Left	Distance from Alignment (m)
	116+680, 123+640, 135+400, 139+030, 153+280,				98+510, 100+820, 101+605, 107+995, 108+550, 115+300, 115+750, 115+950, 116+200, 116+480, 117+150, 120+100, 120+750, 124+500, 125+435, 127+165, 127+440, 133+685, 139+450	004, 015, 100, 070, 002, 010, 005, 013, 200, 005
Nursery	36+540, 64+100, 66+430, 66+575, 67+020, 67+500, 70+410, 71+840, 101+660, 102+350, 155+020	36+140, 36+470, 37+390, 41+420, 67+000, 122+705, 152+080, 115+040, 155+100, 155+170, 115+170, 155+200	74+880, 154+960, 155+280,	15, 05, 05,	15+850, 41+320, 61+130, 64+110, 64+590, 66+250, 66+700, 66+820, 67+080, 67+110, 67+390, 76+290, 77+450, 87+230, 133+520	100, 030, 015, 010, 050, 015, 005, 010, 007, 005, 010, 010, 005, 008
Hatchery	146+140, 146+200, 146+260, 146+320, 146+360, 146+430, 146+510,					
Industries	113+380	57+750	86+460, 113+380, 117+160, 117+420, 120+520, 120+860, 137+200, 143+760, 145+600, 145+700, 147+820, 148+160, 149+160, 149+460, 154+640, 155+100	15, 05, 200, 200, 150, 100, 100, 05, 15, 20, 40, 30, 20, 10, 150, 20,		
Hut / Bazar	6+100-6+300, 9+850-1+000, 16+300-16+800, 25+300-25+600, 28+800-29+050, 31+500-31+680, 32+800-33+100, 33+600-33+1800, 33+900-34+200, 35+700-35+880, 37+200-37+400, 39+000-40+400, 63+900-64+050, 67+200-67+600, 68+260-68+600, 71+080-71+200, 72+800-72+900, 75+700-76+200,					

IECs	Within the RoW		From Boundary of the RoW to 500meter			
	Chainages (km) Right	Chainages (km) Left	Chainages (km) Right	Distance from Alignment (m)	Chainages (km) Left	Distance from Alignment (m)
	80+500-80+700, 84+100-84+500, 88+700-90+00, 94+400-95+000, 98+700-98+880, 101+100-101+800, 106+300-107+400, 113+800-114+600, 122+700-123+020, 115+800-116+100, 133+100-133+400, 136+400-137+700, 152+300-152+600,					
Road Crossing	1+200, 2+590, 1+200, 2+560, 5+680, 7+640, 10+820, 12+020, 14+390, 17+550, 21+150, 28+220, 33+000, 33+295, 33+460, 33+660, 34+300, 34+485, 34+720, 34+860, 37+305, 40+270, 43+580, 50+380, 54+900, 55+410, 55+450, 55+945, 57+300, 58+255, 58+515, 59+390, 59+780, 60+920, 65+810, 68+260, 68+940, 72+440, 75+700, 78+820, 80+600, 83+880, 85+085, 88+140, 88+970, 89+220, 89+310, 89+430, 89+730, 90+150, 98+300, 99+145, 105+350, 100+755, 106+235, 106+700, 108+300, 112+300, 118+580, 124+000, 125+100, 129+950, 133+140, 134+480, 134+620, 135+490, 136+700, 138+520, 140+475, 144+700, 150+750, 151+315, 153+650, 155+340					
Sculpture/ Monuments			1+680, 8+900	500, 100		
Pond	17+480, 28+100, 31+150, 35+540, 40+910, 43+000, 47+600, 47+880, 65+100, 69+300, 72+950, 82+540, 90+340, 91+650, 99+160, 111+820, 128+500, 140+520, 141+240, 141+860, 141+900, 142+010, 142+120, 143+090, 144+160, 144+200,	0+300, 0+650, 1+750-1+900, 2+450, 4+150, 5+100, 5+590, 9+990, 17+880, 20+250, 22+500, 23+120, 24+390, 30+100, 51+950, 71+665, 71+905, 72+310, 72+790, 77+850, 78+110, 81+105, 85+700, 86+750, 90+620, 92+245, 92+280,	18+240, 71+570, 75+170, 82+770, 97+930, 126+020, 127+480, 127+600, 128+770, 133+170, 142+100, 142+930,	40, 70, 20, 30, 10, 20, 05, 80, 60, 70, 30, 100	24+810, 27+300, 35+920, 47+260, 51+310, 52+250, 55+190, 56+410, 71+770, 71+895, 76+700, 84+450, 87+000, 92+500, 100+985, 103+820, 104+925, 110+900, 111+865, 123+000, 125+330, 139+405, 143+100, 144+600,	035, 030, 050, 020, 010, 030, 020, 080, 035, 015, 020, 018, 010, 200, 025, 035, 100, 015, 018, 015, 015, 050, 200, 025, 070, 035, 020, 030, 100, 150

IECs	Within the RoW		From Boundary of the RoW to 500meter			
	Chainages (km) Right	Chainages (km) Left	Chainages (km) Right	Distance from Alignment (m)	Chainages (km) Left	Distance from Alignment (m)
	153+670, 153+820, 154+100	92+340, 97+800, 97+840, 97+885, 97+910, 7+960, 98+025, 98+920, 99+220, 107+415, 108+010, 18+030, 126+205, 127+030, 127+085, 127+800, 135+315, 135+385, 136+350, 138+115, 138+160, 139+210, 139+350, 142+390, 143+050, 144+345, 144+500, 146+600, 149+190, 150+525			146+100, 146+510, 149+700, 149+960, 150+170, 154+310	
Ditches	0+360, 0+640, 1+580, 1+980, 2+450, 2+500, 4+850, 5+420, 6+660, 6+860, 7+420, 9+440, 9+470, 9+660, 10+280, 12+020, 12+565, 12+590, 12+780, 12+800, 13+500, 13+720, 13+950, 17+620, 18+850, 19+240, 19+830, 20+120, 21+200, 23+510, 26+590, 31+270, 39+090, 39+680, 51+360, 53+180-53+260, 53+280-53+360, 53+380-53+420, 56+100, 58+950-59+025,	1+000, 1+050, 1+100, 1+190, 2+090, 3+000, 3+350, 3+850, 4+750, 5+350, 5+880, 6+000, 6+450, 6+680, 7+180, 7+200, 7+310, 7+450, 7+500, 7+550, 7+950, 8+150, 8+450, 8+610, 8+700, 8+980, 9+200, 9+650, 9+800, 10+200, 10+520, 15+050, 15+200, 15+500, 15+600, 15+780, 16+050, 16+200, 16+250, 16+270, 16+310, 16+370, 17+010, 17+120, 17+190, 17+220, 17+390, 17+420, 17+460, 17+470, 17+620, 17+700, 17+780,	1+640, 4+400, 5+450, 6+050, 14+840, 30+760, 47+310, 65+500, 90+490, 91+260, 91+900, 92+170, 92+560, 92+650, 94+060, 96+050, 96+740, 96+960, 97+440, 97+580, 99+220, 104+460, 106+060, 112+570, 115+280, 126+160, 137+520, 141+050, 146+550, 148+900,	30, 60, 20, 20, 20, 80, 70, 40, 70, 40, 30, 50, 50, 50, 20, 20, 10, 10, 70, 10, 40, 100, 40, 100, 05, 15, 20, 40, 05, 05,	24+430, 29+420, 31+290, 31+300, 31+665, 72+710, 72+720, 77+960, 80+905, 82+100, 85+480, 94+300, 94+380, 95+120, 95+550, 97+130, 97+495, 98+390, 100+770, 101+850, 101+885, 102+045, 104+425, 128+800, 131+200, 131+350, 131+450, 134+010, 134+080, 137+190, 138+685, 149+280	040, 030, 050, 020, 040, 015, 010, 020, 018, 025, 020, 008, 008, 020, 025, 010, 008, 015, 008, 015, 050, 005, 012, 007, 005, 008, 005, 005, 006, 015, 010, 015

IECs	Within the RoW		From Boundary of the RoW to 500meter			
	Chainages (km) Right	Chainages (km) Left	Chainages (km) Right	Distance from Alignment (m)	Chainages (km) Left	Distance from Alignment (m)
	60+760, 62+720, 67+730, 72+370, 77+460, 77+480, 77+530, 78+090, 86+180, 91+570, 92+350, 92+390, 92+400, 92+440, 92+470, 92+970, 94+200, 94+260, 94+380, 95+180, 95+630, 95+970, 97+400, 97+980, 98+280, 98+700, 99+720, 100+050, 100+800, 100+880, 100+930, 101+000, 102+100, 102+470, 102+840, 103+900, 104+830, 105+750, 105+940, 108+720, 109+450, 115+100, 115+550, 116+550, 117+050, 125+070, 125+430, 125+450, 125+470, 125+540, 127+760, 127+970, 128+360, 129+270, 129+680, 129+760, 130+670, 132+280, 133+580, 135+230, 135+340, 135+370, 135+420, 135+490, 136+100, 137+400, 137+950, 138+070, 139+240, 139+590, 140+000, 140+070, 140+780, 140+900,	18+000-18+100, 18+240, 18+250, 18+350, 18+450, 18+530, 18+570, 18+640, 18+850, 18+900, 20+310, 20+400, 22+390, 29+980, 30+875, 31+065, 31+200, 31+250, 33+850, 33+920, 34+075, 34+960, 35+740, 39+050, 41+540, 42+120, 51+950, 54+905, 77+050, 78+020, 79+450, 79+470, 79+495, 79+510, 82+110, 86+685, 94+050, 97+750, 98+270, 99+490, 100+015, 100+110, 101+950, 102+590, 102+650, 102+230, 103+750, 104+310, 110+400, 115+150, 117+520, 117+800, 117+880, 121+300, 121+510, 121+850, 124+300, 125+110, 125+475, 127+285, 127+600, 127+700, 133+100, 134+680, 135+410, 135+850, 135+910, 136+010, 136+025, 137+510, 137+850, 137+900, 138+000,				

IECs	Within the RoW		From Boundary of the RoW to 500meter			
	Chainages (km) Right	Chainages (km) Left	Chainages (km) Right	Distance from Alignment (m)	Chainages (km) Left	Distance from Alignment (m)
	141+290, 141+350, 141+670, 141+960, 142+200, 148+550, 148+600, 150+070, 150+540, 152+940, 155+080,	138+210, 138+250, 138+300, 138+800, 138+325-138+615, 139+040, 141+000, 141+370, 141+400, 141+730, 141+750, 141+880, 141+990, 142+280, 142+730, 143+100, 143+400, 144+005, 144+080, 144+230, 145+020, 146+00, 146+000-146+150, 146+155, 146+520-146+560, 148+450, 148+500, 148+590, 148+800, 149+050, 149+515, 153+640, 153+720, 153+980, 154+830, 154+830, 154+890, 154+910, 155+020				
Canal	11+400-11+560, 19+050-19+220, 19+850-20+090, 129+100-129+200	42+630, 44+350, 44+420 - 44+980, 45+020 – 45+340,			112+500, 128+700-129+485	012, 003
River	93+245					
Borrow Pit	7+800-8+100, 103+775, 147+500, 84+300 – 84+500, 87+750 – 87+850, 113+000, 126+240 – 126+475	138+800	136+000, 122+000, 146+850, 150+940-151+700	05, 100, 03, 03,		

APPENDIX J: LIST OF TREES AFFECTED IN THE ROW

1. The survey on affected trees has been conducted in March 2015. The Forest Department of Bangladesh does not have any guideline of separating trees according to sizes. Therefore, the following standards of tree sizes have been followed to count the affected trees:

- **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.

2. According to the Inventory of Losses (IOL) survey conducted in March 2015, a total of 105339 trees of different types (fruit, timber and medicinal) and sizes (large, medium, small and saplings) will be needed to remove being located within the ROW of the Hatikamrul-Rangpur road subproject's alignment.

Table J-1: Number of trees affected in the ROW

District	Type of Tree	Large	Medium	Small	Saplings	Total
Sirajganj	Fruit	168	294	216	58	736
	Timber	51	103	88	13	255
	Medicinal Plant	7	8	10		25
Bogra	Fruit	549	874	1350	182	2955
	Timber	181	546	1236	592	2555
	Medicinal Plant	21	20	6	1	48
Gaibandha	Fruit	381	520	756	72	1729
	Timber	469	974	1268	120	2831
	Medicinal Plant	0	0	0	0	0
Rangpur	Fruit	1077	1318	6531	4477	13403
	Timber	818	1097	2555	438	4908
	Medicinal Plant	2	20	18	5	45
Total	**Fruit**	**2175**	**3006**	**8853**	**4789**	**18823**
	Timber	**1519**	**2720**	**5147**	**1163**	**10549**
	Medicinal Plant	**30**	**48**	**34**	**6**	**118**

Source: Census and IOL Survey, March 2015.

Table J-2: Number of affected trees remained in the Government land

District	Type of Tree	Large	Medium	Small	Saplings	Total
Sirajganj	Fruit	10	28	10	0	48
	Timber	7	14	23	4	48
	Medicinal Plant	1	2	1	0	4
Bogra	Fruit	131	238	397	35	801
	Timber	108	475	689	500	1772
	Medicinal Plant	0	0	0	0	0
Gaibandha	Fruit	852	3387	4905	6322	15466
	Timber	5507	14723	26101	8330	54661
	Medicinal Plant	92	353	2238	29	2712
Rangpur	Fruit	130	7	56	3	196
	Timber	81	18	39	0	138
	Medicinal Plant	1	0	0	0	1
Total	**Fruit**	**1123**	**3660**	**5368**	**6360**	**16511**
	Timber	**5703**	**15230**	**26852**	**8834**	**56619**
	Medicinal Plant	**94**	**355**	**2239**	**29**	**2717**

Source: Census and IOL Survey, March 2015.

Table J-3: Summary of affected trees located in the private and Government land

Types	Large	Medium	Small	Saplings	Total
Fruit	3298	6666	14221	11149	35334
Timber	7222	17950	31999	9999	67170
Medicinal	124	403	2273	35	2835
Grand Total of Affected Trees Remained on Private and Government Land					**1,05,339**

Source: Census and IOL Survey, March 2015.

Table J-4: Summary of affected banana and bamboo trees

Types	Private Land	Gov Land	Total
Banana	6,436	31,349	37785
Bamboo	25,936	13,795	39731
Grand Total of Affected Banana and Bamboo Trees			**77516**

Source: Census and IOL Survey, March 2015.

APPENDIX K: 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 Hatikamrul-Rangpur road project. Other major objectives of the program are to protect the affected cultural/sensitive areas and to enhance the health of the existing ecosystem.

2. Approximately 105339 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 215000 trees.

3. The following areas have been identified for development of plantation sites in the project areas. The required space for tree plantation will not cover areas required to plant 215000 saplings on the slopes and therefore it is suggested to use the open space of private land under social forestry category for tree plantation. The tree plantation programme 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 Hatikamrul-Rangpur road embankment;
- Open places of private land along the Hatikamrul-Rangpur 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 Hatikamrul-Rangpur 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 be as follows:

- **Timber Trees:** Garjan (Dipterocarpus turbinatus), Shal (Shorea robusta), Shilkoroi (Albzia procera), Akasmoni (Acacia auricoliformis), Kat badam (Terminalia calappa), mehogani (Swietenia mahagoni), Raintree (Samania saman) etc.
- **Fruit Trees:** Date Tree (Phoenix sylvestris), Black berry (Syzygium cumini), Olive (Elaeocarpus floribundus), Palm tree (Borossus flabelliformis), Mango (Mangifera indica), Jackfruit (Artocarpus heterophyllus) etc.
- **Fuel Trees:** Epil –epil (Leucaena leucocephala), Raintree (Samania saman), Krishnochura (Delonix regia) etc.
- **Medicinal Trees:** Neem (Azarlirachla indica), Arjun (Terminaliaarjuna), 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 2 trees for each tree felled for the implementation of the project. Total available space for the tree plantation on the slopes of the road embankment is approximately 500000 m^2 taking on an average road height 0.92 m on the left side and 1.10 m on the right side of the road. In this case, on the available areas approximate 125000 saplings are possible to plant and therefore it is suggested to plant rest of the required saplings (90,000 Nos.) under social forestry.

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 1.

Tree species	Spacing of Tree Species (m)	No. of Trees
Fruit (40%)	2.0	86,000
Timber (30%)	2.0	64,500
Medicine (20%)	2.0	43,000
Fuel (10%)	2.0	21,500
Total		**215,000**

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 be encouraged to involve the 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 in along the Hatikamrul-Rangpur 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 be also contacted for raising saplings as well. 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 destitute 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 about 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 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 tree years. Total approximate budget for tree plantation is **BDT 66.65 Million**.

Table K-2: Cost estimates for the tree plantation plan

Item	Rate (BDT)	Quantity	Amount (Million BDT)
Plantation of saplings	100	215000	21.5
Maintenance of replanted trees (three years)	200	215000	43
Provision of additional 10% tree plantation (in case of dead)	100	21500	2.15
Total			**66.65**

APPENDIX L: LIST OF PARTICIPANTS FOR FGDS

TECHNICAL ASSISTANCE FOR SUBREGIONAL ROAD TRANSPORT PROJECT
PREPARATORYFACILITY (Elenga to Hatikamrul and Hatikamrul to Rangpur Road Sections)

Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 01 Date 20.03.17 Time 10:00 AM
Location: Jumdoha High School Field, Polashbari, Gaibandha.
GPS: N 25.25748° E 89.36279°

Sl No.	Name	Age	Occupation	Telephone No.	Signature
1	Md. Shamiful Islam	42	Teacher	01718693851	
2	Md. Rafikul Islam	40	Teacher	01722819744	
3	Md. Belal uddin	50	Teacher	01729870700	
4	Md. Abdus Samad	65	Teacher	01722643358	
5	Md. Abdul mannan	60	Teacher	01718876934	
6	Md. Rejaul Karim	42	Teacher	01787064710	
7	Md. Mehaj uddin	70	Teacher	01768537180	
8	Md. Anisur rahman	26	Teacher	01719214198	
9	Mrs. Nurnajmun	33	Teacher	01718613307	
10	Mrs. Shamima Sultana	40	Teacher	01758478742	
11	Mrs. Shamimasultana	35	Teacher	01725587257	
12	Mrs. Reksanasunin	41	Teacher	01723059795	Reksana
13	Mrs. Thokomina	42	Teacher	01745366305	
14	Mrs. Shamima	20	Teacher	01757862316	
15	Md. Mofiqur rahman	20	Teacher	01788251576	

FGD Completed By: MD. BAPPY RAHMAN

Signature: BAPPY RAHMAN

20.03.17

TECHNICAL ASSISTANCE FOR SUBREGIONAL ROAD TRANSPORT PROJECT PREPARATORYFACILITY (Elenga to Hatikamrul and Hatikamrul to Rangpur Road Sections)

Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 02 Date 21.03.2017 Time 1.30 Pm

Location: The Infront of Cadet College, Modern mor, Rangpur

GPS: N 25.71133 E 89.26048

Sl No.	Name	Age	Occupation	Telephone No.	Signature
01	MD. Saman	25	Service	01747281330	
02	BalBul	28	Service	01962703291	
03	Selina	60	Housewife	—	
04	MD. Rasgak	33	Business	[illegible]	
05	Kohinur	50	Housewife	—	
06	A.M. Javed Mahmood	36	Service	01557278027	
07	Shafi Arman	28	Dentist	01749199637	
08	Mahmudul Hasan	31	Driver	01918099462	
09	MD. Alamgir Hossen	39	Business	01812221559	
10	Sahidul Islam	35	Driver	01786883131	
11	Motahar	35	Service	01723456039	
12	MD. Morshid Alam	35	Driver	01798953521	
13	Sahidul Islam	50	Business	0176119234l	
14	MD. Sokka Mia	35	Business	01789478669	
15	Asiyar	22	Student	01957161378	

FGD Completed By: Taimoore Faiyaz

Signature:

29.3.17

TECHNICAL ASSISTANCE FOR SUBREGIONAL ROAD TRANSPORT PROJECT
PREPARATORYFACILITY (Elenga to Hatikamrul and Hatikamrul to Rangpur Road Sections)

Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 03 Date 22.3.2017 Time 12.30 Pm
Location: Meghina Bazar, Satgram pur, Bogura
GPS: N 24.77152° E 89.38636°

Sl No.	Name	Age	Occupation	Telephone No.	Signature
01	Sahadat Hossen	50	Business	01729840259	
02	MD Alal	40	Farmer	01721989430	
03	Rahaman	57	Business	01717522724	
04	Abdus Sattar	52	Business	01721705892	
05	Jahangir	27	Business	—	
06	Rejaul Karim Raju	34	teaching	01913432688	
07	Sahajahan Ali	47	Business	01712545920	
08	Rafiq	37	Business	01718541280	
09	Hena Banu	55	Housewife	—	
10	MD Hafijar Rahman	42	Business	01718710883	
11	Saiful	42	Business	01700731710	
12	MD Abdus Salam	51	Business	01918360183	
13	MD Nojrul Islam	44	Tailor	01739937313	
14	MD Sahidul Islam	38	Business	01711911798	
15	Motafejar Rahman	35	Business	01731982538	

FGD Completed By: Taimoore Faiyaj
Signature: 22.3.17

TECHNICAL ASSISTANCE FOR SUBREGIONAL ROAD TRANSPORT PROJECT
PREPARATORYFACILITY (Elenga to Hatikamrul and Hatikamrul to Rangpur Road Sections)

Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 03 Date 28.03.2017 Time 12.30 Pm
Location: Meghina Bazar Sahjahanpur, Bogura
GPS: N 24.77165° E 89.356.26°

Sl No.	Name	Age	Occupation	Telephone No.	Signature
16	MD. Abdur Rahman	60	Motor worker	01705288468	
17	Mehedi Hasan	26	Textile engineer	01680969696	
18	Saiful Islam	35	Business	01734042376	
19	MD. Sohel Rana	27	Business	01713729369	
20	Jannati	17	Student	—	

FGD Completed By: Taimoore Faiyaz
Signature:
22.3.17

TECHNICAL ASSISTANCE FOR SUBREGIONAL ROAD TRANSPORT PROJECT
PREPARATORYFACILITY (Elenga to Hatikamrul and Hatikamrul to Rangpur Road Sections)

Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 04 Date 22/03/17 Time 2:00 PM
Location: Shenka Bazar, Sherpur, Bogra
GPS: N 24.60388° E 89.44502°

Sl No.	Name	Age	Occupation	Telephone No.	Signature
01	Md. Mojnu Mia	40	Business	01774201060	
02	Md. Bablu Mia	40	Business	01843445810	
03	Cumeli Begum	35	Housewife	01735076633	
04	Asoli	30	Housewife	—	—
05	Abdul Basit Mondol	70	Agriculture	01933106482	
06	Chan Mahmud	75	—	—	
07	Md. Dilshad Ali	53	Business	017 53329533	
08	Md. Abul Hossain	63	Agriculture	01781303278	
09	Md. Rezaul Kasim	30	Agriculture	01728976302	
10	Md. Bilal Hossain	40	Agriculture	01729531901	
11	Md. Nasrul	35	Business	01745328438	
12	Md. Hafizur Rahman	21	Student	01791211100	
13	Md Abul Hossain	70	—	—	
14	Md. Shamful	17	Business	01718825287	
15	Md. Shamsul Hoque	60	Agriculture	01820734207	

FGD Completed By: MASFIQ BASHIR
Signature: 22/03/17

TECHNICAL ASSISTANCE FOR SUBREGIONAL ROAD TRANSPORT PROJECT
PREPARATORYFACILITY (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 89.55340°

Sl No.	Name	Age	Occupation	Telephone No.	Signature
01	Md Feroz Kawsi	33	Business	01759176950	
02	Md. Abdur Razzak	32	Business	01719985872	
03	Md Abdul Kuddus	40	Agriculture	-	-
04	Md. Abdul Malek	50	-	01938705742	
05	Sultana Begum	30	Housewife	-	
06	Sapla Khatun	30	Housewife	01965796431	
07	Moneara Khatun	32	Housewife	-	
08	Sefali Khatun	32	Housewife	-	
09	Hena Khatuna	36	Housewife	-	
10	Selim Mollah	30	Member (Ward-3)	01719753570	
11	Sabuj	19	Student	01799658822	
12	Nargis Khatun	42	Housewife	-	
13	Md Zoidur Rahman	32	Business	01939795195	
14	Md Abdul Sattar	52	Business	01759110053	
15	Md Muslim Uddin	45	Business	01779215109	

FGD Completed By: JYASFIQ BASHIR
Signature: Jyasfiq Bashir 22/03/17

TECHNICAL ASSISTANCE FOR SUBREGIONAL ROAD TRANSPORT PROJECT
PREPARATORYFACILITY (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 24.41932° E 89.55310°

Sl No.	Name	Age	Occupation	Telephone No.	Signature
16	Alamin Sarker	35	Business	01716140739	
17	Md Jahurul Islam	48	Business	01728029424	
18	Mr Nitai Saha	40	Business	01921473161	
19	Md. Jakaria Hossain	39	Service	01773891834	
20	Bahar Uddin	45	Doctor	01965981575	

FGD Completed By: MASFIQ BASHIR
Signature: Masfiq Bashir 22/03/17

Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 01 Date 18.07.2019 Time 11:00 AM

Location 45+400 (Mazjira Bazzar, Shajahanpur, Bogra)

Sl No.	Name	Address	Occupation	Telephone No.	Signature
1	Md. Edris Ali		Bus	0198-762587	
2	Md. Zeyaur Rahoman		student	01719-251458	
3	Md. Nur Alam		Bus.	01715-652998	
4	Md. Abdul Kafour.		Driver	01983-826328	
5	Md. Mamud Ali		"	01944-288230	
6	Md. Abdul Gafur		Sub Contractor	01718-616928	
7	Md. Shahin Reza			01751-349189	
8	Md. Shahadul Islam		Bus	01833-615837	
9	Md. Sha Alam		Tea Stall	01767-536780	
10	Md. Mizanur Rahoman		Driver	01751-255393	
11	Md. Eman Ali		Job	01711-543464	
12	Md. Sharafat Ali		Bokani		
13	Md. Elias Ali		Mahajan	0129-781205	
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Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 02 Date 18.01.2014 Time 11'30

Location 17+000 (Chandichona Bazar, Raygonj. Sirajgonj.

Sl No.	Name	Address	Occupation	Telephone No.	Signature
1	Md. Nisikanto Sarkar	Chandichona Bazar, Raygonj Siraj	Driver	01728-589389	নিশিকান্ত
2	Sikul Das	"	Bus.	01720-496268	S.D
3	Raju Ahmad	"	Job	01718-609127	[illegible]
4	Chomor chandra	"	Tailor	01733-998400	চমর
5	Kholil Ahmad	"	Bus.	01718-443198	[illegible]
6	Manik Chandro	"	Fish Bus.	01735-401500	মানিক
7	Uzzal Sarker	"	Driver	0	উজ্জ্বল
8	Md. Foridul Islam	"	Chain master	01736-128065	[illegible]
9	Md. Emrul shak	"	Driver	01827-319629	[illegible]
10	Md. Abul Hossain khokon	"	Bus Stand Chainmaster	01718-898827	[illegible]
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Focus Group Discussions (FGDs)
List of Participants

Focus Group No. 03 Date 19.01.2019 Time 10:30 AM

Location 28+900 (Mirzapur, Sherpur, Bogra)

Sl No.	Name	Address	Occupation	Telephone No.	Signature
1	Md. Sirul Islam		Bus	01761-542708	
2	Md. Rofiqul Islam		Farmer	01749-620076	
3	Md. ASadul Islam		Driver	01745-039840	
4	Md. Mamunur		Bus	01740-806056	
5	Md. Hazrurar Rosid		Bus	01734-505387	
6	Md. Fuzlul Hoq		Bus	01792-669694	
7	Md. Mobiz ulla kabir		U.P Member	01798-732842	
8	S.K. Altaf Hossain		X-Teacher	01716-197851	
9	Md. Ansad Shak		Farmer	01761-201973	
10	Md. Golam Mostofa		Dokane	01719-507692	
11	Md. Harunor Rashed		Bus.	01713-729369	
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Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 04 Date 21.07.2019 Time 10:30 AM.

Location 72+900 Chowrikingate, Shibgong, Bogura.

Sl No.	Name	Address	Occupation	Telephone No.	Signature
1	Md. Saiful Islam	Malahir Mokamkh Bus Bogura		01832-636690	
2	Md. Polish Sarkere	"	Drivere	01714-723822	
3	Md. Zohurul Islam	"	Farmar	01742-936848	
4	Md. Mahadul Islam	"	BUS	01719-736671	
5	Md. Asraful Islam	"	Farmar	01935-868237	
6	Md. Zuherul Islam	"	Dokane	01757-962754	
7	Md. Rezaul Islam	"	Driver	01828-135802	
8	Md. Samim	"	mobil Lead	01822-851305	
9	Md. Abdul Basked	"	Raj mistri	01747-018969	
10	Md. Abdul Jobbere	"	Dokani	01920-535857	
11	Md. Anamul Haque	"	Drivere	01846-302041	
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Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 05 Date 21.01.2014 Time 11:45 AM

Location 89+000 (Dhakan Bus Stand, Gobindogonj. Gibandha.)

Sl No.	Name	Address	Occupation	Telephone No.	Signature
1	Md. Younus Ali	Bus stand Gobindogonj, Gibandha	Lebar	01761-70009	
2	Md. Yohadul Shak	"	Tea Stall		
3	Md. Asraful Islam	"	Drivere	01739-012342	
4	md. Sumon Mondol	"	Bus	01716-438163	
5	Md. Nur Mohamaed	"	"	01717-331102	
6	Md. Azad	"	Fermar	01720-847039	
7	Md. Muzadul Islam	"	Job	01725-488037	
8	Md. Jilul Rahaman	"	Bus	01740-963983	
9	Md. Samim	"	Dokani	01916-153086	
10	Md. Mozammal Haque	"	Job	01736-505865	
11	Md. Ripon	"	"	01732-657369	
12	Md. Rasmon	"	Bus	01745-249946	
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Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 06 Date 22.01.2019 Time 3'15 PM

Location 113+700 (Ghibanda) Dhaperhat, Shadullapur, Ghibanda.

Sl No.	Name	Address	Occupation	Telephone No.	Signature
1	Md. Shahin Ferdus	Dhaperhat, Shadullapur, Gaibanda	Teacher	01713-994363	
2	Md. Shahin Akter	"	"	01745-229291	
3	Nandon Sha	"	Bus	01820-611928	
4	Mohammad Ali	"	Dokani	01734-038489	
5	Shipul Chandra Sha	"	Bus	01742-482116	
6	Mahabi Hassan	"			
7	Mounju Miya	"	Day leb.	01770-990629	
8	Mahmedul Hasan	"	Bus.	01733-501015	
9	Sumon Miya	"	Dokani	01914-858994	
10	Shohel Rana	"	Dokani	01796-720401	
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Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 07 Date 23.01.2014 Time 12.10 PM

Location 125+900 (Fotapur Muldigi, Pirgonj, Rongpur.

Sl No.	Name	Address	Occupation	Telephone No.	Signature
1	Md. Abdullah	Fotapur, Pirgonj Rongpur	Driver	01722-076628	
2	Md. Bisu	Fotapur Muldigi, Pirgonj, Rongpur.	Bus	01737897284	
3	Anjer	"	Fermer		
4	Abul Kalam Azad	"	Fermar	01722-305195	
5	Golap Miya	"	"	01738-534740	
6	Md. Hafijur Mondole	"	"	01740-087715	
7	Md. Abdur Razzak	"	Bus	01758-577699	
8	Bikas	"	Dokani	01710-265268	
9	Md Ataur Rahoman	"	Bus	01725-193015	
10	Md. Rustom Ali	"	"	01737-064704	
11	Md. Shohidul Islam	"	UP member	01721-518277	
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Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 08 Date 24.01.2019 Time 12:30 PM

Location 156+400 (Modaran more, Rangpur)

Sl No.	Name	Address	Occupation	Telephone No.	Signature
1	MD. Abdur Razak	Modaran more Rangpur	Business	01739448407	
2	Md. Hafizur Rahoman	"	Driver	01750-797470	
3	Md. Shoel Rana	"	Bus	01759387634	
4	Md. Omer faruque	"	Job	01922-114347	
5	Md. Mukul Miya	"	Bus	01737-343192	
6	Md. Golam Kibria	"	"	01716-097247	
7	Md. Rofiqul Islam	"	"	01823-642215	
8	Md. Nurnobi	"	Job	01767-296376	
9	Md. Fajlur Rahoman	"	"	01943-616504	
10	Md. Shahid	"	Laber	01780-755938	
11	Md. Abu Aoual	"	Bus	01740-640763	
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APPENDIX M: LIST OF INDIVIDUAL INTERVIEWEE

Location	Name	Occupation	Contact Number
Royganj, Sirajganj	Md. Monirul Islam	Business	01729727160
	Palash Chandra	Business	01752445194
	Md. Shafiqur Rahman	Business	01735433150
	Md. Sohel	Business	01736267821
	Somir	Business	01721718440
Bogra Sadar, Bogra	Md. Rezaul Karim	Electrician	01729614812
Shibganj, Bogra	Md. Badsha Mia	Farmer	01835330923
	Md. Mamtaj Uddin	Business	01823609694
	Md. Rezaul Karim	Doctor	01716126866
	Md. Abu-Bakar Siddik	UP Memebr	01718969524
	Md. Badsha Mia	Business	01943622851
	Md. Abdul Motalib	Business	01917211674
	Md. Nurul Islam	Teacher	01713716695
Palashbari, Gaibandha	Md. Jahangir Alam	Labour	
	Md. Saju Miah	Business	01934984629
	Md. Emdadul	Business	01745215730
Sadullahpur, Gaibandha	Subol Kumar	Employee	01786831322
	Md. Sharif Uddin	Business	01729163630
	Md. Bodrul Alam	Teacher	01716336544
Govindoganj, Gaibandha	Md. Monsur Rahman	Teacher	01717975124
	Md. Nazrul Islam	Driver	01743941454
	Md. Aytal Haque	Business	01740801256
	Md. Mehdi Hasan	Business	01725674533
	Md. Anamul	Business	01735115972
	Md. Hasan Miah	Business	01734101837
	Md. Zahid Hossain	Business	01767453688
	Md. Ripon	Business	01711411692
	Md. Sohel Rana	Business	01757963346
Pirganj, Rangpur	Md. Nazrul Islam	Employee	01714169731
	Md. Russel	Business	01722722192
	Md. Abul Kalam	Farmer	01722905195
	Md. Golap	Farmer	01738534740
	Krisno	Business	01724020441