



INITIAL ENVIRONMENTAL EXAMINATION (IEE)

UPGRADING OF JOYDEBPUR-DEBOGRAM-BHULTA-MADANPUR (DHAKA BY-PASS) ROAD (N-105) INTO 4 LANES THROUGH PUBLIC PRIVATE PARTNERSHIP (PPP)



September 2019

Prepared for

SRBG-SEL-UDC



Submitted By

Development Solutions Consultant Limited



House-734 (5-B), Road-10, Avenue-04, DOHS Mirpur,
Dhaka -1216, Bangladesh, Tel: +8801822758548
E-mail: dscl@dsclbd.com, Web: www.dsclbd.com

Table of Contents

ABBREVIATIONS	viii
EXECUTIVE SUMMARY	ix
I. INTRODUCTION	1
A. Background	1
B. Purpose of Report	1
C. Identification of the Project	2
D. Extent of the IEE Study	2
E. Responsibility for Preparation	3
F. Scope of Works	3
G. Approach & Methodology	3
1. Approach	3
2. Methodology	4
H. Contents of the Report	10
II. ENVIRONMENTAL POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK	12
A. Regulatory Requirements for the Project	12
B. National Legal and Institutional Framework	12
1. National Environmental Policy, 1992	12
2. National Environmental Management Action Plan (NEMAP), 1995	12
3. Environmental Conservation Act (ECA), 1995	13
4. The Water Act, 2013	14
5. Environment Conservation Rules, 1997 (Amended in 2002)	14
6. Environmental Courts Act, 2000	16
7. Labour Rules, 2015	16
8. The EIA Guidelines for Industry (1997)	16
9. National Land Transport Policy	17
10. Wetland Protection Act 2000	17
11. RHD's Road Master Plan	17
12. National Road Design Standard	18
13. The Forest Act (1927) and the Forest (Amendment) Act (2000)	18
14. National Forest Policy (amendment), 1994	19
15. The Private Forests Ordinance, 1959	19
16. Bangladesh Wildlife (Conservation & Security) Act, 2012 (previously known as Bangladesh Wildlife (Preservation) Order, 1973; amended as Bangladesh Wildlife (Preservation) Act 1974)	19
17. National Water Policy, 1999	20
18. National Fisheries Policy, 1998	20
19. Protection and Conservation of Fish Act 1950 (Amended 1982)	20
20. National Agriculture Policy, 1999	21
21. National Land Use Policy, 2001	21
22. The Embankment and Drainage Act, 1952	21
23. Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009	22
C. International Conventions, Treaties and Protocols (ICTPs)	22
D. Asian Development Bank (ADB) Policies	25
E. Legislation Relating to Occupational Health and Safety	25
F. Environmental Categorization by GOB	26

G.	Environmental Categorization by ADB.....	26
H.	GoB Environmental Clearance	27
I.	Environmental Studies Needed	28
III.	DESCRIPTION OF THE PROJECT	30
A.	General.....	30
B.	Need for the Project.....	30
C.	Important Locations and Difficult Point of the Road	30
D.	Design Features.....	33
E.	Design Plan for Bridges and Culverts	33
1.	Selection of Superstructure form	33
2.	Selection of substructure form	33
F.	Subproject Components	34
1.	Alignment and Right of Way (ROW)	34
2.	Designs for the Alignment.....	34
3.	Pavement work	36
4.	Bridges and Culverts and pedestrian bridge Facilities	36
5.	Road Safety Aspect	41
6.	Disability Access	41
7.	Bus Bays	41
8.	Toilets Facilities.....	41
9.	Materials Used and Sources for Construction	41
10.	Earthworks	41
11.	Concrete Aggregate	41
12.	Cement and Steel Reinforcement.....	42
13.	Bitumen	42
14.	Recycled Pavement Materials.....	42
G.	Existing Traffic and Forecast	42
H.	Toll Plaza	43
I.	Social and Resettlement Considerations	46
J.	Schedule of Implementation.....	46
IV.	DESCRIPTION OF THE BASELINE ENVIRONMENT	47
A.	General.....	47
B.	Physical Environment.....	47
1.	Climate	47
2.	Topography	50
3.	Physiographic Features	51
4.	Geology and Soil.....	52
5.	Water Resources and Hydrology	52
6.	Seismicity	56
7.	Natural Hazards.....	58
8.	Ambient Air Quality.....	61
9.	Noise and Vibration	61
C.	Biological Environment	62
1.	Bio-ecological Zones	62
2.	Biodiversity	64
3.	Environmentally Sensitive Areas.....	69

D.	Environmental Quality Test	71
1.	Ambient Air Quality.....	73
2.	Noise Level	85
3.	Vibration Level	97
4.	Groundwater Quality	99
5.	Surface Water Quality.....	100
6.	Soil Quality	101
E.	Socio-economic Environment.....	101
1.	General.....	101
2.	Administrative Structures	102
3.	Demography.....	102
4.	Settlement and Housing Pattern	103
5.	Land Use Patterns	103
6.	Water Supply and Sanitation	103
7.	Agricultural Environment.....	103
8.	Cultural and Common Property Resources.....	104
V.	ANALYSIS OF ALTERNATIVE.....	105
A.	Background	105
B.	Alternatives to the Project	105
1.	The Without-Project Alternative.....	105
C.	The Alternatives Alignments.....	105
D.	Conclusions	106
VI.	ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES	107
A.	General.....	107
B.	Project Corridor.....	107
1.	Project Right of Way (RoW)	107
2.	Corridor of Impact (Col)	107
C.	Anticipated Adverse Impacts and Mitigation Measures.....	107
1.	Design/Pre-construction Stage	107
2.	Construction Stage.....	112
3.	Specific Impacts due to Bridge Construction	131
4.	Operation Stage	134
VII.	INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION	138
A.	Purpose of Public Participation.....	138
B.	Consultation and Participation during Feasibility Stage	138
1.	Focus Group Discussions (FGDs)	138
2.	Consultations with Stakeholder	139
C.	Conclusion.....	140
VIII.	CLIMATE CHANGE ASSESSMENT.....	141
A.	Overview	141
B.	Greenhouse Gas Emission.....	141
C.	Climate Change Impacts Considerations	144
1.	Climate Projections: Temperature.....	144
2.	Climate Projections: Precipitation	145
3.	Climate Projections: Wind Speed/Cyclone	146
4.	Climate Projections: Sea Level Rise.....	146

5.	Flood Flow	147
6.	Storm-surge Inundation	148
7.	Salinity Intrusion	148
D.	Climate Adaptation	150
1.	Introduction	150
2.	Adaptation to Flooding	150
3.	Construction Materials Policy Adaptation	151
4.	Adaptation to High Temperature.....	152
IX.	ENVIRONMENTAL MANAGEMENT PLAN	153
A.	General.....	153
B.	Objectives of the Environmental Management Plan.....	153
C.	Environmental Mitigation Plan	153
D.	Environmental Monitoring Plan.....	196
1.	Objectives.....	196
E.	Institutional Requirements	215
F.	Institutional Arrangements	215
G.	Institutional Responsibilities.....	216
1.	Ministry of Road Transport and Bridges (MoRTB)	216
2.	Inter-ministerial Steering Committee	216
3.	Roads and Highways Department.....	217
4.	The Social and Environmental Circle.....	217
5.	Project Implementation Unit	217
6.	Syndicate Banks	217
7.	Independent Engineers (IE)/Consultants	218
8.	Project Company	218
9.	EPC Contractor & Sub-contractor	218
H.	Environmental Monitoring Cost Estimation	219
X.	GRIEVANCE REDRESS MECHANISM	221
A.	Requirements of the ADB	221
B.	Grievance Redress Mechanism	221
C.	Details of Mechanism	221
1.	Formation and Operation of the GRC	221
2.	Steps to a Solution	222
3.	Publicizing the Grievance Redress Steps and the Committee	223
4.	Construction Workers Grievance.....	223
XI.	CONCLUSIONS AND RECOMMENDATIONS.....	225
	REFERENCES	226
	APPENDICES	227

List of Tables

Table I.1:	Explanation and Assignment of Scores to ‘Magnitude of Impact’	9
Table I.2:	Explanation and assignment of scores to ‘likelihood’	9
Table I.3:	Two-Dimensional Risk Assessment matrix.....	9
Table II.1:	International Conventions, Treaties and Protocols Signed by Bangladesh	22
Table II.2:	Relevant Occupational Health and Safety Laws and Rules	25

Table II.3: Actions Required for Different Stages of the Project.....	27
Table III.1: Main Design Features of the Project.....	33
Table III.2: Detailed Bridges Specification along the Joydebpur-Madanur Road	38
Table III.3: Lands and Households Affected.....	46
Table IV.1: List of Plants in the Project Area	64
Table IV.2: Endangered/Threatened Floral Species Found in the AOI (Source: Field Survey 2017)	66
Table IV.3: Exotic Floral Species Found in The Project AOI (Source: Field Survey 2017)	66
Table IV.4: List of Fauna Identified in and around the Project Area	67
Table IV.5: Test Result of Ambient Air Quality Analysis.....	73
Table IV.6: Monitoring Results of Weather Data	74
Table IV.7: CALINE 4 Prediction of CO Concentration (ppm) Based on Baseline (2018) Scenario	81
Table IV.8: CALINE 4 Prediction of CO Concentration Based on Future (2043) Scenario	82
Table IV.9: CALINE 4 Prediction of NOx Concentration (ppm) Based on Baseline (2018) Scenario	83
Table IV.10: CALINE 4 Prediction of NOx Concentration Based on Future (2035) Scenario.....	84
Table IV.11: Results of Noise Level Measurement	86
Table IV.12 Surveyed Sections of The Road and Traffic Volume Counts	87
Table IV.13: Modelling Results of Baseline Scenario (2018) of Daytime Noise Prediction.....	95
Table IV.14: Modelling Results of 2035 Scenario of Daytime Noise Prediction	95
Table IV.15: Modelling Results of 2045 Scenario of Daytime Noise Prediction	96
Table IV.16: Modelling Results of 2045 Scenario of Daytime Noise Prediction	96
Table IV.17: Results of Vibration Level Measurement.....	98
Table IV.18: Test Results of Groundwater Analysis	99
Table IV.19: Test Results of Surface Water Analysis.....	100
Table IV.20: Test Results of Soil Analysis	101
Table IV.21: Populations in the Project Road Area	102
Table IV.22: Populations along the Project Road	102
Table IV.23: Quantity of Affected Structure along the Project Road.....	103
Table VII.1: Details of Consultations with Local People	138
Table VIII.1: Fuel Efficiency in Km/l.....	142
Table XV.2: Emission Standards of Fleet (%).....	142
Table VIII.3: Annual Average Daily Traffic (AADT) for Joydeppur-Madanpur Road.....	142
Table VIII.4: Normal Traffic Growth Rates for Different Category of Vehicles	143
Table VIII.5: Input Parameters for TEEMP	143
Table VIII.6: CO2 Emission Factors for Different Vehicle Types.....	143
Table VIII.7: Output and Output Intensity of CO2, PM and NOx	144
Table VIII.8: Projected Surface Change in Global Mean Air Temperature (likely range).....	145
Table VIII.9: Projected Temperature Change for Bangladesh under CC Scenario	145
Table VIII.10: Projected Precipitation Change for Bangladesh under CC Scenario.....	145
Table VIII.11: Global Mean Sea Level Rise (values shown as median and likely range)	146
Table XVI.1: Environmental Management Plan-Mitigative Measures.....	154
Table IX.2: Environmental Management Plan-Monitoring Actions	197
Table IX.3: Cost Estimation for Environmental Mitigation Measures and Monitoring	220

List of Figures

Figure I.1 Risk Assessment Process 8

Figure II.1: Government of Bangladesh Environmental Assessment Process 28

Figure III.1: Project Location Map 32

Figure III.2: Types of Abutment in the Project 34

Figure III.3: Typical Cross Section of the Sub Grade Main Section is 32.2m Wide 35

Figure III.4: Typical Cross Section from k21+600 to Purbachal Area at Kanchon Bridge. 35

Figure III.5: Typical Cross Section of Post Tensioned Concrete Simply Supported T Beam 37

Figure III.6: Toll Gate Marked Line 44

Figure III.7: Toll Gate ETC Marked Line 44

Figure III.8: Layout of Toll Plaza 45

Figure IV.1: Temperature and Rainfall in Project Area 48

Figure IV.2: Number of Sunny, Rainfall and Cloud Coverage Days in Project Area 49

Figure IV.3: Wind rose Diagram in Project Area 50

Figure IV.4: General Topography of the Project Road Area..... 51

Figure IV.5: Surface Water Bodies along the Project Road..... 53

Figure IV.6: Hydrological Network of the Project Area..... 55

Figure IV.7: Seismic Zone and Activity of the Project Road 57

Figure IV.8: Cyclone Risk Zone of the Project Road 59

Figure IV.9: Flood Zone of the Project Road 60

Figure IV.10: Bio-ecological Zone of the Project Road Alignment 63

Figure IV.11: Roadside Vegetation along the Project Corridor 66

Figure XI.12: Environmental Protected Areas in the Project Location 70

Figure IV.13: Locations of Samples Collection in the Project Area 72

Figure IV.14: Ambient Air Quality Sampling in the Project Area 73

Figure IV.15: Depiction of Road and Receptor Coordinate System 74

Figure IV.16: CALINE 4 Prediction of CO Concentration (Ch-0 to 10km) 76

Figure IV.17: CALINE 4 Prediction of CO Concentration (Ch-11 to 20 km) 77

Figure IV.18: CALINE 4 Prediction of CO Concentration (Ch-21 to 30 km) 78

Figure IV.19: CALINE 4 Prediction of CO Concentration (Ch-31 to 37 km) 79

Figure IV.20: CALINE 4 Prediction of CO Concentration (Ch-38 to 48 km) 80

Figure IV.21: Noise Level Measurement in the Project Area 86

Figure IV.22: Setup environment of the TNM for this project 88

Figure IV.23: Result Output of TNM..... 88

Figure IV.24: Sensitive Receptors at First Segment 90

Figure IV.25: Sensitive Receptors at Second Segment..... 91

Figure IV.26: Sensitive Receptors at Third Segment 92

Figure IV.27: Sensitive Receptors at Fourth Segment 93

Figure IV.28: Sensitive Receptors at Fifth Segment 94

Figure IV.29: Vibration Level Measurement in the Project Area 97

Figure IV.30: Sampling and Onsite Test of Groundwater Quality in the Project Area..... 99

Figure IV.31: Sampling and Onsite Test of Surface Water Quality in the Project Area 100

Figure IV.32: Soil Sampling from the Project Area..... 101

Figure VII.1: Consultations with Local People 139

Figure VIII.1: Storm Surge Inundation Area (2050 in a changing Climate) 148

Figure VIII.2: Salinity Intrusion for different Sea Level Rise during Dry Season (DEFRA 2007).....	149
Figure IX.1: Proposed Institutional Framework for EMP Implementation	216
Figure X.1: Grievance Redress Mechanism of the Project	223

List of Appendices

Appendix 1: Rapid Environmental Assessment (REA) Checklist	227
Appendix 2: Renewal of ECC of Dhaka Bypass Road.....	232
Appendix 3: Test Result of Air Quality Measurement	233
Appendix 4: Test Result of Noise Level Measurement	235
Appendix 5: Test Result of Vibration Level Measurement	237
Appendix 6: Test Result of Groundwater Quality	238
Appendix 7: Test Result of Surface Water Quality.....	241
Appendix 8: Test Result of Soil Quality Analysis	245
Appendix 9: Consultations Details and List of Participants for FGD	247
Appendix 10: Waste Management Plan	255
Appendix 11: Tree Plantation Plan	257

ABBREVIATIONS

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ADB	Asian Development Bank
AEZ	Agro-ecological Zone
BBS	Bangladesh Bureau of Statistics
BECA	Bangladesh Environmental Conservation Act
BRTA	Bangladesh Road Transport Authority
BECR	Bangladesh Environmental Conservation Rules
BWDB	Bangladesh Water Development Board
DoE	Department of Environment
EA	Environmental Assessment
EC	Executive Committee
ECC	Environmental Clearance Certificate
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
FD	Forest Department
GOB	Government of Bangladesh
IEE	Initial Environmental Examination
IECs	Important Environment Components
MOEF	Ministry of Environment and Forest
NGO	Non-Governmental Organization
PAPs	Project Affected Persons
PPEs	Personal Protection Equipment
RHD	Roads and Highways Department
RoW	Right of Way

EXECUTIVE SUMMARY

INTRODUCTION

The Roads and Highways Department, with the support of the Public-Private Partnerships Office is currently planning and designing the four-laning of the Joydevpur-Debogram-Bhulta-Madanpur (N105) Road, colloquially known as the Dhaka By-Pass Road. This project would provide for a major arterial connection between the industrial zone of the North and North East, with the port connection to Chittagong in the South. The road is contemplated to include a controlled access toll road, in addition to a two-lane service road, along 48 kilometres that link with the National Highways N1, N2, N3, and N4.

Since the project is on the existing ROW of the Dhaka By-Pass Road that has been in operation since 2007, the socio-economic impact due to homestead and livelihood displacement for the upgrade of the existing 2-lane facility to a 4-lane facility has been found to be minimal. However, since the ROW was never protected from encroachment by local businesses, religious institution development and illegal homestead developments, there may be a need to compensate non-land related loss due to displacement from the existing ROW as well as relocating semi-permanent and temporary religious and educational establishments.

The land survey indicates that no additional lands will be required for the construction of the four-lane highway from the north portal to the south portal. However, in order to meet the required highway design speed and to accommodate additional interchanges at mid-way points along the alignment (e.g., at the Bhulta/N2 interchange or the Purbachal intersection) and two service roads (4.8 m), some additional land will be required. While the analysis demonstrates minimal impact on the financial viability of the road as a PPP project, additional land will need to be underway prior to issue of the RFP, and fully procured and transferred prior to financial close. The proposed interchange, which would provide future access to the Purbachal Land development by RAZUK, will need additional land of 5.08 hectares.

This report is the Initial Environmental Examination (IEE) study for the following road section:

- Joydeppur – Madonpur Road (48.112954 km)

Scope of Works

This IEE report has been prepared keeping in view the requirement of DoE and ADB. The scope of the present IEE report describes the following most important features:

- A review of the environmental legislative, regulatory and policy guidelines and considerations relating to the implementation of the project;
- A general description of the project and existing physical, biological and socio-economic conditions;
- Analysis of different alternatives to the project in terms of environmental and social perspectives;
- Identification and assessment of the potential impacts on the natural and human environment in the project area, from the construction of the project;
- Consultation with the locals/stakeholder involving concerned people in order to identify and act on any undocumented or perceived environmental issues;
- Identification of mitigation measures in the form of an Environmental Management Plan (EMP); and
- Recommendations and conclusions in order to operate the project works in an environmentally safe and sound manner.

Objectives

The objective of this study is to identify the environmental issues or parameters that may be affected by the implementation of the project, as well as an assessment of the current status of these issues and parameters related to the construction of the proposed Project. It has also included a consideration of means to avoid or mitigate significant environmentally negative impacts of the project.

Moreover, an IEE is an obligatory requirement that application to the Department of Environment (DoE) for Project Site Clearance and EIA document for the Environmental Clearance Certificate (ECC) from the DoE for initiating project implementation. Though, an ECC has already been obtained from DoE for this project.

This IEE has been prepared in accordance with the requirements of the Government of Bangladesh defined in the Bangladesh Environment Conservation Act (BECA) and the Asian Development Bank (ADB) as defined in Chapter 2. The Format of the IEE following the ADB recommendations as outlined in the ADB Good Practice Sourcebook; Draft Working Document: November 2012.

Methodology

As limited secondary information on the environmental quality and the ecology of the study area are available, the Consultant used a number of methods and techniques to assess the environmental issues of the proposed project. These included desktop review of the background information, GIS mapping, reconnaissance survey, consultation with stakeholders and community members, and professional judgment. Geographical Information Systems (GIS) was used as a specialized analysis and presentation tool. Before commencing field investigations, spatial analysis of satellite imagery was used to identify present administrative areas and other boundaries/constraints to be considered for both the environmental and social assessments. A review was conducted of the physical, biological and legal literature relevant to the Project. The review of secondary sources and informal initial field investigations were undertaken using the ADB Rapid Environmental Assessment (REA) Checklist in order to prepare a preliminary assessment of the physical and social environment, biodiversity, and conservation significance of the identified study area. This preliminary environmental examination also assisted in identifying data gaps, which would require collection of additional primary information through physical field survey during the detailed design stage and further assessment. The consultant also examined different routes/sections for the upgrading of the proposed road in terms of environmental impacts and evaluated for the suitable widening options. An extensive stakeholder consultation has been done as part of this initial environmental examination process. During field survey several community consultations were conducted in the forms of Key Informant Interview and Focus Group Discussion.

ENVIRONMENTAL POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

The project is classified as 'Red Category' according to the ECR, 1997 of Government of Bangladesh and as 'Category B' according to the ADB SPS, 2009.

As per the government of Bangladesh guidelines the project requires to submit the Initial Environmental Examination (IEE) for obtaining the Site Clearance Certificate (SCC) and the Environmental Impact Assessment (EIA) for getting Environmental Clearance Certificate (ECC) during project feasibility and detailed design stage respectively. The ADB safeguard policy document (Safeguard Policy Statement [2009]) requires a number of additional considerations, including: (i) project risks and respective mitigation measures and project assurances; (ii) project level Grievance Redress Mechanism including documentation in the EMP; (iii) definition of the project area of influence; (iv) physical cultural resources damage prevention analysis; (v) climate change mitigation and adaptation; (vi) occupational and community health and safety requirements; (vii) biodiversity conservation and natural resources management requirements; (viii) ensuring adequate consultation and participation; and (ix) ensuring that EMP includes implementation schedule and (measurable) performance indicators.

DESCRIPTION OF THE PROJECT

Dhaka by Pass Road is a two lane road starting from Vogra point in the Gazipur District and ends at Madanpur in the Nrayanganj District connecting national highway N4 (a part of the national highway network) and the national highway N-1 which ends at the Chittagong City. There is no separate provision for slow moving vehicular traffic (SMVT) or non-motorized traffic (NMT). There are capacities constraints caused by congested junctions, heavy traffic moving around the land port, road side parking, and markets and built up areas.

The DBR intersects the Dhaka-Mymensingh, Dhaka-Chittagong railway track, Dhaka-Mymensingh (N3), Dhaka-Rangpur (N4) and Dhaka-Sylhet (N2) highways. Several other metalled and non-metalled roads intersect the DBR in the east-west direction. The upgraded bypass road will hinder east west movement by motorized transports during the construction and operation stages. Interchanges at highway and service road intersections may slow down traffic movement during the construction stage.

The project related intervention involves 48.112954km highway improvement from 2-lane to 4-lane. The bidding proposal of the project includes 6 new bridges for the mainline and service lanes, 8 new mainline overpasses, 46 existing box culverts and lengthened box culverts, 49 new culverts, 12 new channels and 8 pedestrian overpasses.

DESCRIPTION OF THE BASELINE ENVIRONMENT

The Study Area is characterized by heavy rainfall. With the exception of the relatively dry western region of Dhaka, where the annual rainfall is about 1,600 mm (63.0 in), most parts of the country receive at least 2,300 mm (90.6 in) of rainfall per year. As temperature record shows, April is the warmest month with average temperature of 37°C and January is the coolest month with temperatures averaging 13°C. In the project area the wind direction is predominantly characterized by East-Southeast, South-East, and South-Southeast and wind flow. The average wind speed ranges from 5 to 19 km/h during maximum period in a year. According to (BNBC, 1993), Bangladesh has three seismic zones with moderate and low seismic activity. The Project area falls in Zone 2, i.e. moderate risk zone intensity seismic zone of the country.

The proposed road geographic location, flood occurs regularly in the project area. The proposed 48.112954 km long Joydebpur-Madanpur alignment will traverse through number of major and minor rivers (Nagda River, Turag River, Balu River and Shittolakhya River), canals, creeks, small water bodies and borrow pits.

Total of 57 plant species has been recorded from the project area including road alignments. Among the species maximum represented by herbs followed by trees, shrubs and climbers. Among the species no endemic species were found in the project site and even no genetic resources found. We checked data to find flagship species, umbrella species, and key stone species. But no such species found in the project area. Some wildlife supporting species recorded in the project site. The major species are Banyan tree, Black berry, Laurel, Neem, etc. Such species are available outside the project. A good number of medicinal plants were recorded within the project area, but status of such species outside of the project area was satisfactory. Data analysis shows that maximum diversity was found in roadsides followed by homestead, cultivated land and wetlands. Among the uses categories, medicinal plants scored highest followed by fodder plants, edible fruits, ornamental plants, vegetable plants, timber plants, fuel wood plants, commercial plants and duck weed plants.

A total of 94 species of wildlife were observed in the area on the proposed road alignments. Among them, 3 were amphibians, 9 were reptiles, 70 were birds and 12 were mammals. Among the observed wildlife, 1 species are vulnerable, 3 are near threatened and 90 are least concerned according to IUCN Red List of Threatened Species. According to (IUCN Bangladesh, 2003) near threatened wildlife in the area were Bengal Monitor (*Varanus bengalensis*), Small Indian Civet (*Viverricula indica*) and Jungle Cat (*Felis chaus*). Bengal Fox (*Vulpes bengalensis*) was reported as vulnerable species in the project area. Fish is the most important aquatic fauna of the project areas, along with other groups. The aquatic fauna includes Prawns (*Macrobrachium* spp.), crabs, snails (*Pila*, *Vivipara*, *Lymna* etc.), freshwater mussels (*Lamellidens* sp.) etc. invertebrates and several species of fish. Kolabang (*Rana tigrina*); Guishap (*Varanus bengalensis*) and Matia sap (*Enhydrisenhydris*) are common. The aquatic birds are Pancowri (*Phalacrocorax*), Kanibok (*Ardeolagraria*), Sadabok (*Egretta garzetta*), Borobok (*Egretta alba*), Machranga (*Halcyon pileata*), Dahuk (*Gallinago cinnerea*), and winter migratory birds – Balihash (*Dendrocygna javanica*) and Chakha (*Tadorna ferruginea*).

The key air quality parameters (particulate matter- PM_{10} and $PM_{2.5}$, oxides of sulphur - SO_x , carbon monoxide- CO, oxides of nitrogen – NO_x , ground ozone- O_3) were analysed from samples collected over an eight (8) hour period at each sampling sites. During monsoon season ambient PM_{10} and $PM_{2.5}$, CO, NO_x , SO_x and O_3 concentrations in all the sampling points showed compliance with DOE standard of ambient air quality. The noise measurement readings were cumulated and disaggregated into three categories to compare commercial land uses. The time weighted average value of the sound monitored at Five different locations of the project influence area are within the national standard for both day and night time which is in Gazipur District. In the project area vibration level was measured at 05 sampling location (for monsoon) during the day time. The vibration level recorded at 05 locations. The maximum velocity was 42.57 m/s in Mirerbazar, Pubail, Gazipur and minimum velocity was found for two locations 0.05 m/s at purbachal interchange and Bhulata mor in Gazipur. Maximum acceleration occurred in Bhulta Mor, Rupganj which was 19.7 m/s^2 . Minimum acceleration was mostly 0.1 m/s^2 for most of the locations. Maximum displacement occurred in Bhogra Bypass Mogorkhala, Gazipur and the value was 0.039 mm while the minimum acceleration was 0 for all of the locations. For surface water pH shows concentration within the standards for each and every sample whereas the DO and Temperature values for some of the tested locations were below the standard value. For groundwater, all the parameters are within the standard value set by ECR 1997. For Riverbed Sediments Parameters analyzed in baseline quality of sediment were observed to be well below the threshold limits for cadmium (Cd) and chromium (Cr) Intervention as per the Dutch Standards.

ANALYSIS OF ALTERNATIVES

As referred to above the principle of the Feasibility Study is to utilize the existing 2 lane alignment and to widen to a divided 4 lane highway. Since for most of the alignment sufficient ROW is available the proposed alignment largely follows the existing alignment. However, some changes to the alignment is proposed in a number of locations and these are referred to Chapter V of the report. In general, these changes to the original alignment have environmental (as well as resettlement) advantages.

ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Pre-construction Phase

The two most significant components applicable to the street venture are changes to precipitation examples and ocean level ascents. It is noticed, that because of Global Warming and Greenhouse gas impacts the patterns of precipitation, temperatures and moistness are evolving. The mitigation measures should be taken corresponding to climate issues, such as precipitation and temperature variation due climate change should be considered during the design stage. Ensure Road structure, dike stature, pavement design, and filling material choice are intended to withstand high precipitation designs.

The proposed Project related structures such as embankments, bridge/culverts, flyovers, etc. will be constructed. Visual changes to the topography would be permanent in nature. The aesthetic elements (such as plantation) should be incorporated in the design to overcome the impacts. In order to construct the embankment for the proposed project, commercial infrastructure, the cultural and community property resources (e.g. mosque, eidgah, grave yard, shrine, school, college, hospital/clinic and so on) located within the ROW will be partially/fully affected. Proper compensation must be provided at first as per the national legal frameworks and ADB's SPS. Within the ROW of the project alignment, there are water supply pipelines, optical fibre, gas distribution lines, and electricity distribution lines with transformers, telephone line and mobile network tower. Relocation of the utilities will temporarily cause inconvenience to the users. Clearance of vegetation on the ROW along the alignment will cause permanent and/or temporary dislocation of some wildlife because of disturbance on their habitat. While clearing vegetation it must be ensured that no wildlife like snakes, mongoose, fox, squirrel and other wildlife species do not injure and/or die. Harming and/or killing of any types of wildlife by the workers of the project must be prohibited. In case of appearance of any endangered/threatened wildlife species respective regulatory authority must be informed as

early as possible. Removal of mature trees will cause ecological loss to the environment, takes initiative to replant trees as per the guidance of Forest Department (FD) of Bangladesh (e.g. minimum two tree seedlings to be planted for each tree felled after completion of the construction activities of the project).

Design and budget provision for the relocation of current utility infrastructure where necessary. All government utilities (e.g. water pipes, gas pipes, power / telephone lines likely to be affected by the proposed highway will be moved well in advance before the construction work actually begins. One of the significant effects of the project will be the acquisition of property. The required 50 m RoW along the significant segments of the project alignment is not accessible to RHD. The total land to be acquired is 37.60 acres, of which 39.74 per cent is (high) cropland, 28.35 per cent is (low) cropland, and 31.25 per cent is farmland. The acquisition of land will result in the removal of cultural and commercial structures, the resettlement of affected people, the removal of vegetation, the relocation of utilities and the inconvenience to be acquired by local people.

The land acquisition and resettlement plan must be prepared in accordance with the national legal frameworks and the ADB Safeguard Policy Statement by social and resettlement experts in order to provide adequate compensation and resettlement for affected individuals. Due to the construction of bridges, no significant effects on the hydrological elements of the river are anticipated. Strong precautionary and mitigation measure will be taken to protect rivers, especially the Shitalakshya River which is Ecologically Protected Area (ECA) from any further deterioration by the project activity.

Construction Phase

Construction of bridges and culverts is possible if diversions and dragging materials are not properly managed to cause drainage congestion. Establish local drainage line with appropriate silt collector and silt screen for rainwater or wastewater connecting to the existing established drainage lines already there. Dredging will be required to source earth material for filling up of the project sites. Riverbed sediment will be contaminated if construction wastes are disposed in the river or adjacent water bodies. In addition, there is also a risk of contamination of bottom sediments by accidental spilling of construction material. Erosion can be happened at the bridge and culvert construction sites. The Contractor is required to reuse the excavated soil as much as possible unless the soil is considered not suitable for filling. The construction of the embankment may cause soil contamination around the areas of road cuttings, embankments, construction camps, workshop, and equipment washing yards, asphalt plants, batching plants, fuel and chemical storage. The movement of construction vehicles, machinery and equipment will be restricted to the corridor or identified route. The unusable, non-saleable, non-hazardous construction waste shall be disposed of in the designated locations only. Air pollution during construction phase is mainly caused by: (1) flying dust produced from mixing lime and soil, (2) material stock grounds, (3) Emission, leakage/ spillover of materials/spoils during transportation, (4) dust from temporary roads and unpaved road surfaces. Provide water spray vehicles to water the unpaved ground, storage piles and other areas where airborne dust may originate. The water spray operation should be carried out in dry and windy day, at least twice a day (morning and afternoon). Noise pollution during construction phase will be caused by the equipment and process such as operations of construction machines and equipment: trucks, bulldozer, excavator, air compressor, Concrete mixing station, Pile drivers, Earth leveling and Generator operation etc. The Contractor shall at its own expense take all appropriate measures to ensure that work carried out (including works by sub-contractors), whether on or off the site, will not cause any unnecessary or excessive noise. If the construction materials such as asphalt, fuel, oil and chemicals are not well preserved, they may be washed away into rivers causing water pollution. The Contractor shall comply with the national legislation and other regulations currently applied in Bangladesh as they relate to water pollution control. Construction of bridges may cause impact to groundwater level and quality. Environmental training with information on the importance of biological diversity and its relationships with sustainable development will be arranged for project workers. For any construction/engineering work over the water bodies, proper measures need to be taken to keep the existing water flow

as usual as possible. Moreover, to protect the fisheries habitat, erosion and siltation have to be kept in control at bridge and culvert sites. The construction of bridges may lead to the loss of aquatic animal habitat due to increased turbidity, decreased dissolved oxygen in the water, and reduction of food sources including temporary decline of plankton and benthos organisms. A proper occupational health and safety plan has to be prepared and will have to be followed to avoid health hazard of the workers. First aid box and personal protective equipment (PPE) such as ear plugs, helmets, hand gloves, safety shoes, goggles, masks, raincoats (during rains) etc. have to be provided to the workers while working at construction site.

Mitigation measures mentioned below should be taken- Selection by the appropriate built-in damping methods and appropriate muffler systems of the recent machinery and plants with a decreased noise level. During the day, the noisiest operations should be carried out. Proper maintenance of equipment and limited operations will decrease noise between 0700 to 1800 hours. Storage or uncontrolled disposal of construction materials close to water bodies can result in temporary drainage congestion, particularly at the sites of modest bridges, tanks, service areas, and constructions. The adequate cross drainage system shall be given to draining water readily into canals and other lowland areas. The elevation level of the highway in the project region should be intended to take into account the level of flood threats. The project region should have an adequate cross drainage system into consideration.

Operation Phase

A new infrastructure (such as residential and co-commercial buildings, shopping, market, etc.) is expected to join the project route. Settlements near the highway will be immediately affected, which will have an adverse effect due to elevated noise and air pollution. The plantation of trees, maintaining due safety protocols, along the corridor can mitigate this. In addition, noise barriers have to be built to reduce noise disturbance in the sensitive community places, e.g. religious places and school adjacent to the ROW.

Increased motion and velocity can lead to safety problems on roads such as road accidents. The accidents can also be caused by dizziness. The measures of mitigation shall include rigorous speed limit enforcement, the installation of speed controllers and category channeling. Traffic signs are given to make it easier for road users to visit rest zones, food stores etc. All tracks, medium, sharp curves are reflected to facilitate night-time travelers. A correct lighting arrangement is made at necessary locations on the RoW.

The settlements in the immediate vicinity of the proposed road will be directly affected which would be minor negative impact. Structures attached with the road, such as flyovers, bridges, auxiliary facilities etc. would cause slight negative effect on landscape. This can be mitigated by tree plantation along the proposed Corridor. The construction of new structures such as flyovers, bridges and culverts as well as road side plantation will improve the aesthetics view of the project area. The proposed Project will promote better business opportunities such as new petrol pumps and hotels. For the operation and maintenance work of the road and bridge/culverts job opportunities will be created.

INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

The stakeholder consultation process disseminates information to all key stakeholders, including the general public and authorities, through meetings and surveys along the project corridor. Information was provided in advance on the scale and scope of the project works, expected impacts, and the proposed mitigation measures by means of consultations with government departments, local authorities, and the general public in meetings and by surveys. The process also gathered information on relevant concerns of the authorities and local community so as to address these in the project implementation stage.

CLIMATE CHANGE ASSESSMENT

Climate change in Bangladesh indicate risks and vulnerabilities due to changes of temperature, rainfall, and 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 0.3m above flood level of sub-base of SMVT lane/ Main carriageway (whichever is lower) to avoid any kind of inundation; (2) Fixation of bridge height considering the HFL as per the hydrological analysis; (3) Incorporation of longitudinal drains along the highway and increasing the number of cross drainage as required; (4) Construction materials policy adaptation through the use of river sand rather than clayey agricultural soil for roadway embankment; (5) and using high quality asphalt pavement to adapt to increase in temperature.

ENVIRONMENTAL MANAGEMENT PLAN

On the basis of identification of the environmental impacts and recommended mitigation measures linked with the project activities, an EMP has been prepared which will be followed at the preconstruction, construction and operation stages. While preparing the EMP, medium and significant impacts are taken into consideration to recommend possible mitigation measures. A mitigation measure will be considered as successful when it complies with the Environmental Quality Standards (EQS), policies, legal requirements set by ADB SPS, 2009 and DoE environmental guidelines & other relevant GoB legal requirements. In absence of DoE's own EQS, other relevant international or other recognized organization's quality standard will be applied. 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. Since the project is in feasibility stage thus the consultant yet not prepared the environmental monitoring plan as well as the environmental monitoring budget. These will be prepared during the detailed design stage when all the baseline environmental quality will be measured.

The executing agency for the project is the Roads and Highways Division (RHD). A project implementation unit (PIU) will be established which will be headed by a full-time project manager. PIU will have an environmental unit who will be assisted by a non-government organization to implement the resettlement plan. Safeguard specialists for environment and resettlement will be a part of the PIU to monitor the EMP implementation and ensure compliance with both ADB and Government of Bangladesh requirements.

GRIEVANCE REDRESS MECHANISM

A GRM will be established to receive, evaluate and facilitate the resolution of affected people's concerns, complaints, and grievances. The GRM aims to provide a time bound and transparent mechanism to voice out and resolve social and environmental concerns linked to the project.

CONCLUSIONS AND RECOMMENDATIONS

The project will have a number of environmental impacts during the construction and operation periods. Assuming effective implementation of the mitigation measures and monitoring requirements as outlined in the Environmental Management Plan, the Project is not expected to have significant adverse environmental impacts. It should also be pointed out that the environmental benefits are likely to be important; an all-weather transport route will link major population and industrial centers in the west of Bangladesh. The potential for congestion will be reduced which will reduce vehicle emissions due to increased and more regular speeds and air quality adjacent to the road will improve.

The EMP provides the specific guidelines for the implementation of measures to prevent or mitigate these effects. RHD is committed to implementing the EMP and has fully endorsed the IEE; the basis for the EMP. RHD will ensure that the work is carried out in an environmentally

acceptable manner and that the monitoring and reporting is completed in a compliant and timely fashion, acceptable to both DoE and ADB.

Contractor's environmental experts have to prepare Site Specific Environmental Management Plan (SEMP) and submit the same to the PMU of EA for approval at least 30 days before entering to the project's sites. Contractors would be allowed to take over the sites only after having approved SEMP.

I. INTRODUCTION

A. Background

1. Bangladesh's trade with South Asia and Southeast Asia has been on the rise since the early 2000s, and about 40% of total trade currently takes place with these regions. The operation of the South Asian Free Trade Area (SAFTA) since 2006 and duty-free market access for most products in the Indian markets since 2011 have created potential opportunities for higher trade with South Asia, particularly with India. The development of cross-border connectivity between these neighbouring countries will open up opportunities to further enhance trade. Bangladesh has the potential to become a Sub-Regional transport and transshipment centre, linking the heavily populated South Asian region to the burgeoning markets and countries to the north and south-east of Asia. It borders mostly with India and a small section with Myanmar, and is geographically close to Bhutan and Nepal, as well as Kunming - the key transportation hub in the south-west of the People's Republic of China (PRC).

2. Road transport being the predominant mode of transport in Bangladesh accounting for about 80% of total traffic moved road quality does not correspond to the Asian Highway standards. The existing highway links are primarily two-lane roads and rail links are primarily single track (although initiatives for upgrading the railway from Dhaka to Chittagong are underway at the moment). Most of Bangladesh's road network needs to be upgraded for handling modern diversified vehicles. However, Bangladesh has already taken many steps to strengthen its regional and international transport connectivity; specially aiming to facilitate trade between Bangladesh and the north-eastern states of India, the Indian state of West Bengal, Bhutan, Nepal and Myanmar. The Road Master Plan 2009 targeted to expand the major roads and highways of Bangladesh to four lanes.

3. In order to improve key transport corridor and road networks that would address the current transport bottlenecks for trade and help boost national, regional and international trade for Bangladesh, the ADB has been providing technical and financial support to the GoB to establish transport connectivity with neighboring countries including India, Nepal and Myanmar, China and beyond.

4. In continuation of the ongoing support for other transport projects, the GoB recently received a loan from the Asian Development Bank (ADB) for additional financing for Upgrading of Joydebpur-Debogram-Bhulta-Madanpur (Dhaka By-Pass) Road (N-105) Into 4 Lanes through Public Private Partnership (PPP).

B. Purpose of Report

5. This report is the Initial Environmental Examination (IEE) for the following road section:

- Joydebpur- Madanur Road (48.112954km)

6. The objective of this study is to identify the environmental issues or parameters that may be affected by the implementation of the project, as well as an assessment of the current status of these issues and parameters related to the construction of the proposed Project. It has also included a consideration of means to avoid or mitigate significant environmentally negative impacts of the project.

7. This IEE has been prepared in accordance with the requirements of the Government of Bangladesh defined in the Bangladesh Environment Conservation Act (BECA) and the Asian Development Bank (ADB) as defined in Chapter 2 below. The Format of the IEE following the ADB recommendations as outlined in the ADB Good Practice Sourcebook; Draft Working Document: November 2012.

8. Moreover, an IEE is an obligatory requirement that application to the Department of Environment (DoE) for Project Site Clearance and EIA document for the Environmental Clearance Certificate (ECC) from the DoE for initiating project implementation. However, this project has already obtained the ECC from DoE and a copy of the certificate has been attached in Appendix 2.

C. Identification of the Project

9. The Roads and Highways Department, with the support of the Public-Private Partnerships Office is currently planning and designing the four-laning of the Joydevpur-Debogram-Bhulta-Madanpur (N105) Road, colloquially known as the Dhaka By-Pass Road. This project would provide for a major arterial connection between the industrial zone of the North and North East, with the port connection to Chittagong in the South. The road is contemplated to include a controlled access toll road, in addition to a two-lane service road, along 48 kilometres that link with the National Highways N1, N2, N3, and N4.

10. Since the project is on the existing ROW of the Dhaka By-Pass Road that has been in operation since 2007, the socio-economic impact due to homestead and livelihood displacement for the upgrade of the existing 2-lane facility to a 4-lane facility has been found to be minimal. However, since the ROW was never protected from encroachment by local businesses, religious institution development and illegal homestead developments, there may be a need to compensate non-land related loss due to displacement from the existing ROW as well as relocating semi-permanent and temporary religious and educational establishments.

11. The land survey indicates that no additional lands are required for the construction of the four-lane highway from the north portal to the south portal. However, in order to meet the required highway design speed and to accommodate additional interchanges at mid-way points along the alignment (e.g., at the Bhulta/N2 interchange or the Purbachal intersection) and two service roads (4.8 m), some additional land will be required. While the analysis demonstrates minimal impact on the financial viability of the road as a PPP project, additional land will need to be underway prior to issue of the RFP, and fully procured and transferred prior to financial close. The proposed interchange, which would provide future access for the Purbachal Land development by RAZUK, will need additional land of 5.08 hectares.

12. In terms of utility and in-ground services relocations, our findings indicate that since the existing alignment is mostly within non-urbanized areas, there are no observed underground utilities such as water and sewerage lines. Furthermore, while no gas transmission pipelines were observed along the roadside, a number of gas-pits were observed which require further verification with the Titas Gas Company. There are in excess of 1,500 electric poles and several deep-tube wells and water pump houses located within the ROW which will require relocation.

D. Extent of the IEE Study

13. The IEE for the Joydebpur-Madanpur Road has been prepared in accordance with DoE, GoB and ADB guidelines based on primary and secondary data, site visits, completion of a Rapid Environmental Assessment (REA) Checklist (Appendix 1), consultation with selected local people and close coordination with the rest of the SRBG-SEL-UDC team. The influence of impact has been defined as 100m on each side from the centerline of the project road alignment during the study. However, the study area has been extended up to 1 km area on each side of the project alignment according to the guideline of DoE, GoB. Geographical Information System (GIS) techniques have also been used based on recent satellite imageries of the project area for above purposes. Assessment is carried out on the following environment components: terrestrial and aquatic ecology, soil, water, air, noise, and socio-economic aspects. The impacts on ecologically sensitive areas (e.g. wildlife sanctuaries, biosphere reserve, and protected places) within 1 km of the project alignment have also been assessed.

14. The primary data on physical, ecological, and human conditions collected by the project teams during site visits have been incorporated in the IEE. A rapid survey and quality assessment on the roadside environment were conducted by the environmental team. Published data relevant to the project area have also been used in preparing the document.

E. Responsibility for Preparation

15. A consortium of Sichuan Road and Bridge Group, Shamim Enterprise Ltd., and UDC Construction Limited has signed a concession contract with the Government of Bangladesh to upgrade the Dhaka Bypass under a public-private partnership (PPP) arrangement. The 48.112954 km project will provide a major arterial connection between the industrial zone northeast of Dhaka and national highway N1 connecting to Chattogram city, as well as to N2, N3, and N4 highways leading to other major cities to upgrade the Dhaka By-Pass Road from the existing 2-Lanes to a 4-Lane access control toll road. The Environmental Team is based in the same project office and work closely with the rest of the team responsible for the preparation of the Project. The IEE covers the complete alignment of the road as described above. The IEE has been prepared to comply with both the Government of Bangladesh and ADB requirements.

F. Scope of Works

16. This IEE report has been prepared keeping in view the requirement of DoE and ADB. The scope of the present IEE report describes the following most important features:

- A review of the environmental legislative, regulatory and policy guidelines and considerations relating to the implementation of the project;
- A general description of the project and existing physical, biological and socio-economic conditions;
- Analysis of different alternatives to the project in terms of environmental and social perspectives;
- Identification and assessment of the potential impacts on the natural and human environment in the project area, from the construction of the project;
- Consultation with the locals/stakeholder involving concerned people in order to identify and act on any undocumented or perceived environmental issues;
- Identification of mitigation measures in the form of an Environmental Management Plan (EMP); and
- Recommendations and conclusions in order to operate the project works in an environmentally safe and sound manner.

G. Approach & Methodology

1. Approach

17. 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

18. In order to establish the baseline biophysical conditions within the study area, relevant secondary and primary data was collected and reviewed, a comprehensive field visit was undertaken, and a number of consultations with local people were carried out. For better assessment the data collection programme was planned as per the segmented contract packages. The data generated allowed to better understand the complex interplay between the various biotic and abiotic factors within the study area and to establish the baseline conditions. Once this baseline was established it was used as a reference point to identify potential changes to the environment that may occur as a result of the proposed Project activities, as well as to allow development of measures to prevent, mitigate or manage these potential impacts.

a) Environmental Data Collection and Analysis

19. This section describes the methods and techniques used to investigate and describe the potential environmental risks of the Project. In order to establish the baseline biophysical conditions within the Project area, relevant secondary and primary data was identified and reviewed, a comprehensive field visit program established, and a number of specialist studies were carried out. This included the gathering of primary and secondary data from various sources including from discussions with groups, discussion with individuals, Government sources, RHD and from locally active NGOs.

20. The assessment of potential environmental impacts requires detailed information on all aspects of the habitats, biodiversity and physical aspects of the Project area. It also requires development of an understanding of how the existing environmental processes work together to form a complex ecosystem. This information can be used to identify potential changes to the environment that may occur because of the Project, and to propose measures to prevent, mitigate or manage potential environmental impacts.

21. The potential for environmental impacts was considered for activities during all stages of the proposed Project. This includes site establishment, drilling operations and site decommissioning and demobilization stages. As the environments within the Project area have not been widely studied in the past, knowledge gaps identified within the consultation phase have been filled through detailed investigations and field visits as part of this more comprehensive IEE report.

Secondary Data Collection

22. A review was conducted of the biophysical, ecological and legal literature relevant to the Project. The review of secondary sources and informal initial field investigations were undertaken in order to prepare a preliminary assessment of the physical and social environment, biodiversity, and conservation significance of the identified study area. This preliminary literature reviews also assisted in identifying data gaps which would require collection of additional primary information through physical field survey. The following activities were included in this phase of the Project:

- Data and information were collected from various government relating to site aspects climate (weather), groundwater quality and soils; secondary ecological data sources were collected and assessed;
- An appraisal was made of all legislation having direct and indirect relevance to environmental management within the Study Area including aspects such as biodiversity conservation, water quality, waste management, natural resource management and spill response;
- Previous environmental site studies, where available, were reviewed as well as relevant scientific journal articles; and

- Thereafter, an information gap analysis was undertaken to identify the areas where further primary data collection would be required to complete the IEE.

23. Thereafter, an information gap analysis was undertaken to identify the areas where further primary data collection would be required to complete the IEE. Further detail regarding the titles of the relevant literature, policies, acts and other regulations and guidelines reviewed and applied during the course of this process can be found in legal section of this report.

Baseline Data Collection and Analysis

24. Primary data collection was initiated to fill gaps in knowledge resulting from the secondary data review. Further, it aimed to provide a site-specific data set of relevant physical and biological environmental aspects relevant to the Project. The primary data collection program was undertaken in July 2019. During the field visit, stakeholders were consulted and several important additional secondary sources of environmental information, data and literature were collected.

Physical Environment Field Survey

25. To comprehensively evaluate the existing Project area baseline conditions, a field visit and data collection program incorporating a number of biophysical investigations was developed and implemented. A desktop assessment was then prepared to enable the collection of refined and verifiable information. The field survey program was conducted throughout the Project area by a specialist environmental team.

26. This survey aimed to identify important environmental components and environmental issues within the study area. It included investigation and observation of the local landforms, market location, habitat types, drainage patterns, species abundance and distribution, soil types, water quality (surface water and groundwater), air quality, noise, vibration and hydro-morphology.

27. The study area and surrounds were surveyed on foot and by boat. Important environmental features were identified and logged. Hand-held geographic positioning systems (GPS) were used to identify specific features for mapping and further analysis in the Project office. Features that were recorded or ground-truthed with GPS included:

- ✓ Habitation and settlement areas;
- ✓ Cultural Physical Properties (CPR);
- ✓ Plantations;
- ✓ Habitat areas;
- ✓ Sensitive environments; and
- ✓ Transportation routes;

28. Direct observation and key informant interview techniques were employed within the field survey. Direct observations were subject to accessibility and were guided by satellite image maps and local information. Observations were made along rivers, roads, embankments, and local footways across the agricultural fields and village groves. An environmental observation checklist was completed for each of the areas.

Ecological Field Survey

29. Initially, secondary data sources were reviewed in order to compile a potential presence/absence list of significant fauna and flora species. Thereafter two members among the field survey team were deployed to undertake the required sampling and assessment. Sampling and survey were conducted for both aquatic and terrestrial ecosystems, validation

checks were confirmed against the earlier-compiled species lists in order to establish a comprehensive baseline.

30. The following activities were undertaken during the terrestrial and aquatic field surveys:

Direct Observation

31. Direct observation on the occurrence and abundance of flora and fauna was made while travelling along road edges, across the agricultural fields, the forest areas and within village groves. As well as direct sightings, identification of animal presence was also based on identification of tracks, foot prints, feeding signs and animal/bird calls. Appropriate field guides and data proformas were used for this activity so that information was accurately recorded.

Interviews with Local Residents

32. Many of the mammalian and reptilian species are cryptic and unlikely to be encountered using standard field sampling methods. As such, experience suggests that interviews with local people are a very useful method for collecting information on local biodiversity. This data is anecdotal and as such should not form the core of any assessment; however, it does nonetheless provide useful supplementary information. During the field survey period, extensive interviews with local people were conducted to collect information on animal and plant presence, including occurrences, behavior, breeding, distribution and seasonal appearance.

Socioeconomic Field Survey

33. The IEE study mostly used the socio-economic data collected by the Social and Resettlement Team for social assessment. However, during the environmental survey some consultations were conducted with the local people on environmental issues but social conditions were also discussed.

Consultations

34. For this report, Focus Group Discussions (FGD) were conducted along the project corridor. A team of experienced professional and support staff has conducted surveys and consultation meetings after being briefed about the project. The respondents were selected by random sampling method from each of the locations. Respondents' contact information was collected for further verification, if and when required.

b) Impact Assessment Methods

35. The IEE process identifies the potential environmental impacts that may result from the implementation of the Project. Both positive and negative potential impacts for the Project were identified through the application of standardized international best practice methods of environmental impact assessment. Some of the methods of environmental impact assessment utilized include:

- Ad-hoc methods;
- Application of expert judgment;
- Risk based approach including residual risk assessment;
- Systematic and sequential approaches; and
- Spatial analysis methods (including GIS).

36. Further to these methods, potential impacts were assessed by drawing from the experiences and opinions of local people, important stakeholders such as government agencies and through the review of environmental literature and data collected relevant to the Project area.

37. The principal method for assessing the potential impacts of the Project on the biophysical and social environments utilized for this IEE was risk assessment. Details on the risk assessment process and how it was utilized to identify impacts, the likelihood and consequence of the actions and implement appropriate mitigation measures to reduce any potential impacts to an acceptable level is detailed within the following sections.

Geographical Information Systems (GIS)

38. Geographical Information Systems (GIS) was used as a specialized analysis and presentation tool. Before commencing field investigations, spatial analysis of satellite imagery and present administrative areas and other boundaries/constraints was considered for the environmental assessments. For example, the sanctuaries, forest areas, spawning grounds, infrastructures, and the contract packages were identified. It also supports more detailed on-ground survey, particularly spatial features that may be directly or indirectly influenced by Project activities.

39. Detailed on-ground validation of spatial information – particularly land use – was undertaken using a hand-held, non-differential GPS. The spatial data acquisition team took detailed transect walks through the Project area in order to identify various land use types and confirm the findings of the satellite imagery analysis. This extensive ground-truthing exercise both validated the land use mapping and identified additional sensitive areas to include within the environmental fieldwork for sampling.

Risk Assessment Matrix of Proposed Project

40. Relevant environmental issues were taken from the IEE and further investigated within the IEE utilizing a risk-based assessment methodology. Risk assessment is a process that supports the analysis of potential negative impacts that may result from implementation of a Project. It provides a means of categorizing how potential impacts are to occur, and of categorizing what the potential consequences might be if impacts were to occur. Risk assessment is the primary method of impact assessment that is applied in this IEE.

41. Risk assessment was utilized in this IEE as the primary tool to support environmental and socio-economic impact assessments. It provides a means of categorizing the frequency and magnitude of potential impacts and provides a basis for the application of different degrees of mitigation and management measures.

42. By successfully categorizing the likelihood and consequence of potential impacts, direction can be given to those potential impacts that should be subjected to the most rigorous attention. Such impacts are designated as potentially significant impacts. Alternatively, potential impacts that are shown to be infrequent and a low magnitude of consequence can be treated as less significant. Figure I.1 presents a schematic of the risk assessment process adopted for the developed of this IEE.

43. All socio-economic and environmental impact assessment methods, including risk assessment, incorporate a degree of inherent uncertainty. This is largely due to the unavoidable variations and uncertainties characterized by natural, social and economic systems. However, the use of risk assessment allows analysis of risks (or potential impacts) to be classified on an empirical scale. Such a scale is useful because it limits the inherent subjective and interpretive nature of impact assessment. Further accuracy in risk assessment results are driven by the workshop approach to hazard categorization and through the application of experienced expert knowledge.

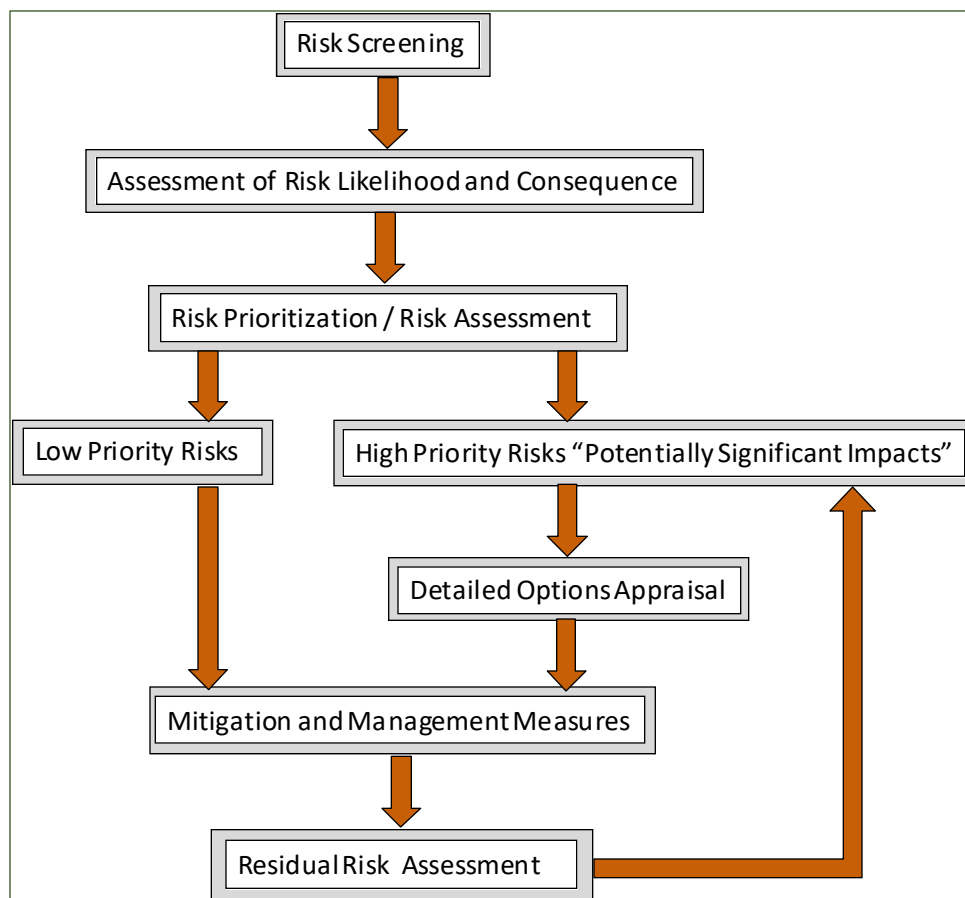


Figure I.1 Risk Assessment Process

44. Certain impacts identified in this section have the potential to be significant. The determination of whether a given potential impact is significant depends on several factors:

- The potential for on-site and off-site impacts;
- The potential for direct and indirect impacts;
- The frequency and duration of a potential impact;
- The geographic area affected by a potential impact
- The period of time affected by any potential impact;
- The sensitivity of the receiving environment; and
- The degree of confidence with which the potential impacts of the action/activity are known and understood.

45. Measures of potential impact significance as part of the Project planning and assessment phase presented in this IEE have been determined using a risk-based model. The risk-based model is a two-dimensional matrix of 'magnitude of impact' and 'likelihood'. Both are assigned score between 1 and 5 based on severity or probability and multiplied to obtain the 'risk band'.

46. The 'magnitude of impact' is a 5-point based scale set by expert's judgment. The scale and its explanation are given in Table I.2.

Table I.1: Explanation and Assignment of Scores to 'Magnitude of Impact'

Colour Band	Incidental	Minor	Moderate	Major	Severe/catastrophic
Score	Score: 1	Score: 2	Score: 3	Score: 4	Score: 5
Explanation	Impacts such as localized or short-term effects on habitat, species or environmental media.	Localized, long term degradation of sensitive habitat or widespread, short-term impacts to habitat, species or environmental media	Impacts such as localized but irreversible habitat loss or widespread, long-term effects on habitat, species or environmental media	Widespread and persistent changes in habitat, species or environmental media	Persistent reduction in ecosystem function on a landscape scale or significant disruption of a sensitive species.

47. The 'likelihood' is also a 5-point based scale set by expert's judgment. The scale and its explanation are given below.

Table I.2: Explanation and assignment of scores to 'likelihood'

Colour Band	Rare	Unlikely	Seldom	Occasional	Likely
Score	Score: 1	Score: 2	Score: 3	Score: 4	Score: 5
Explanation	Rare or unheard of	Reasonable to expect that the consequence will not occur during this project though has occurred several times in industry	Exceptional conditions may allow consequences to occur within the project lifetime	Conditions may allow the consequence to occur during the project lifetime, or the event has occurred within similar projects	Consequence can reasonably be expected to occur in life the project

48. Therefore, "Risk" factor is derived from the following equation:
 Risk = Magnitude x likelihood

49. The score of 'Risk' ranges from 1 to 25. The score is classified in 3 classes. The explanation is given in Table I.3. The score matrix for risk assessment has been used to identify the priority environmental impact and their mitigation plan.

Table I.3: Two-Dimensional Risk Assessment matrix

			MAGNITUDE OF IMPACT				
			Incidental	Minor	Moderate	Major	Severe/cats.
			Score: 1	Score: 2	Score: 3	Score: 4	Score: 5
LIKELIHOOD	Rare	Score: 1	1	2	3	4	5
	Unlikely	Score: 2	2	4	6	8	10
	Seldom	Score: 3	3	6	9	12	15
	Occasional	Score: 4	4	8	12	16	20
	likely	Score: 5	5	10	15	20	25

Methods for Mitigation and Management

50. Mitigation measures are the means by which potential negative impacts associated with the Project may be avoided or reduced to appropriate levels through modifications to the design, construction methods or context of the Project. In real terms, 'reducing negative impacts to an appropriate level' means that the potential impacts are reduced to a point where they no longer pose a significant threat to the current or future status of the surrounding natural environment, biodiversity value, and social or economic environment of the region.

51. Suggested mitigation measures for this Project are provided in Chapter VI. The mitigation measures have been translated into actions to maintain the environmental integrity of the Project and provide workable solutions.

52. An Environmental Management Plan (EMP) has been developed for each of the major issues identified and assessed within this IEE in Chapter IX. The EMP incorporates environmental mitigation measures identified in Chapter VI and forms a practical guide to the ongoing management of all aspects of the Project, including biophysical monitoring and performance criteria auditing for the life of the Project.

53. Each EMP Sub-Plan is consistent with the standards and guidelines of Bangladesh and with international best practice principles. The EMP Sub-Plans document the following elements for each environmental aspect.

H. Contents of the Report

54. This report includes the following main elements;

Chapter I: Introduction and background

This chapter consists of the background of the project along with the objectives, scope and the methodology of preparing the IEE report. This chapter also includes the organization of the total IEE report.

Chapter II: Legislative framework

In this chapter the national and international laws and policies are described which are relevant to the environmental aspects of the project. The relevant guidelines of the funding agency ADB are also described in this chapter. Finally, the requirements for making IEE for this project according to DoE and ADB are described.

Chapter III: Project background

This chapter includes the background and objectives of the proposed project. The location of the project, proposed project interventions and project cost are described here. In total, this chapter gives a detailed idea about the project.

Chapter IV: Description of the baseline environment

This section provides the definition and baseline conditions or attributes of the study area and its existing physical, biological and socio-economic environment. This section presents both environmental and socio-economic aspect and draws upon both secondary and primary data collection. Maps tables, figures and plates are used to present relevant data about the study area to provide a comprehensive picture of the existing environment prior to Project implementation.

Chapter V: Analysis of alternatives

In this chapter the alternative options of the proposed project are analyzed. It starts from no project alternative and ends at analyzing all the possible alternatives. This chapter concludes

with declaring the proposed project as the best solution after analyzing all the other alternatives.

Chapter VI: Anticipated environmental impacts of the proposed project

This section identifies the potential positive and negative environmental, physical and socio-economic impacts of the Project. Each key aspect is analysed and discussed in relation to the Project. For key aspects, the potential impacts are broken down into the different delivery stages of the Project. A risk prioritization matrix is presented which forms the guideline adopted for the undertaking of a risk assessment to identify the significance of potential impacts by way of likelihood and consequence. From this risk assessment, the identified potentially significant impacts are drawn out and presented as those that require most attention in the development of specific management and mitigation measures.

Chapter VII: Public consultation

This section presents the outcomes of the stakeholder engagement and consultation undertaken as part of the IEE. Different types of engagement and consultation were undertaken with different stakeholder groups including local and divisional government administrations, the local community, business and social leaders, NGO's and individuals. These were largely undertaken by one-on-one meetings, small group interviews, and focus group discussions.

Chapter VIII: Climate change assessment

This chapter illustrated with a detailed literature review on the climate change and its impact of the project road along with adaptation measures.

Chapter IX: Environmental management plan

This chapter includes the environmental management plan which includes the impacts of the proposed project on environment and society is described. All the anticipated impacts in pre-construction stage, construction stage and operational stage are described here.

Chapter X: Grievance redress mechanism

This chapter includes the mechanism to redress the grievances from the local people during the implementation of the project.

Chapter XI: Conclusion and recommendation

This chapter includes the conclusion and some recommendations are suggested here about the proposed project.

II. ENVIRONMENTAL POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. Regulatory Requirements for the Project

55. 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. National Legal and Institutional Framework

1. National Environmental Policy, 1992

56. 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.

57. **Relevance to the project** - 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 (NEMAP), 1995

58. 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.

59. **Relevance to the project** - The plan proposes development and application of guidelines to avoid environmental pollution due to transport and communication system. It particularly puts emphasis on different environmental pollution, hamper of natural drainage pattern and agricultural land acquisition due to development of transport system.

3. Environmental Conservation Act (ECA), 1995

60. 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.

61. The main objectives of ECA are:

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

62. 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.

63. 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.

64. The Project will be undertaken in line with the aims and objectives of the Act by conserving the environment and controlling and mitigating potential impacts throughout the drilling program.

- ***Environmental Conservation Act (Amendment 2000)***

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

- ***Environmental Conservation Act (Amendment 2002)***

66. The 2002 Amendment of the ECA elaborates on the following parts of the Act:

- Restrictions on polluting automobiles;
- Restrictions on the sale, production of environmentally harmful items like polythene bags;
- Assistance from law enforcement agencies for environmental actions;
- Break up of punitive measures; and
- Authority to try environmental cases.

- **Environmental Conservation Act (Amendment 2010)**

67. 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.

68. **Relevance to the project** - According to this law no industrial unit or project shall be established or undertaken without obtaining, in the manner prescribed by rules, an Environmental Clearance Certificate from the Director General.

4. The Water Act, 2013

69. Bangladesh Water Act, 2013 has been made for the improvement, management, collection, distribution, usage, protection and preservation of the water. The Act recognizes the significance for managing all forms of water resources in the context of natural flow of surface water and recharge of groundwater. The private landowners will be able to use the surface water inside their property for all purposes in accordance with the Act. No individuals or organizations will be allowed to extract, distribute, use, develop, protect, and conserve water resources, nor will they be allowed to build any structure that would impede the natural flow of rivers and creeks.

70. Conservation of wetlands as grazing ground and sanctuary of the migratory birds has been given much importance while conservation of ponds as a source of pure drinking water in critical areas has been abandoned. But this is unfortunate that the Act recognizes the significance for managing all forms of water resources in the context of natural flow of surface water and recharge of groundwater rather making a commitment by the government to ensure the quality of water for various beneficial uses. The lack of clear directives that will facilitate recovery of the flood flow zone by evicting land grabbers and encroachers remains as a serious weakness of the Act.

71. The Act specifically mentions that rights over surface water on any private land shall remain with the owner of such land. But the executive committee can issue a protection order to the owner of such private land without discrimination for the protection and conservation specially to prevent the wastage and misuse of water¹⁰. Conservation of ponds is included as a clause within section 22 of The Water Act as 'Conservation of water source and management thereof' which bears no importance. As a result, the sole public demand in the critically water scarce areas remain mixed up with the issue of conservation of water bodies as the sanctuary and grazing ground of the migratory birds.

5. Environment Conservation Rules, 1997 (Amended in 2002)

72. 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.

73. 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.

74. 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.

75. 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.

76. 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. These are Orange B for work that requires Initial Environmental Examination (IEE) and Red for work that requires full environmental assessment.

77. 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.

78. 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.

79. **Relevance to the project** - In accordance with the Environment Conservation Rules (ECR) of 1997, the Project is classified as a Red Category, requiring a complete Environmental Impact Assessment (EIA) for RHD to obtain clearance for construction.

6. Environmental Courts Act, 2000

80. The Environment Court Act, 2000 has been enacted in order to establish environmental courts in each administrative division of Bangladesh. This Act sets out policy for effective pursuance and completion of legal proceedings related to environmental crimes. Under this Act the Director General of the DOE has the power to impose heavy penalties to industrial polluters who are dumping untreated wastewater into the environment or not operating their legally mandated ETPs.

81. **Relevance to the project** - According to this act, government can take legal actions if any environmental problem occurs due to project interventions.

7. Labour Rules, 2015

82. Major Key points of the policy are as follows:

- Employment Policy/Service Rules: If any establishment wants to have its own Employment Policy/Service Rules, it must obtain approval from the Chief Inspector of Labour. All existing Employment Policy/Service Rules must be submitted to the Chief Inspector of Labour within November 15, 2015 for approval.
- Registration of Manpower supply agency: The Rules prescribed the process and forms for the registration of manpower supply agencies under the Labour Act. Some new conditions are also imposed on the manpower supply agencies.
- Establishment Organogram: Every owner of an establishment must prepare an organogram for the establishment and must obtain the approval of Chief Inspector of Labour for such organogram.
- Appointment Letter: Under the Labour Act, an appointment letter must be issued for hiring any labour. The Labour Rules makes it mandatory that the appointment letter must contain certain information such as salary, other financial benefits, applicable rules etc.
- Various Register: The Labour Rules prescribe certain forms for various register such as service book, labour register, leave register, etc.
- Misconduct and punishment: The Rules prescribe the process for investigation of misconduct.
- Two festival bonuses: The Rules makes it mandatory that a labour, who continuously works for a year, must receive two festival bonuses in every year. Each bonus shall not be more than a basic salary.
- Provident fund elaborated: The Rules provide detailed guidelines regarding provident fund. New additions include provisions related to selection of nominee, management of the fund, activities of the trust for managing provident fund.
- Holiday: The Rules detailed the provisions related to holidays. It also clarifies the provisions related to compensatory weekly holiday.
- Health and fire safely: The Rules provide a detail guideline on health and fire safety.

8. The EIA Guidelines for Industry (1997)

83. The EIA Guidelines is a handbook defining procedures for preparing EIAs and for reviewing them, prepared for the benefit of the development partners, EIA consultants, reviewers, and academicians.

84. **Relevance to the project** - The Guidelines provide a step-by-step methodology for the completion of EIAs.

9. National Land Transport Policy

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

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

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

10. Wetland Protection Act 2000

87. The latest Wetland Act – The Playground, Open Spaces, Gardens, and Wetland Conservation Act 2000 – suffers from loopholes and inadequacies regarding protection of water bodies. Section 1 of this Act suggests that it has application on the water bodies of the cities, divisional and district towns and municipalities. The water bodies in the rural areas are outside the jurisdiction of this Act.

88. The Act does not have any provision that prohibits construction of any kind of permanent or temporary structure within a determined distance of the water bodies. The Act also does not have any provision that provides that the water bodies that have been marked in survey records and exist in other approved government documents will be recovered if they have been encroached on.

89. The Act specifies the fine and imprisonment term for violation of any of its provisions, it does not direct the government to recover the original characteristics of the water bodies if someone fills them up.

11. RHD's Road Master Plan

90. The objectives of RHD's road master plan are:

- Protecting the value of RHD's road and bridge assets
- Improving the connectivity of the road network
- Enhancing and developing the strategic road network to meet economic and traffic growth targets
- Improving the zilla road network to enhance connectivity to the country's growth targets
- Improving road safety to reduce road accidents
- Provide environmental and social protection
- Outline the institution improvements required for RHD

91. **Relevance to the project** - According to the plan, the physical and social environment must be protected from adverse effects of road construction.

12. National Road Design Standard

92. A comprehensive National Transport Policy (NTP) need be formulated to integrate different modes of transport for most efficient performance considering intermodal interactions, to develop communications network without damaging the physical environment, and to allocate resources according to conservation and environmental considerations and priorities of economic development.

- **Design speed:** The selected design speed influences the characteristics of various geometric elements on a roadway, such as lane widths, horizontal and vertical curves, and sight distance. The speed selected should reflect the speed drivers expect to travel at on a section of roadway, and should take into account the abutting developments, the roadway function and its physical limitations (due to terrain, expected traffic volumes, etc.).
- **Lanes and shoulders:** Crash risk can be linked to the total seal width (lane and shoulder seals). Crash risk decreases with increasing seal width (i.e. wider lanes and larger shoulders), as the sealed area provides a recovery zone for errant vehicles and space for evasive maneuvers. For two-lane rural roads, shoulder sealing can reduce crash risk by up to 35%.
- **Horizontal alignment:** This involves the design of horizontal curves along a road. Crash risk increases with decreasing curve radius (i.e. as a turn gets tighter). The risk increases more rapidly for curve radii below 400m. The crash risk is also higher for isolated curves (or where the driver might not be expecting it), and lower for curves in a sequence of similar-standard curves.
- **Vertical alignment:** This involves the road grade (the rate of change of vertical elevation) and vertical curves (i.e. crests and sags). Sag curves are not known to have any significant effect on safety. The most crucial effect crests have on safety is through sight distance, which is covered in the next bullet point. There is a small relationship between crash risk and vertical grade – the crash risk also increases more rapidly for grades beyond 6% as vehicle speeds becomes more difficult to manage.
- **Stopping sight distance:** This is the distance required for a driver to recognize a need to stop and brake to a stop from a particular speed. Horizontal and vertical curves limit a driver's sight distance, particularly crests. There is the suggestion of a small increase in crash risk as sight distance over a crest decrease. This risk increases more rapidly for sight distances below 100m. Road widening (either as wider shoulders or an overtaking lane) over a crest with less than adequate sight distance can be an effective countermeasure rather than flattening the crest. It is suggested that safety is unlikely to be affected by limited stopping sight distance; however, improving limited sight distance at locations where other vehicles may be slowing or stopping (in particular intersection sight distance) can be extremely important for safety.
- **Roadside clearance:** Also known as horizontal clearance or lateral offset, roadside clearance is distance between the edge of the roadway or shoulder to a vertical roadside obstruction, and the type of obstruction a vehicle might hit. Crash risk can potentially be reduced by 35 to 45% when all roadside hazards are removed (e.g. trees, poles, fences, etc.); however, a barrier installation can be an effective countermeasure for reducing run-off-road crashes. It should be noted that a 'clear' roadside must also be flat or mildly sloping (e.g. 1:4 or flatter), and that roadsides with steeper gradients can have a large impact on vehicle safety.

13. The Forest Act (1927) and the Forest (Amendment) Act (2000)

93. The Forest Act (1927) was enacted to control trespass, illegal resources extraction from forests and to provide a framework for the forestry revenue collection system. It is the main legislative context for forestry protection and management in Bangladesh. The Act allows for the notification of forest reserves in which the government, through the Forest Department, regulates the felling, extraction and transport of forestry produce in Bangladesh. The Act grants

the government several basic powers, largely for conservation and protection of government forests, and limited powers for private forests.

94. **Relevance to the project** - The Act is relevant to the project as construction of the project road will require cutting 10782 trees.

14. National Forest Policy (amendment), 1994

95. The National Forest Policy of 1994 is the amended and revised version of the National Forest Policy of 1977. The policy is designed to conserve the existing forest areas, bring about 20 % of the country's land area under the Forestation Programme, and increase reserve forests by 10 percent per year to 2015 through coordinated efforts of GoB-NGOs and through active participation of the people.

96. **Relevance to the project** - The Act is relevant to the project as construction of the project road will require cutting 10782 trees.

15. The Private Forests Ordinance, 1959

97. An Ordinance to provide for the conservation of private forests and for the afforestation in certain cases of waste lands in Bangladesh.

98. **Relevance to the project** - According to the section 61 of this ordinance any land is required for any of the purposes of this Ordinance; such land shall be deemed to be needed for a public purpose.

16. Bangladesh Wildlife (Conservation & Security) Act, 2012 (previously known as Bangladesh Wildlife (Preservation) Order, 1973; amended as Bangladesh Wildlife (Preservation) Act 1974)

99. This Order aims to protect and conserve wildlife in Bangladesh. Wildlife preservation, conservation and management fall within the jurisdiction of the Forestry Department. The previous Wildlife (Preservation) Order, 1973 & Wildlife (Preservation) (Amendment) Act, 1974 have been revamped to Wildlife (Conservation & Security) Act of 2012.

100. The Act has adopted new types of protected areas for conservation and protection of wildlife resources, created avenue for community conserved areas and also community-based management of protected areas. This Act protects 1,307 species of plants and animals under four schedules that mandates imprisonment and fines for wildlife poaching, capturing, trapping, and trading. Bangladesh Wildlife (Preservation) Order (1973) and Act (1974) regulates the hunting, killing, capture, trade and export of wildlife and wildlife products. It designates a list of protected species and game animals. Protection of wildlife is provided with lists of species within four schedules of the Order:

- First Schedule - The Schedule -1 (823) represents Protected Animal (Amphibians-14, reptiles-96, birds-578, mammals-110, fishes-25) of Bangladesh which are open to shooting and may be hunted on a special hunting permit (though since 1988 no hunting permits have been issued by the Government).
- Second Schedule – Schedule-2 (424) also represents Protected Animal (Amphibians-18, reptiles-58, birds-44, mammals-3, fishes-27, phylum cnidaria – class anthozoa (coral)-32, molluscs – shells and snails-137, arthropods – crustacea (crabs and lobster)-22, insect (butterflies and moths)-59, Insect – beetles-24 those species that are not to be hunted, killed or captured and CITES Specification;
- Third Schedule – Schedule -3 (6) represents Vermin-6 Protected animals; and
- Fourth Schedule - Schedule -4 (54) represents Protected Plants-41 and Orchid-13.

101. **Relevance to the project** - This Act is relevant to the project as intervention may affect wildlife habitation, obstruct movement.

17. National Water Policy, 1999

102. The policy aims to provide guidance to the major players in water sector for ensuring optimal development and management of water. The policy emphasizes efficient and equitable management of water resources, proper harnessing and development of surface and ground water, availability of water to all concerned and institutional capacity building for water resource management. It also addresses issues like river basin management, water rights and allocation, public and private investment, water supply and sanitation and water need for agriculture, industry, fisheries, wildlife, navigation, recreation, environment, preservation of wetlands, etc. The policy has several clauses related to the project for ensuring environmental protection.

103. **Relevance to the project** - Clause 4.6b of this policy states that natural depressions and water bodies in major urban areas must be preserved in order to recharge of underground aquifers and rainwater management. Moreover, measures must be taken to minimize disruption to the natural aquatic environment in streams and water channels (Clause 4.9b). In addition, this policy requires each water resources development project or rehabilitation program to give full consideration to environmental protection, restoration and enhancement measures consistent with National Environmental Management Action Plan (NEMAP) and the National Water Management Plan (NWMP) and adhere to a formal environment impact assessment (EIA) process, if required by the Government (Clause 4.12a and clause 4.12b).

18. National Fisheries Policy, 1998

104. The policy recognizes that fish production has declined due to environmental imbalances, adverse environmental impact and improper implementation of fish culture and management programs. The policy suggests, among others, that biodiversity will be maintained in all-natural water bodies and in marine environment and control measures will be taken against activities that have a negative impact on fisheries, resources and vice-versa. National Fisheries Policy focuses on aquaculture and marine fisheries development and includes the following mandates:

- Maintaining biodiversity in all natural water bodies and in marine environment,
- Ensuring that chemicals harmful to the environment will not be used in fish shrimp farms;
- Using environment friendly fish shrimp culture technology;
- Expanding fisheries areas and integrating rice, fish and shrimp cultivation;
- Undertaking control measures against activities that have a negative impact on fisheries resources and vice-versa; and
- Formulating laws will to ban the disposal of any untreated industrial effluents into the water bodies.

105. **Relevance to the project** - The project required to take proper action to prevent any hindrance of biodiversity in all natural water bodies and in marine environment.

19. Protection and Conservation of Fish Act 1950 (Amended 1982)

106. The Protection and Conservation of Fish Act of 1950, as amended by the Protection and Conservation of Fish (Amendment) Ordinance of 1982 and the Protection and Conservation of Fish (Amendment) Act of 1995, provides provisions for the protection and conservation of fish in inland waters of Bangladesh. This is relatively unspecific and simply provides a means by which the Government may introduce rules to protect those inland waters not in private ownership.

107. This is framework legislation with rule making powers. Among others, some of these rules may prohibit the destruction of, or any attempt to destroy, fish by the poisoning of water or the depletion of fisheries by pollution, by industrial effluent or otherwise.

108. **Relevance to the project** - Through this framework legislation, the government makes rules to prohibit the destruction of, or any attempt to destroy, fish by the poisoning of water or the depletion of fisheries by pollution, by industrial effluent or otherwise. Protection and Conservation of Fish Rules (1985).

109. The Fish Rules (1985) specifies in section-6 of the Rules states that “No person shall destroy or make any attempt to destroy any fish by poisoning of water or the depletion of fisheries by pollution, by trade (industrial) effluents or otherwise in inland waters”. It is considered that the proposed project construction works are in line with the objectives of the above-mentioned Act and Rules.

110. The project required to take proper action to prevent any hindrance of biodiversity in all natural water bodies and in marine environment.

20. National Agriculture Policy, 1999

111. This policy aims to make the nation self-sufficient in food through increasing production of all crops including cereals and ensure a dependable and secure food system for all. One of the objectives of this Act is to preserve and develop land productivity. The policy particularly stresses on research and development of improved varieties and technologies for cultivation in water-logged and salinity affected areas. The policy also recognizes that adequate measures should be taken to reduce water-logging and salinity and provide irrigation facilities for crop production.

112. **Relevance to the project** - According to the policy alignment of the proposed project must be selected carefully so that acquisition of fertile agricultural land is minimal. Moreover, adequate measures should be taken to reduce water-logging and hamper of irrigation system due to construction of the project road.

21. National Land Use Policy, 2001

113. 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.

114. The main contents of this policy are:

- Stopping the high conversion rate of agricultural land to nonagricultural 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.

115. **Relevance to the project** - The proposed project must adhere to this policy so that environmental sustainability of land-use practices is assured.

22. The Embankment and Drainage Act, 1952

116. This Act consolidates the laws relating to Embankments and drainage. It provides provision for the construction, maintenance, management, removal and control of

embankments and water courses for the better drainage of lands and for their protection from floods, erosion or other damage by water.

117. **Relevance to the project** - Disposal of dredged spoil may create drainage obstruction. So, adherence to relevant section of the Act must be addressed in the environmental assessment.

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

118. The GoB 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.

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

120. **Relevance to the project** - Relevant as the country is vulnerable to climate change effect.

C. International Conventions, Treaties and Protocols (ICTPs)

121. Bangladesh is a party to a large number of international conventions; treaties and protocols (ICTPs) related to the Project and are committed to ensuring that these protocols are complied with during all development works. The five applicable ICTPs that BR is also aware of and is complying with are enumerated in Table II.1.

Table II.1: International Conventions, Treaties and Protocols Signed by Bangladesh

Conventions	Years	Ratified/Accessed (AC)/Accepted (AT)/ Adaptation (AD)	Relevance
International Plant Protection Convention (Rome,) & Plant Protection Agreement for SE Asia and Pacific (1999 Revision)	1951 1999	01.09.1978 04.12.1974 (AC) (Entry into Force)	Ensuring that the Project work or construction materials do not introduce plant pests
Convention on Wetlands of		20.04.1992	Protection of significant wetland

Conventions	Years	Ratified/Accessed (AC)/Accepted (AT)/ Adaptation (AD)	Relevance
International Importance ("Ramsar Convention":1971)		(ratified)	and prevention of draining or filling during construction
Convention Concerning the Protection of the World Cultural and natural Heritage (Paris, 1972)		03.08.1983 (AT) 03.11.1983 (ratified)	Prevention of damage or destruction of culturally and/or historically significant sites, monuments, etc.
Convention on Biological Diversity, (Rio de Janeiro, 1992.)	1992	05.06.1992	Protection of biodiversity during construction and operation.
Convention on Persistent Organic Pollutants, Stockholm.	2001	In process	Restrict use of different chemicals containing POPs.
United Nations Framework Convention on Climate Change, (New York, 1992.)	1992	15.04.94	Reduction of emission of greenhouse gases.
Convention on Biological Diversity, (Rio De Janeiro, 1992.)	1992	03.05.94	Conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.
Kyoto protocol to the United Nations Framework Convention on Climate Change		21.8.2001 (AC) 11.12.1997 (AD)	Reduction of emission of greenhouse gases.
International Convention for Protection of Birds, Paris	1950	Signed	Protection of the birds in their wild state.
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matters (as amended), London-Mexico City-Washington	1972	Signed	Effective control and prevention of all sources of pollution of the sea by the dumping of waste and other matter that is liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea.
Convention Concerning the Prevention and Control of Occupational Hazards caused by Carcinogenic Substances and Agents, Geneva.	1974	Signed	To protect workers against hazards arising from occupational exposure to carcinogenic substances and agents.
Convention Concerning the Protection of Workers Against Occupational Hazards in the Working Environment due to Air Pollution, Noise and Vibration, Geneva	1977	Signed	Protection of workers' health against occupational hazards in the working environment due to air pollution, noise and vibration.
Convention on the Conservation of Migratory Species of Wild Animals, Bonn.	1979	Signed	Conservation and sustainable use of migratory animals and their habitats
Convention Concerning Occupational Safety and Health and the Working Environment, Geneva.	1981	Signed	Ensuring occupational health and safety of workers in all branches of economic activity.
Vienna Convention for the Protection of the Ozone Layer, Vienna	1985	02.08.90 (AC)	Preventing human activities that

Conventions	Years	Ratified/Accessed (AC)/Accepted (AT)/ Adaptation (AD)	Relevance
		31.10.90 (entry into force)	may have adverse effects on ozone layer.
Convention Concerning Occupational Health Services, Geneva.	1985		Convention Concerning Occupational Health Services, Geneva.
Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal.	1987	31.10.90 (entry into force)	Reduction of the abundance of the substances that deplete the ozone layer in the atmosphere, and thereby protect the earth's fragile ozone Layer.
Convention Concerning Safety in the Use of Chemicals at Work, Geneva.	1990	Signed	Regulating the management of chemicals in the workplaces in order to protect workers from the harmful effects of these substances.
London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, London.		18.03.94 (AC) 16.06.94 (entry into force)	To strengthen the control procedure and extend the coverage of Montreal Protocol to new substances.
Preparedness, Response and Cooperation (London, 1990.) United Nations Framework Convention on Climate Change, New York	09.06.92	15.04.94	Achieving stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.
Convention on Biological Diversity, Rio De Janeiro	05.06.92	03.05.94	Conservation of biological diversity (or biodiversity) and sustainable use of its components.
International Convention to Combat Desertification, Paris.	14.10.94	26.01.1996 (Ratification) 26.12.1996 (entry into force)	Combating desertification and mitigating the effects of drought.
Agenda 21, UNCED, Rio de Janeiro	1992	Signed	Ensuring sustainable development.
Copenhagen Amendment to the Montreal protocol on Substances that Deplete the Ozone Layer, Copenhagen, 1992	1992	27.11.2000 (AT) 26.2.2001 (Entry into force)	Extending the coverage of Montreal Protocol to new substances
Montreal Amendment of the Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal		27.7.2001 (Accepted) 26.10.2001 (Entry into force)	Controls in the trade of ozone depleting substances and the use of licensing procedures to control the import and export of new, recycled and reclaimed ozone depleting substances.

Source: MoEF, 2013

D. Asian Development Bank (ADB) Policies

122. The ADB Safeguard Policy Statement (SPS), 2009 (ADB, 2009) defines, generally, the actions that should be undertaken to avoid, minimise, or mitigate adverse environmental and social impacts, including protecting the rights of those likely to be affected or marginalised by the development process. The three operational components of the safeguard policy are: protection of the environment, protection of vulnerable (indigenous) people, and preventing/minimising involuntary resettlement. These three safeguard policies involve a structured process of impact assessment, planning, and mitigation to address the adverse effects of projects throughout the project cycle. The safeguard policies require (i) identifying and assessing impacts early in the Project cycle; (ii) developing and implementing plans to avoid, minimise, mitigate, or compensate for the potential adverse impacts; and (iii) informing and consulting affected people during the Project preparation and implementation.

123. ADB classifies all its projects into three categories to reflect the significance of a project's potential environmental impacts. The projects with significant adverse environmental impacts that are irreversible, diverse, or unprecedented are categorized as Category A and required a full Environmental Impact Assessment (EIA) with Environmental Management Plan (EMP). On the other hand, a proposed project is classified as category B if its impacts are site-specific, few, and mitigation measures can be designed more readily and required an Initial Environmental Examination (IEE). All other projects with minimal or no adverse environmental impacts are classified as Category C requiring only a short project description/justification statement. Category A projects requires two consultation phases as well as the placement of the EIA on ADB's website for 120 days before ADB Board approval.

124. ADB's safeguard policies have provisions for compliance monitoring throughout the Project cycle and an accountability mechanism whereby people adversely affected by ADB-financed projects can express their grievances and seek solutions. The procedure referred to as the Grievance Redress Mechanism (GRM) must be defined in every IEE and EIA. It is presented in Chapter X of this IEE.

125. SPS 2009 has also provisions for identify measures to avoid, minimize, or mitigate potentially adverse impacts on and risks to biodiversity, natural resources, safety of both workers and affected community and physical cultural resources during the design, construction, operation, and decommissioning of the project.

E. Legislation Relating to Occupational Health and Safety

126. During construction, the project will conform to the labour laws and occupational and health related rules as outlined in Table II-2.

Table II.2: Relevant Occupational Health and Safety Laws and Rules

Title	Overview
Bangladesh Labor Act, 2006	Provides for safety of work force during construction period. The act provides guidance of employer's extent of responsibility and the workman's right to compensation in case of injury caused by accident while working.
Labor Relations under Labor Laws, 1996	General concerns during the project implementation state that the project manager must recognize labor unions.
Public Health (Emergency Provisions) Ordinance, 1994	Calls for special provisions 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	Covers accidents, risks, and damages with respect to employment injuries

Title	Overview
Act, 1938	
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.

F. Environmental Categorization by GOB

127. The MoEFCC enacted the Bangladesh Environmental Conservation Act (BECA 1995) and the Bangladesh Environmental Conservation Rules (BECR, 1997) in accordance with the guidelines of the National Environmental Policy (NEP 1992), as follow-up of the Rio Conference (1992). A National Land Transport Policy (NLTP 2004) was enacted accordingly to reduce the number of deaths and injuries caused every year due to road accidents. The BECR (1997) categorized the various industries/projects in the country as Green, Orange, and Red, depending on their environmental impacts.

128. The road sector projects including bridge construction have been categorized as Orange-B and Red categories, as shown below:

- **Red Item 67:** Construction/reconstruction/extension of the regional, national, and international roads;
- **Red Item 68:** Construction/reconstruction/extension of bridges longer than 100 meters;
- **Orange-B Item 65:** Construction/reconstruction/extension of feeder roads and local streets; and
- **Orange-B Item 66:** Construction/reconstruction/extension of bridges less than 100 meters long.

129. A project that falls into the Red category requires the preparation of an Environmental Impact Assessment (EIA). It is therefore concluded that an IEE should be prepared along with the Terms of Reference (TOR) for EIA preparation during feasibility study and an EIA during the detailed engineering design stage is required for this project.

G. Environmental Categorization by ADB

130. The operational policy of ADB includes the Safeguard Policy Statement of 2009 (SPS, 2009) which covers environment safeguards, involuntary resettlement, and indigenous people. Safeguard policies are generally understood to be operational policies that seek to avoid, minimize, or mitigate adverse environmental and social impacts, including protecting the rights of those likely to be affected or marginalized by the development process. The policy under all 3 safeguard issues involves a structured process of impact assessment, planning, and mitigation to address the adverse effects of projects throughout the project cycle. The safeguard policies require that (i) impacts are identified and assessed early in the project cycle; (ii) plans to avoid, minimize, mitigate, or compensate for the potential adverse impacts are developed and implemented; and (iii) affected people are informed and consulted during project preparation and implementation. The policies apply to all ADB-financed projects, including private sector operations, and to all project components.

131. The classification is completed primarily by ADB staff and the Project is implemented with a classification included. Occasionally the Consultant is asked to classify projects, as was the case with this project. However, the ADB also confirmed the categorization prior to the preparation of this report.

132. The project road connects with several National Highways through its alignment which is presently runs through several urban and semi-urban areas. Due to extensive anthropogenic activities the roadside land areas are already degraded and hardly can be said as rural and

biodiversity enriched area. Additionally, the road upgradation will be conducted mostly within the RHD land and the direct/indirect impact will remain within the road side areas only. Therefore, due to the nature and small scale of this project and applying safeguard standards the project has been classified as category B project. Category B refers to proposed projects if it is likely to have environmental impacts that are generally site-specific, largely reversible and readily addressed through mitigation measures. In this case an Initial Environmental Examination (IEE) is required.

H. GoB Environmental Clearance

133. Steps to be followed for obtaining the Environmental Clearance Certificate for this road are shown in Figure II-1. For any Orange B or Red Category project, an IEE must be submitted to DoE in order to obtain clearance to proceed to construction, or to undertake the full EIA if Orange B is upgraded to Red by DoE. Once the IEE of Orange B is approved by DoE, the environmental requirements have been met. All Red Category projects require a DoE-approved IEE before proceeding to EIA preparation. Once the EIA has been approved, the clearance certificate is issued.

Table II.3: Actions Required for Different Stages of the Project

Stage of Project	Required Actions
Feasibility Study	Initial Environmental Examination (IEE), Obtaining Site Clearance, and preparation and finalizing of terms of references (TOR)
Detailed Engineering Design	Completion of Environmental Impact Assessment and obtaining Environmental Clearance Certificate (ECC).
Preparation of Development Project Proposal (DPP)	Inclusion of recommendations from EIA in the DPP
Approval and construction of project	Implementation of Environmental Management Plan (EMP) of construction stage
Operational Stage	Implementing Monitoring Plan set by Environmental Management Plan (EMP) of operational stage

134. The No Objection Certificate (NOC) – this is a mandatory requirement to obtain environmental clearance from the Department of Environment (DoE). Usually DoE indicates the name of the agencies from whom NOC would be required. DoE requires that proponent obtain NOCs from affected agencies or local/regional administrations, which essentially sign off on the project. It is only after these NOCs are provided that DoE gives the Environmental Clearance Certificate, or green light to proceed to construction.

135. A NOC letter basically contains description of the project including location, justification to obtain NOC from that agency, and proposed measures under the project. In this Project, RHD will submit the NOC letter to the agencies mentioned-above. This is a labour and time intensive process and can take more than a month, and is largely contingent on regular and persistent follow up. Therefore, the ECC steps are:

136. RHD submits NOC letter or submits the standard NOC form of DoE, if applicable. The steps are:

- RHD sends letters to head of the agency;
- The requesting agency then evaluate the NOC request that sometime require field investigation for verification;
- RHD will pursue this and generally requires constant follow up to get a result; and
- Once the NOC's are received-signed, they are forwarded by RHD to DOE.

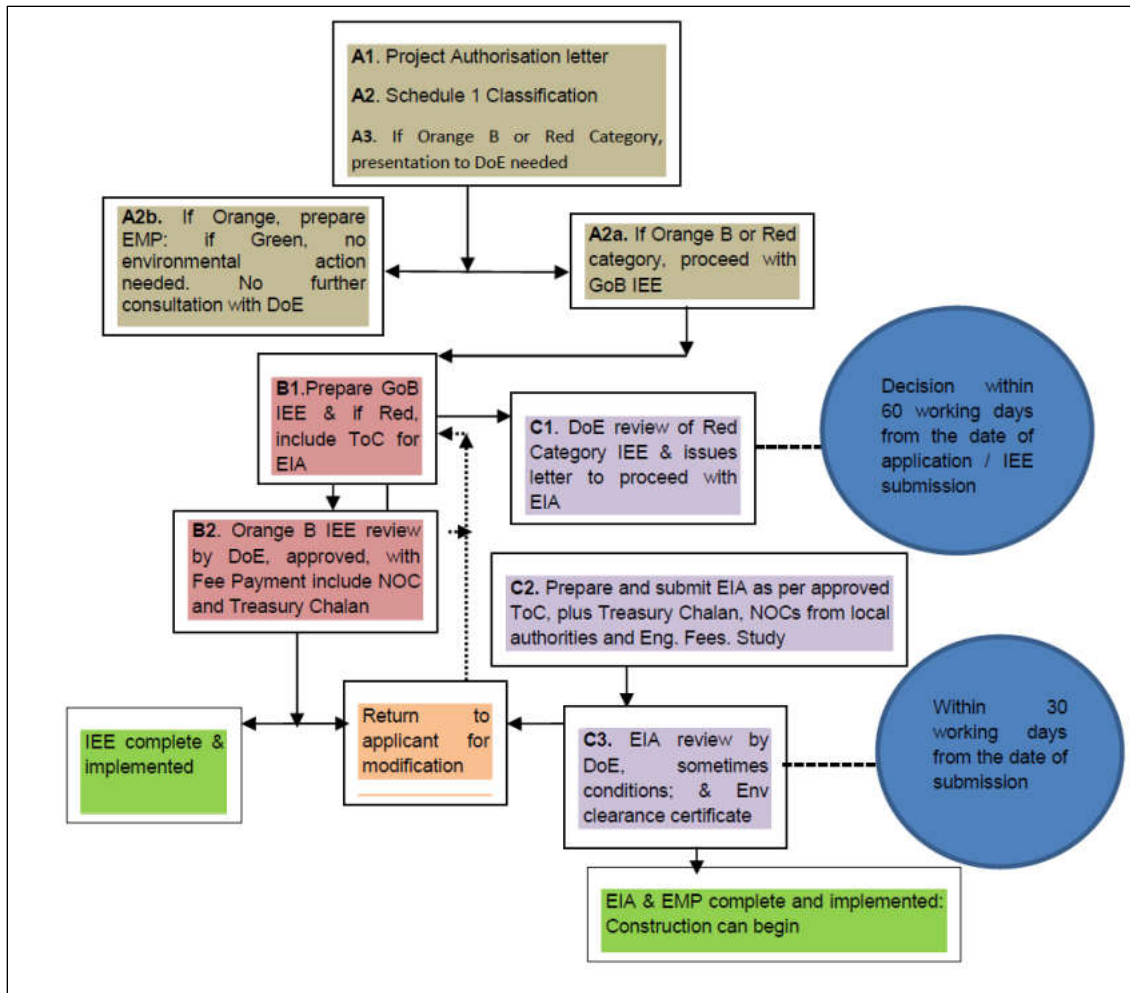


Figure II.1: Government of Bangladesh Environmental Assessment Process

I. Environmental Studies Needed

137. Environmental Assessment (EA) Studies for development interventions are the Initial Environmental Examination (IEE), Environmental Impact Assessment (EIA), Environmental Management Plan including Environmental Monitoring Plan. The main objectives of the Environmental studies are:

- To assess the potential environmental impacts of the Project,
- To identify mitigation measures to minimize and /or off set the adverse impacts at pre-construction, construction and operational phase of the Project, and
- To prepare and implement an Environmental Monitoring Plan to ensure that the project is environmentally sound and sustainable.

138. These studies are related to the types of development interventions and impacts on environmental components (Physical, Ecological, Socio-economic, and Pollution) at different implementation stages (Pre-construction, Construction, and Operational). Environmental studies are conducted based on primary data collected during site visits, from the socio-economic, hydrological, topographic, geotechnical, and engineering surveys at project sites, data collected from consultation with a cross-section of the public, consultation with project colleagues and concerned RHD officials, and from secondary data.

139. Implementation of the above interventions will have significant impacts on various environmental components; hence, they will require comprehensive environmental studies in accordance with the DoE and ADB guidelines. The project roads involve the improvement and widening of the existing 2-lane road into four-lane highways, hence their impacts on environmental conditions may be significant, but will be less compared to new road construction. In addition, the impacts on agriculture, livelihoods, ecological components, infrastructure, and pollution, may be significant.

140. The preparation of IEE and EIA during the feasibility and detailed design phases is obligatory under environmental legislations and rules of Bangladesh, as well as for compliance the environmental guidelines of donor agency, ADB. An environmental clearance certificate (ECC) from DoE is required for initiating project implementation activities which is already obtained for this project. The EA study needed is based on the degree of project impacts for decision making and planning, acts as legal document for the implementing agency and as a management tools to stakeholders and guidelines for the PPP Advisor during project implementation phases.

III. DESCRIPTION OF THE PROJECT

A. General

141. The Roads and Highways Department, with the support of the Public-Private Partnerships Office is currently planning and designing the four-lane of the Joydebpur-Debogram-Bhulta-Madanpur (N105) Road, colloquially known as the Dhaka By-Pass Road. This project would provide for a major arterial connection between the industrial zone of the North and North East, with the port connection to Chittagong in the South. The road is contemplated to include a controlled access toll road, in addition to a two-lane service road, along 48 kilometers that link with the National Highways N1, N2, N3, and N4.

142. Since the project is on the existing ROW of the Dhaka By-Pass Road that has been in operation since 2007, the socio-economic impact due to homestead and livelihood displacement for the upgrade of the existing 2-lane facility to a 4-lane facility has been found to be minimal. However, since the ROW was never protected from encroachment by local businesses, religious institution development and illegal homestead developments, there may be a need to compensate non-land related loss due to displacement from the existing ROW as well as relocating semi-permanent and temporary religious and educational establishments.

143. The land survey indicates that no additional lands are required for the construction of the four-lane highway from the north portal to the south portal. However, in order to meet the required highway design speed and to accommodate additional interchanges at mid-way points along the alignment (e.g., at the Bhulta/N2 interchange or the Purbachal intersection) and two service roads (4.8 m), some additional land will be required. While the analysis demonstrates minimal impact on the financial viability of the road as a PPP project, additional land will need to be underway prior to issue of the RFP, and fully procured and transferred prior to financial close. The proposed interchange, which would provide future access for the Purbachal Land development by RAZUK, will need additional land of 5.08 hectares.

B. Need for the Project

144. The growing road traffic to the Joydeppur-Madanpur, Dhaka and from other regions will not be fulfilled by the existing highway. Road safety on the existing road is inadequate because it is overcrowded with different types of vehicles, including rickshaws, bicycles, motorcycles, cars, buses, and trucks. When vehicles break down this reduces the highway to a single lane leading to traffic delays and congestion. This improvement will provide enough additional capacity in this important corridor to accommodate future traffic growth and will also meet the demand for a safer and more reliable road connection. A limited controlled access road will prevent many of the issues noted in the RHD Road Master Plan, including the movement of slow-moving vehicles and hawkers into the traffic lanes. An uninterrupted access controlled 2 lane dual carriageway (four lane) will provide an unhindered flow of traffic, with no traffic signals, intersections or property access. They are free of any crossings with other roads, railways, or pedestrian paths, which are instead carried by overpasses and underpasses. Moreover, the access control road will opposite direction of travel by a central traffic barrier. Therefore, elimination of the sources of potential conflicts with other directions of travelers dramatically improves safety.

C. Important Locations and Difficult Point of the Road

145. The project intersects Naojuri, Vogra, Mirerbazar, Purbachal, Bhulta, Bostail and Madanpur as well as crossing the railway for two times. It is critical to maintain the whole project properly to treat the above locations. Specific treatment is as follows:

146. **Intersect Road N3:** vogra Bus Rapid Transit system is set at the intersection between N3 and N105, which is set for a crossing the bridge and the bottom is a flat junction. At the intersection, a bridge is built for the mainline to cross vogra bus rapid transit system which does not change the original traffic organization and facilitates to lead the traffic to the point. The project crosses two railways which are currently used for diesel locomotive. Through on-site investigation and consultant with the relevant department in order to ensure the clearance for future railway transformation, the clearance is increased from 7.6 m to 9.0m

147. **Intersect Mirerbazar (R301), Purbachal (N301), and Bhulta (N2):** the important intersected roads except for these at the start and end are heavy traffic volume.it is consider to use the bridge to cross the above major intersections in the project to ensure the rapid passage of toll roads. Within the allowable range of ROW, the subgrade on both sides of the bridge is widened to set up four toll station to convert the traffic of the intersected roads and the nearby local towns traffic .an Overpass Bridge is constructed at bhulta and can be adopted in the project

148. **Intersects Bostail:** the mainline crosses the intersected road through a bridge in the project area.

149. **Mainline toll stations at the start and end points:** mainline toll stations are set within the allowable range of ROW in combinations with the ROW in the project

150. **Madanpur section at the end:** There is heavy traffic volume flowing towards Chittagong so the traffic is heavy is at the intersection between the end of the project and N1 and it is considered to widen the subgrade to be suitable for arranging six two-way lane within the 500m around the end, and to widen the service lane 7.3 m and set traffic lights at junctions.

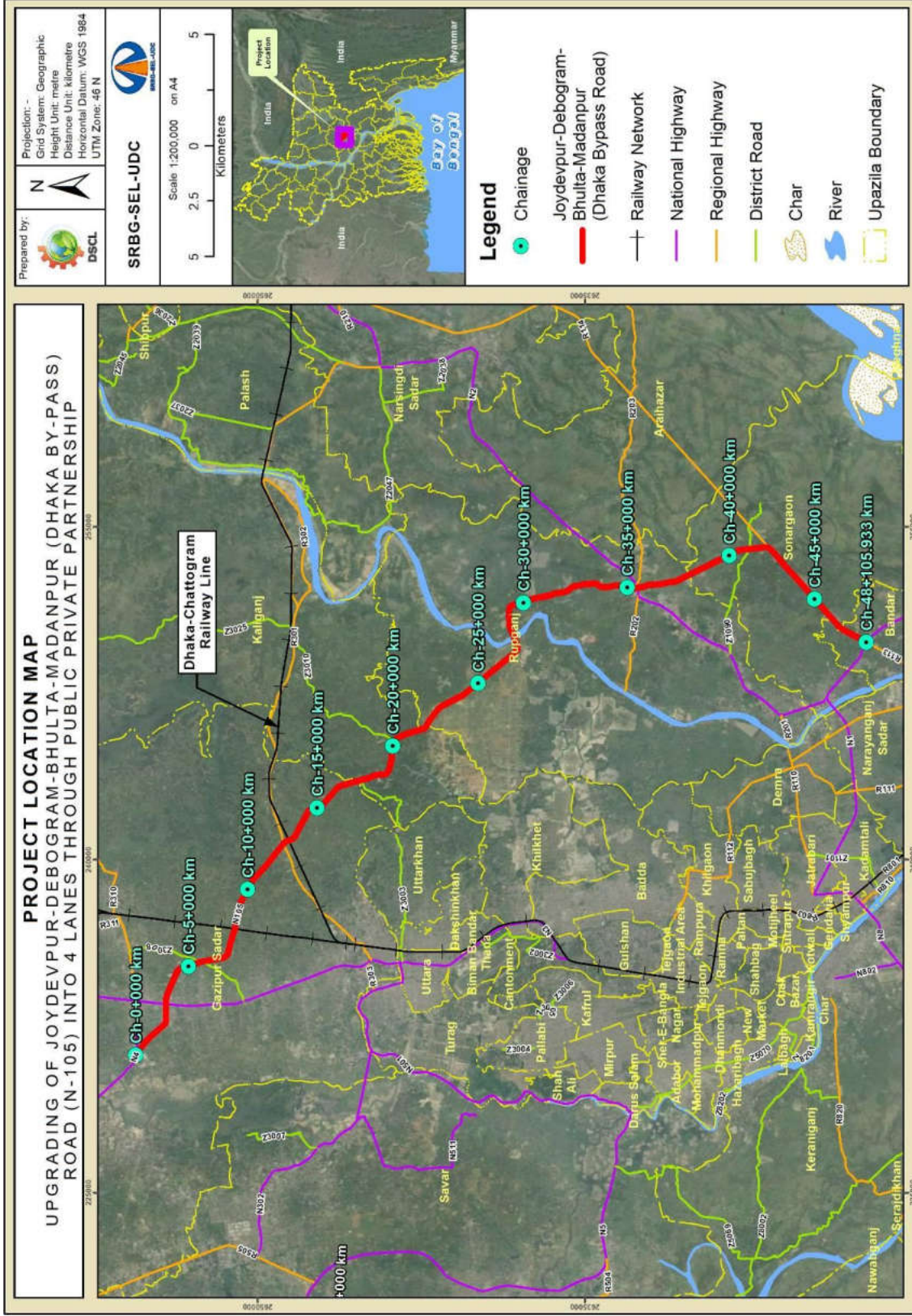


Figure III.1: Project Location Map

D. Design Features

151. The following are the main design elements of the project (Table III-1).

Table III.1: Main Design Features of the Project

Length	Total Length of the Road (km)	48.112954
Speed	Design Speed (km/h)	80
Stopping Control	Stopping Sight Distance (m)	120
	Target (object)height-vehicle	0.6 m
	Target (object)height-pavement	0.0m
	Height of Driver's Sighting Line	1.2m
Horizontal Control	Maximum super-elevation in (%)	6
	Minimum curve radius (m)	80
	Minimum Bending radius	500
	Minimum Spiral	70 A
Vertical Control	Maximum slope gradient (%)	3
	Minimum slope gradient (%)	0
	Minimum Convex curve Value	70 k
	Minimum Sag curve (headlight control distance)	70k
	clear height	5.7
Cross-section	Lane width	3.65
	Crown cross slope	Lane;3.0%, bridge;2.0%, shoulder;5.0%

E. Design Plan for Bridges and Culverts

1. Selection of Superstructure form

152. According to design principle, the bridge of the main line is simply supported structure, and its super structure is precast mounting T beam. The bridge span is selected as per as the bridge principle:

153. The span of new service Lane Bridge is considered to be the same as the existing bridge span. The span of precast T-beam is 50m, 40m, 30m and 25m respectively. New mainline overpass should adopt precast mounting T-beam with span of 30m referring to the local customary practice which reduce the project cost.

154. The pedestrian overpass is steel beam bridge.

2. Selection of substructure form

155. The substructure of the new service lane bridge is considered to be coordinated with the substructure of the existing bridge, and adopt reinforced concrete vase pier cushion cap and pile foundation. The substructure of new mainline overpass adopts reinforced concrete cylinder pier and pile foundation. The abutment adopts reinforced concrete pile type abutment.

156. When the bridge crosses V-shaped valley, the pier should not be arranged in the center of the valley for the better adaption of the terrain, reduce the height of the abutment, and adopt combined span scheme.

157. If the height of the pier is >6m is it is associated to set bottom collar beam to increase the overall stiffness.

158. In order to facilitate the connection between the abutment and the subgrade retaining wall, the outer slope of the side wall of masonry bridge shall be consistent with in the retaining wall. If the height is <8m, the ration of outer slope is 20:1; if ≥ 8 m the ratio is 10:1

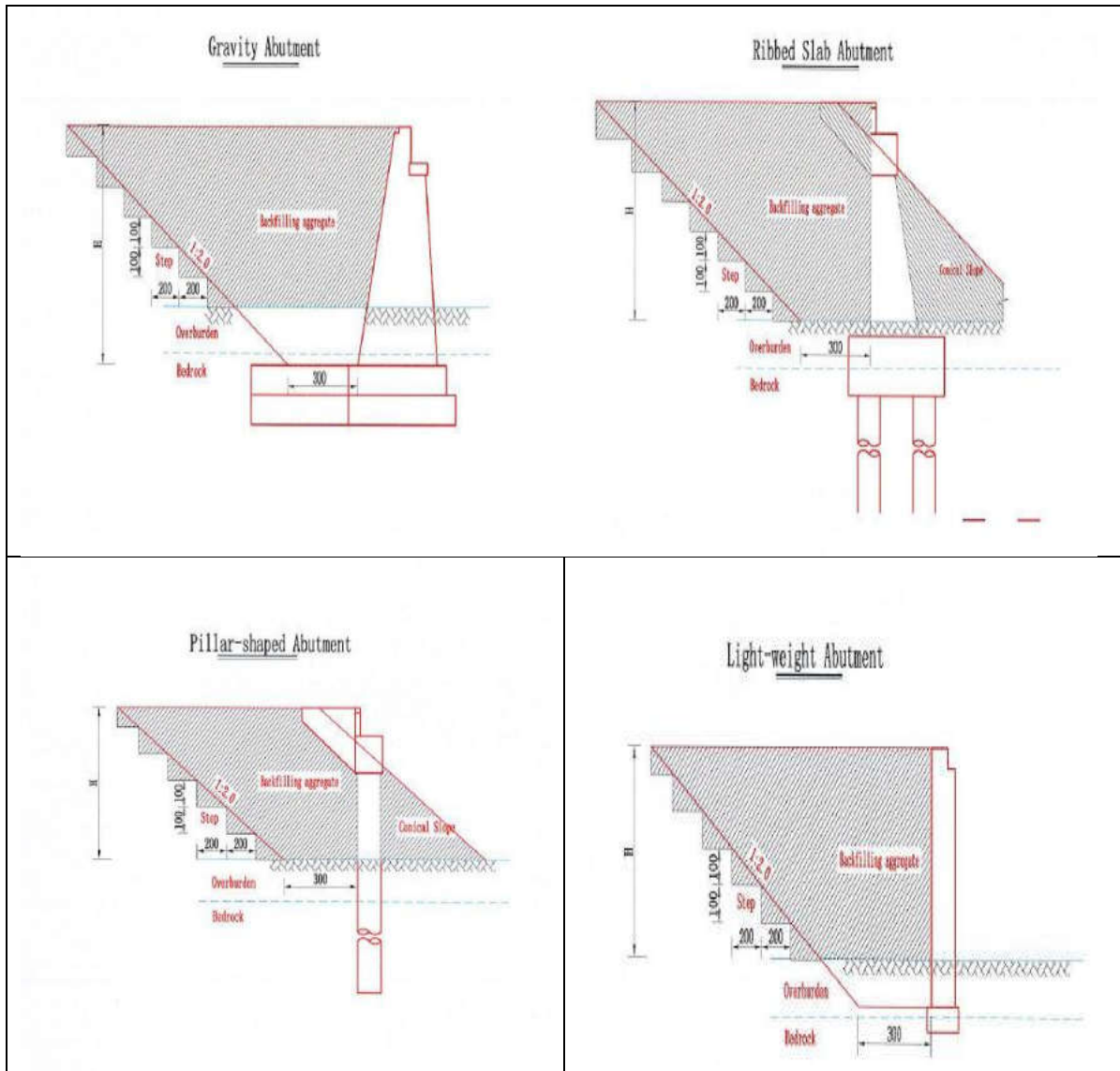


Figure III.2: Types of Abutment in the Project

F. Subproject Components

1. Alignment and Right of Way (ROW)

159. The length of the proposed project alignment is 48.112954 km and the project corridor will have a well-defined ROW that will vary from place to place and ranges from 47.5 m to a maximum of 60.5 m for the entire length of the road.

2. Designs for the Alignment

160. Preliminary designs have been completed for the proposed alignment during the feasibility study. The typical cross sections for proposed alignment are shown below Figure III-3 and Figure III-4.

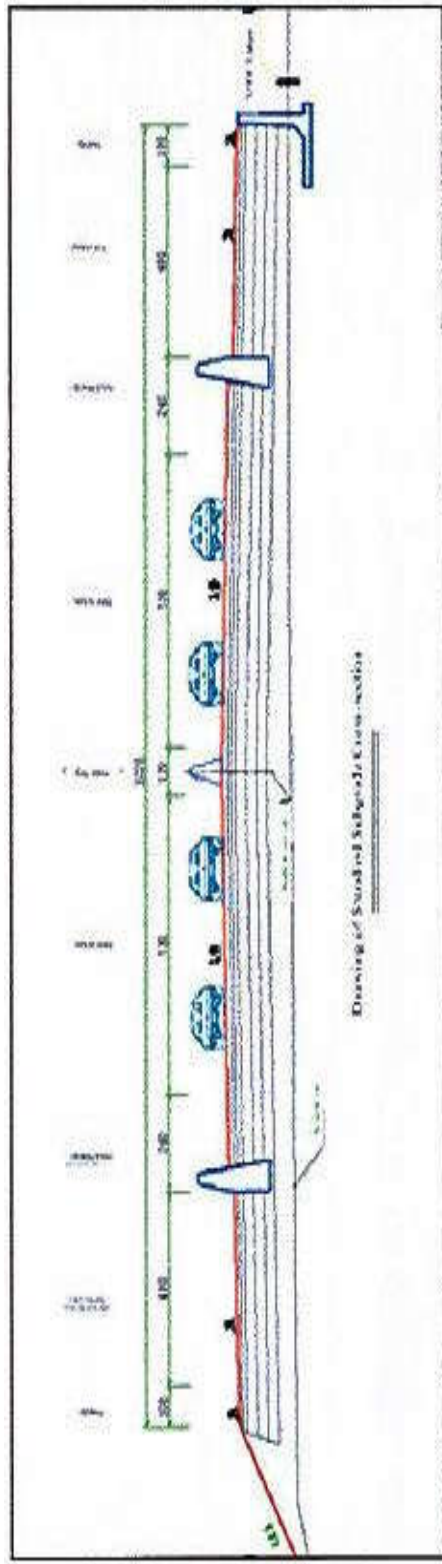


Figure III.3: Typical Cross Section of the Sub Grade Main Section is 32.2m Wide

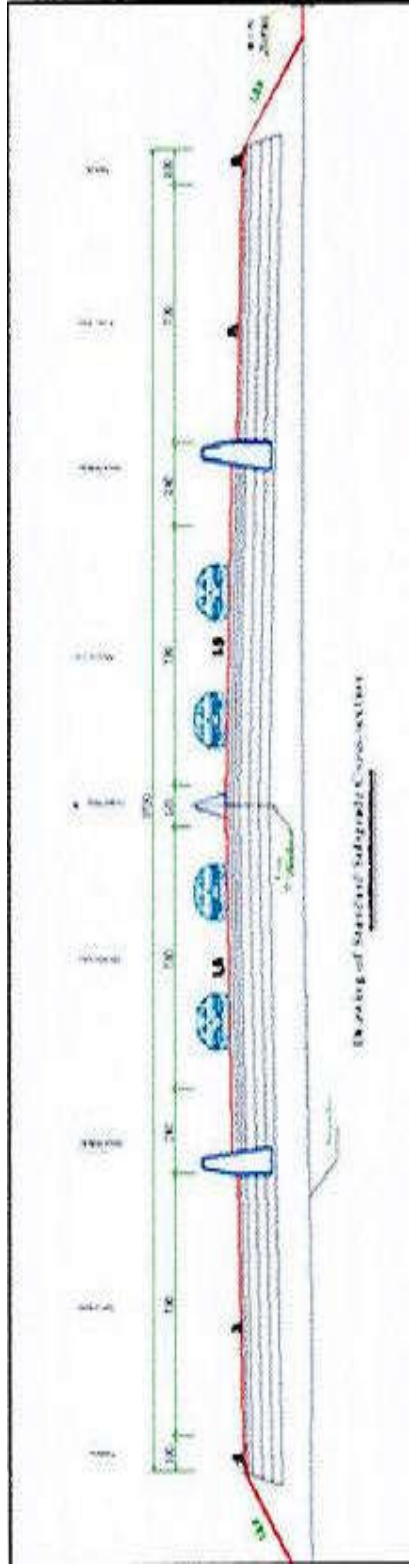


Figure III.4: Typical Cross Section from k21+600 to Purbachal Area at Kanchan Bridge.

3. Pavement work

a) Mainline Lane Pavement Structure

161. The pavement works comprise construction of surface course (binder course & wearing course), basecourse, sub-base course and sub-grade. The project road has been designed following road safety requirements as per RHD published guidelines and standards.

162. Concurring to the traffic volume forecast the concept of “durability, environmental protection, economization, life cycle cost and sustainable development”. The pavement structure plan of the project determining the experience of the pavement design and operation of the similar project in Bangladesh.

163. Asphalt pavement is more appropriate according to the forecast of traffic volume, operating requirement, geological, hydrological of the completed project, selecting material rationally pavement structure of the completed project.

164. According to the distribution of road materials along the route, the carriageways and service lands of the mainline are constructed with Asphalt concrete pavement. The recommended structure type is as follows.

Structure	Mainline Lane Pavement structure	Service Lane Pavement structure
Structure layer	Mainline Lane Pavement Structure	Mainline Lane Pavement Structure
Upper course/Surface	Dense graded asphalt concrete, 5 cm	Dense graded asphalt concrete, 5 cm
Lower course	Asphalt stabilized macadam, 14.5 cm	-
Base	Aggregate base type I, 22.5 cm (CBR \geq 80%)	Aggregate base type I, 22.5 cm (CBR \geq 80%)
Base	Aggregate base type II, 30 cm (CBR \geq 50%)	Aggregate base type II, 30 cm (CBR \geq 50%)
Sub-base	Grade A sub-base (CBR \geq 25% & GRADING-A)	Grade A sub base (CBR \geq 25% & GRADING-A)
Improved subgrade	Improved subgrade, 30cm (CBR \geq 8%)	Improved subgrade, 30cm (CBR \geq 8%)

b) Deck Pavement Structure

165. There are more bridges set along the whole line. In order to ensure the pavement performance of the structure, the deck pavement is made of 5 cm dense graded asphalt concrete+ 5cm Asphalt stabilized macadam.

4. Bridges and Culverts and pedestrian bridge Facilities

166. The bidding proposal of the project includes 9186/6 new bridges for the mainline and service lanes, 4608/8 new mainline overpasses, 46 existing box culverts and lengthened box culverts, 49 new culverts, 12 new channels and 8 pedestrian overpasses.

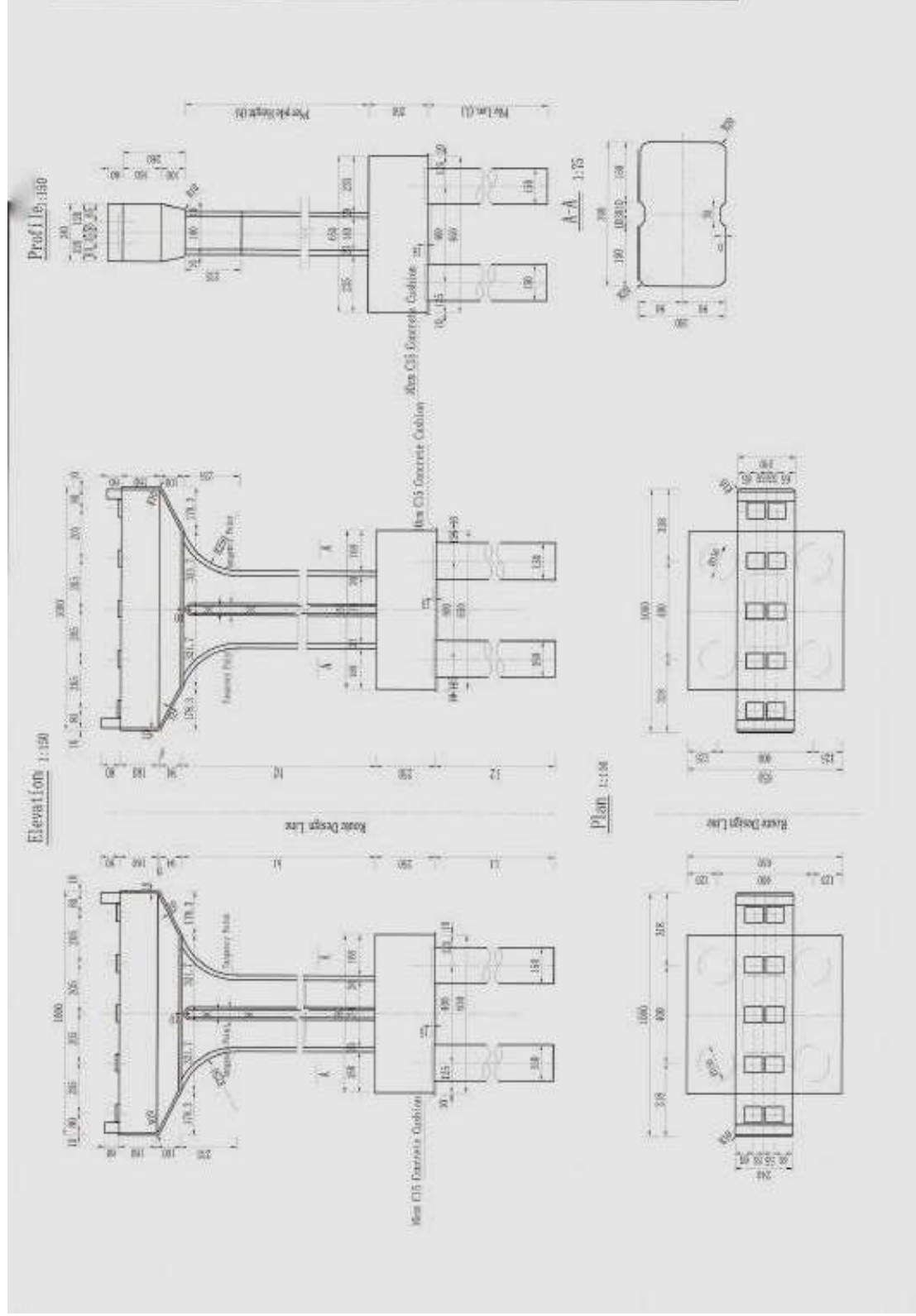


Figure III.5: Typical Cross Section of Post Tensioned Concrete Simply Supported T Beam

Table III.2: Detailed Bridges Specification along the Joydebpur-Madanur Road

S/N	Central Chainage	Bridge Name	Bridge Total Lane (m)	Superstructure	Deck Width (m)	Existing Bridge Current Situation and Utilization	Existing Bridge Maintenance Workload	Remarks
1	2	3	4	5	6	7	8	9
I. Existing Bridge								
1	K 14+ 908	Negda Bridge	176	Pre-stressed Concrete Simply Supported T-beam	17.65	The structure of the bridge in good condition and can be preserved	Replaces two 80-type expansion joints with 35.5 in total.	Across Negda river deep water foundation
2	K 17+ 289	Ulu khula Bridge	216	Pre-stressed Concrete Simply Supported T-beam	17.65	The structure of the bridge in good condition and can be preserved	Replaces three 80-type expansion joints with 53 in total.	Across Balu river deep water foundation
3	K 27+881	Kanchon Bridge	461	Pre-stressed Concrete Simply Supported T-beam	17.65	The structure of the bridge in good condition and can be preserved	Replaces five 80-type expansion joints with 88.25 in total.	Across Shitakyakkhya river deep water foundation
4	K37+303	Asia Bridge	35	Pre-stressed Concrete Simply Supported T-beam	17.65	The existing bridges conflict with the scope of ROW and shall be demolished and rebuilt	Demolish the existing bridge	Across river and ditches
5	K38+511	Canal Medium Bridge	30	Pre-stressed Concrete Simply Supported T-beam	17.65	The structure of the bridge in good condition and can be preserved	Replaces five 80-type expansion joints with 35.5 in total.	Across river and ditches
6	K40+370	Medium Bridge	30	Pre-stressed Concrete Simply Supported T-beam	17.65	The existing bridges conflict with the scope of ROW and shall be demolished and rebuilt	Demolish the existing bridge	Across river and ditches
			Existing Bridge Subtotal					
II. Newly-built Mainline & Service Lane Bridge								
1	K 14+ 908	Negda Bridge	168	Pre-stressed Concrete Simply Supported T-beam	10.2x2	The main bridge is utilized the existing bridges and newly- built service lane bridge on both sides		Across Negda river deep water foundation
2	K 17+ 289	Ulu khula Bridge	208	Pre-stressed Concrete Simply Supported T-beam	10.2x2	The main bridge is utilized the existing bridges and newly- built service lane bridge on both sides		Across balu river deep water foundation
3	K 27+881	Kanchon Bridge	461	Pre-stressed Concrete Simply Supported T-beam	10.2x2	The main bridge is utilized the existing bridges and newly- built service lane bridge on both sides		Across Shitakyakkhya river deep water foundation
4	K37+303	Asia Bridge	31	Pre-stressed Concrete Simply Supported T-beam	10.2+20.6+10.2	Demolish the existing bridges, and build new main line and service lane bridges.		Across river and ditches
5	K38+511	Canal Medium Bridge	25.9	Pre-stressed Concrete Simply Supported T-beam	10.2x2	The main bridge is utilized the existing bridges and newly- built		Across river and ditches

S/N	Central Chainage	Bridge Name	Bridge Total Lane (m)	Superstructure	Deck Width (m)	Existing Bridge Current Situation and Utilization	Existing Bridge Maintenance Workload	Remarks
6	K40+370	Medium Bridge	25.9	Pre-stressed Concrete Simply Supported T-beam	10.2+20.6+10.2	service lane bridge on both sides		Across river and ditches
		Newly-built Mainline & Service Lane Bridge Subtotal	919.8			Demolish the existing bridges, and build new mainline and service lane bridges.		
III. New Span Bridge on Mainline								
1	K2+843.5	Across Bashon Shorak Highway bridge on Mainline	1061	Pre-stressed Concrete Simply Supported T-beam	20.60			Across Bashon Shorak Highway bridge on Mainline
2	K8+062	Across Old Railway Bridge on Mainline	571	Pre-stressed Concrete Simply Supported T-beam	20.60			Across Railway line on Mainline
3	K12+800	Across new Railway Bridge on Mainline	871	Pre-stressed Concrete Simply Supported T-beam	20.60			Across new Railway and Highway line on Mainline
4	K18+176	Mainline Viaduct	541	Pre-stressed Concrete Simply Supported T-beam	20.60			Across urban highway on mainline
5	K22+104	Mainline Viaduct	331	Pre-stressed Concrete Simply Supported T-beam	20.60			Across urban highway on mainline
6	K26+912	Across Highway Bridge on Mainline	361	Pre-stressed Concrete Simply Supported T-beam	25.73			Across highway on mainline
7	K30+855	Across Highway Bridge on Mainline	361	Pre-stressed Concrete Simply Supported T-beam	20.60			Across urban highway on mainline
8	K41+925	Across Highway Bridge on Mainline	511	Pre-stressed Concrete Simply Supported T-beam	20.60			Across urban highway on mainline
		New Span bridge on Mainline Subtotal:	4608					

Table III.3: Detailed pedestrian Bridges Specification along the Joydebpur-Madanur Road

S/N	Center Chainage	Works Name	Intersected road category	Angle of Intersection (0)	Structure Type	Qty. of Holes and Hole Span	Total Length (m)	Net Width	Net Height(m)	Other ancillary works	Remarks
1	2	3	4	5	6	7	8	9	10	11	12
Pedestrian Bridge											
1	K0+700.00	Pedestrian Bridge	Main Line	90	Steel-Structured beam pedestrian bridge	2-20	43.5	3.5	≥5.5		New
2	K1+500.00	Pedestrian Bridge	Main Line	90	Steel-Structured beam pedestrian bridge	2-20	43.5	3.5	≥5.5		New
3	K3+800.00	Pedestrian Bridge	Main Line	90	Steel-Structured beam pedestrian bridge	2-20	43.5	3.5	≥5.5		New
4	K6+200.00	Pedestrian Bridge	Main Line	90	Steel-Structured beam pedestrian bridge	2-20	43.5	3.5	≥5.5		New
5	K43+700.00	Pedestrian Bridge	Main Line	90	Steel-Structured beam pedestrian bridge	2-20	43.5	3.5	≥5.5		New
6	K44+900.00	Pedestrian Bridge	Main Line	90	Steel-Structured beam pedestrian bridge	2-20	43.5	3.5	≥5.5		New
7	K46+800.00	Pedestrian Bridge	Main Line	90	Steel-Structured beam pedestrian bridge	2-20	43.5	3.5	≥5.5		New
8	K47+450.00	Pedestrian Bridge	Main Line	90	Steel-Structured beam pedestrian bridge	2-20	43.5	3.5	≥5.5		New

5. Road Safety Aspect

167. As per PPP Contract, Road safety auditor and Independent Engineer will also have a road safety team.

6. Disability Access

168. SASEC standards will be follow in disability Access

7. Bus Bays

169. Bus Bays provide 1km long passing lanes in every 5 km. Also, sufficient number of bus bays/stops will be provided as per requirement/PPP contract. For Expressway bus stop requirement is very minimal and only for transit points

8. Toilets Facilities

170. Sufficient facilities will be available as per guidelines/PPP contract.

9. Materials Used and Sources for Construction

171. The main groups of materials to be considered as part of this study include:

- i. Road construction materials
- ii. Structure construction materials

172. Within this grouping of materials, the types of materials to be considered include:

10. Earthworks

173. 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.

174. The improvement of the road will require both filling of low land and cutting through the highland in order to achieve a workable grade. The earth filling to create proper embankment heights will range from 2.5 to 3.5 m. The proposed embankment will be constructed with suitable fill material, likely obtained by suction dredging from the nearby rivers crossed by the alignment. Preparation of the road embankment will require the placement of more than 8.8 million m³ of embankment material which is mostly dredged sand.

Table III.4: Estimated Earthwork Quantities

Item	Unit	Quantity
1	Earth excavation	196,739 cum
2	Borrowing sand filling	3,646,408 cum
3	Replacement of filling sand	979,936 cum
4	ISG (300mm)	1,506,659 sqm
5	Sub-base (300mm)	1,485,663 sqm
6	Base Type I (225mm)	1,443,672 sqm
7	Base Type II (200mm)	1,464,667 sqm

11. Concrete Aggregate

175. Bangladesh is occupying most part of the Bengal Delta having very thick sedimentary cover. Main source of construction aggregates is sedimentary rock but government developed

an underground mine (Maddhapara Granite Mine, Dinajpur) for high quality aggregates from igneous rock. Unfortunately, the country fulfills their most demand from imported rock both igneous and sedimentary rock. Stone aggregates from Sylhet quarries are commonly used for the manufacture of normal and high strength concrete. Panchagarh is also a local source of stone aggregate which is located within the project road alignment. Additionally, aggregate of high strength concrete is likely to be imported from India and Bhutan also. A significant amount of concrete aggregate will be required for the construction of 48.112954Km Joydebpur to Madanpur Road.

12. Cement and Steel Reinforcement

176. 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. A significant amount of cement and steel reinforcement will be required for the construction of the proposed road.

13. Bitumen

177. Bitumen used for the construction work is usually imported from other countries. 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.

14. Recycled Pavement Materials

178. The preliminary design envisages recycling pavement materials by milling the existing asphalt concrete and re-using the product. It is estimated that total 254296.46 m³ existing pavement materials could be used after recycling for the proposed carriageways. 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.

G. Existing Traffic and Forecast

179. 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 2017 including two and three-wheelers and forecast traffic are given at Table III-4.

Table III.5: Existing and Traffic Forecast for Joydebpur-Madanpur Road

Traffic Assessment Year	Traffic in AADT (Maximum of any section of the road)
2019	18,211
2020	26,433
2021	28,151
2022	29,981
2023	31,930
2024	29,775
2025	31,711
2026	33,772
2027	35,967
2028	38,305
2029	40,603
2030	43,039
2031	40,303
2032	42,721
2033	45,284
2034	48,001

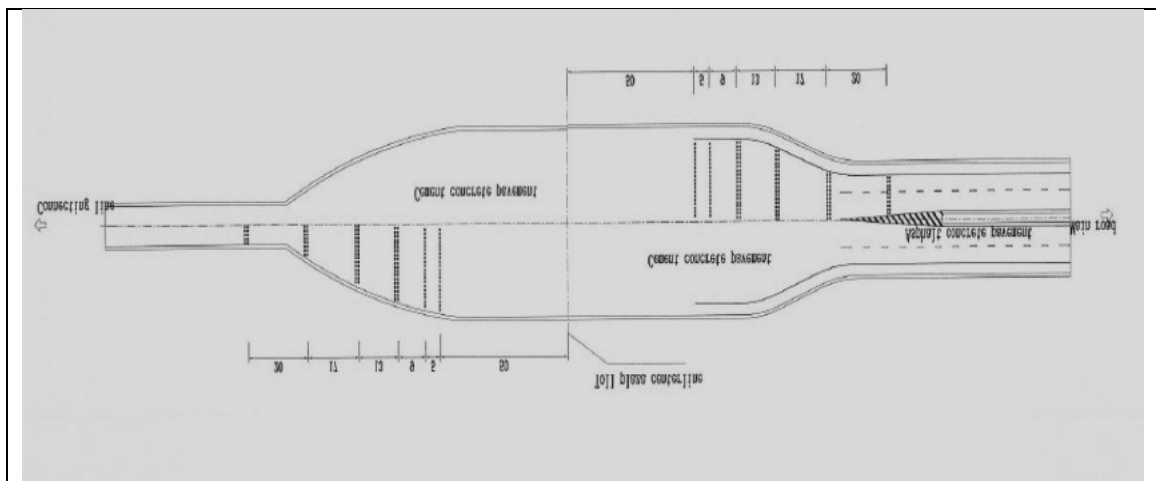
Traffic Assessment Year	Traffic in AADT (Maximum of any section of the road)
2035	50,881
2036	53,934
2037	57,170
2038	60,600
2039	64,237
2040	68,091
2041	72,176
2042	76,507
2043	81,099
2044	85,969

Source: (Traffic Survey 2017)

H. Toll Plaza

180. As this is a tolled road, toll plazas have to be constructed at all entry and exit points. The principle for the all entry point configurations is to charge the toll to everyone entering the system. For this road, a closed toll system is proposed. In a closed toll system, users pay the toll based on kilometers of travel on the road and category of vehicle. There are no free-rides. In a closed toll system, plazas are located at all the entry and exit points, with the users receiving a ticket upon entering the system.

181. Toll Plazas are located at the Mirerbazar Toll station, Purbachal Toll station & Bhulta Toll station. Toll booths are located on both the entry and exit lanes. A single plaza administration building is proposed at each toll plaza to provide the operations staff-cash handling, restroom, amenities, locker facilities as well as protection for computer and communications equipment. As well as the administration building, the toll plaza will include weighbridges, a police station, emergency response facilities, parking areas and medical facilities. The toll gate marked line system and Toll Gate ETC Marked Line is shown in Figure III.6 and Figure III.7.



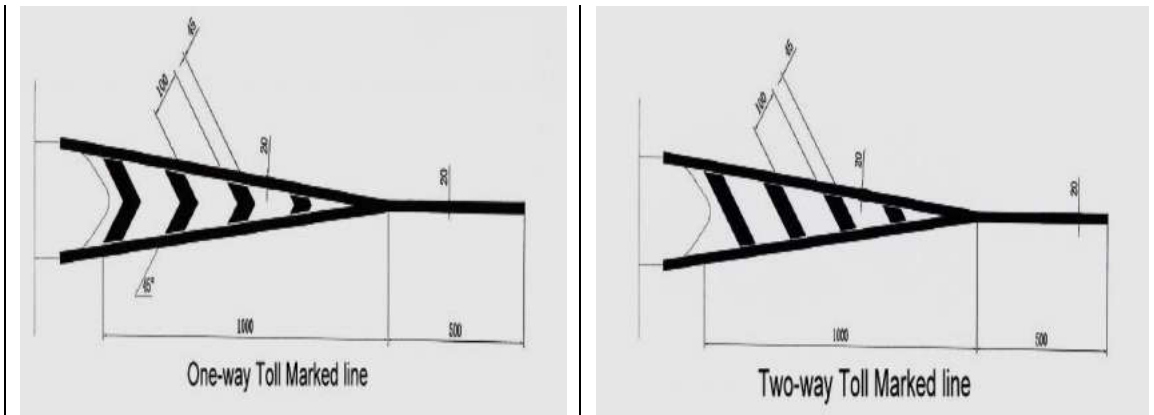


Figure III.6: Toll Gate Marked Line

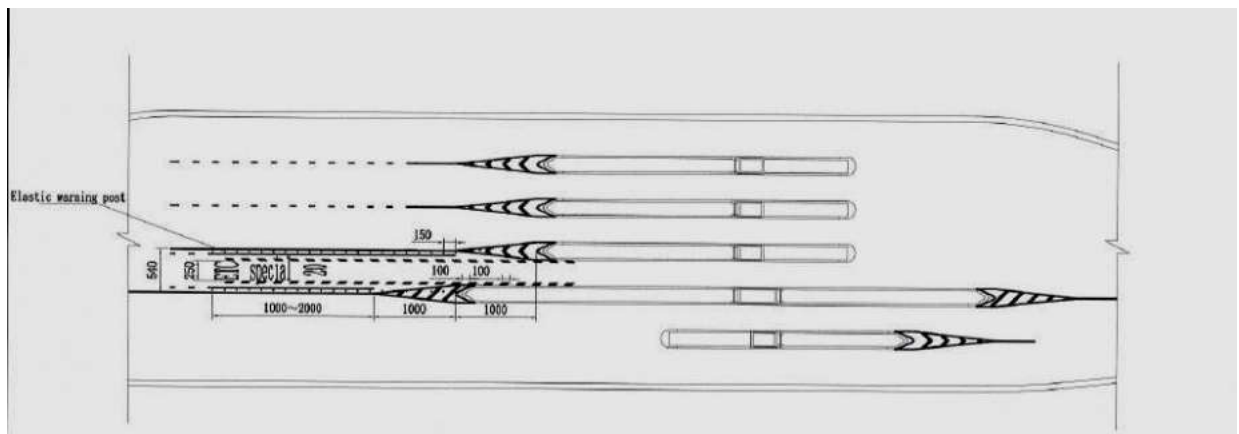


Figure III.7: Toll Gate ETC Marked Line

182. Toll Gate ETC (Electronic Toll Collection) Marked Line is an automatic cashless payment system for passing through toll gates. This is a convenient way of paying expressway tolls without having to stop at tollbooths; the cost of the toll will be simply charged to the IC chip embedded in the ETC card.

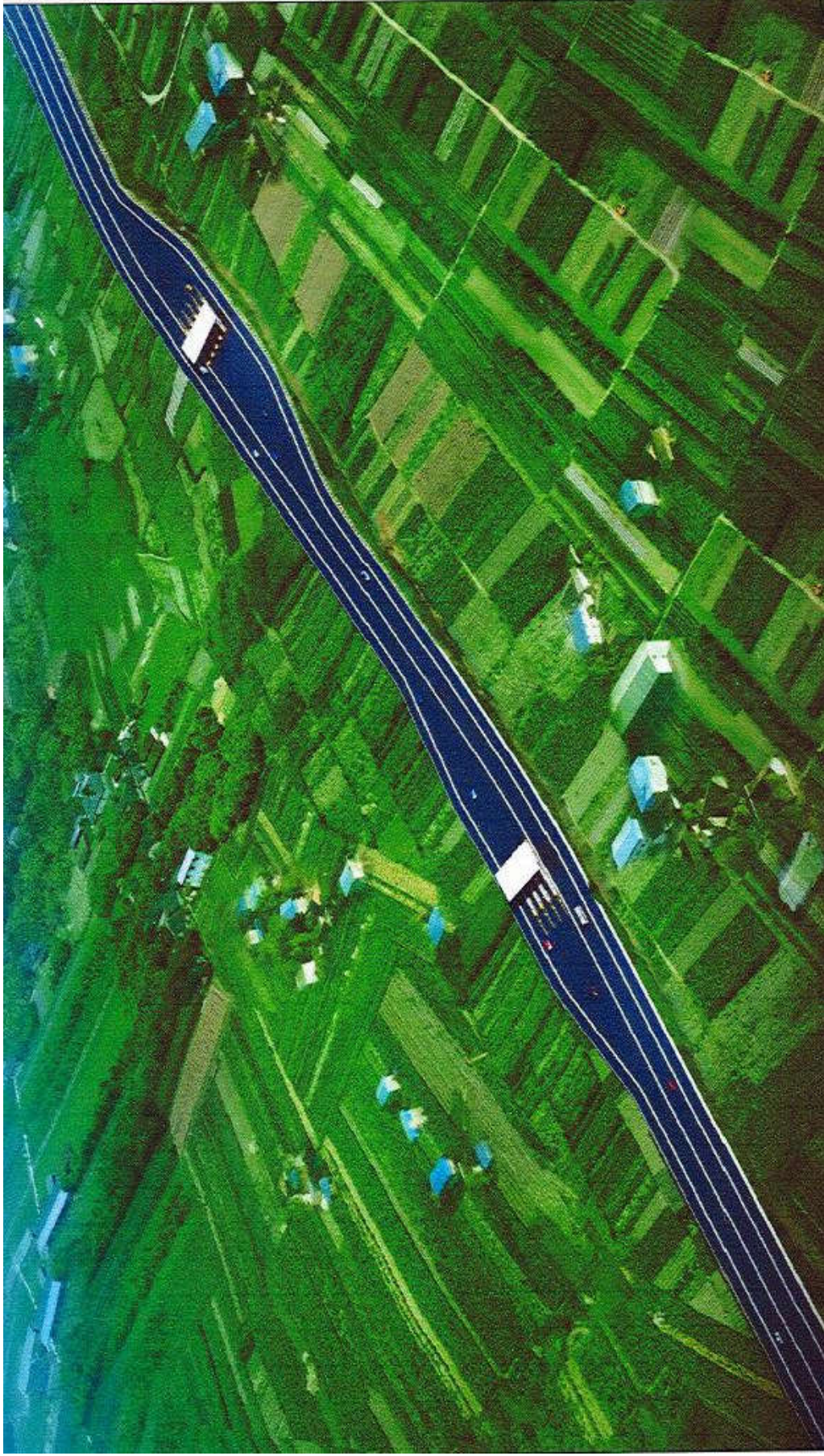


Figure III.8: Layout of Toll Plaza

I. Social and Resettlement Considerations

183. The social safeguard work to be addressed under Project was triggered due to (i) the impacts of land acquisition for construction of the 48 Km length of the road from Joydebpur to Madanpur, and (iii) relocation of houses, shops, and businesses from the proposed RoW.

184. The scope of social safeguard works for Project preparation thus include (i) consultation with affected communities and stakeholders; (ii) social surveys and census of all affected households and structures (residential, commercial, community structures), (iii) property valuation survey (land, structures, trees) for replacement value; (iv) preparation and disclosure of the Resettlement Plan, including the Project entitlement policy and matrix; and (v) income and livelihood restoration of the affected households as well as vulnerable groups. Despite the limited and linear acquisition, there are 1926 households/units within the Project alignment. The table below represents area wise primary occupation of the affected HHs. It was remarkable that although most of the affected HHs is from commercial HHs, the largest number of populations 787, which is the 40.86% of the total HHs. The second largest number is employed in service/Garments worker. Although there are versatile job opportunities in the area, female is only engaged in teaching, business, garments, etc.

Table III.6: Primary Occupation of Affected HHs

Occupation	Gazipur	Narayanganj	Total
Agriculture	65	89	154
Housewife	48	69	117
Business	321	466	787
Service/Garments Worker	131	622	753
Others	34	81	115
Total	599	1327	1926

Source: Census and IOL survey, 2019

185. The project road alignment will require a total of 37.60 ha of land. RHD will acquire this land for Project construction through the resettlement of households and business establishments currently occupying on the land. About 75% of the land to be acquired is agricultural; the remaining portions are commercial land (15%) and homestead land (10%). The Project will also require the removal of trees of various sizes and species. Table III.6 provides a summary of Project impacts.

Table III.3: Lands and Households Affected

Project Impacts	Unit	Total
Amount of land to be acquired	ha	37.60
Total number of households/units to be affected	No.	707

Source: (DBR, Social Survey 2019)

J. Schedule of Implementation

186. The Project Company has signed the agreement with RHD in December 2018 and already has started the detailed design of the road afterwards. The financial closure time is 9 months with long stop date of 18 months. It is expected to start the construction from the beginning of 2020 which will be finished within 38 months. The length of the PPP agreement between the government and the Concessionaire is 25 years.

IV. DESCRIPTION OF THE BASELINE ENVIRONMENT

A. General

187. 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.

188. Data was collected mostly from secondary sources for the macro-environmental setting like climate (temperature, rainfall, humidity, and wind speed), physiography, geology etc. Firsthand information collection was limited during the feasibility study 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. Consultation was another source of information and to explain local environmental conditions, impacts, and suggestions, etc.

189. 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; and
- **Socio-economic Environment-** anthropological factors like demography, income, land use and infrastructure.

B. Physical Environment

1. Climate

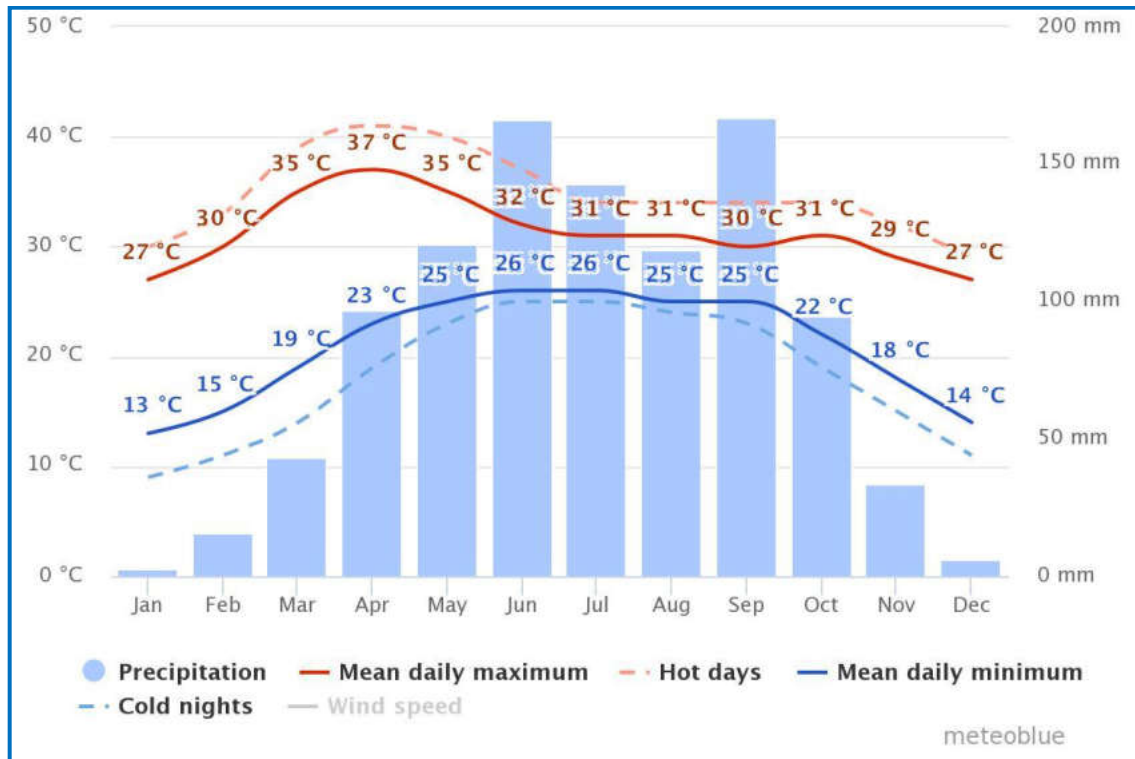
190. Although less than half of Bangladesh lies within the tropics, the presence of the Himalayan mountain range has created a tropical macroclimate across most of the east Bengal land mass. Bangladesh can be divided into seven climatic zones (Rashid 1991). According to the classification, the project area is located in south-central climatic zone.

- i. **South-central zone:** In this zone rainfall is abundant, being above 1,900 mm. The range of temperature is, as can be expected, much less than to the west, but somewhat more than in South-eastern zone. This is a transitory zone between the South-eastern, North-western and South-western zones and most of the severe hail storms, nor'westers and tornadoes are recorded in this area.

191. The climatic condition of the whole project area may be considered same as reported in Dhaka meteorological station, since this station is closed to the project areas. The climate data are derived from the meteoblue. The meteoblue climate diagrams are based on 30 years of hourly weather model simulations. The weather models with historical data from 1985 onwards and generated a continuous 30-year global history with hourly weather data.

a) Temperature

192. The "mean daily maximum" (solid red line) shows the maximum temperature of an average day for every month for project area. Likewise, "mean daily minimum" (solid blue line) shows the average minimum temperature. Hot days and cold nights (dashed red and blue lines) show the average of the hottest day and coldest night of each month of the last 30 years. For vacation planning, you can expect the mean temperatures, and be prepared for hotter and colder days.



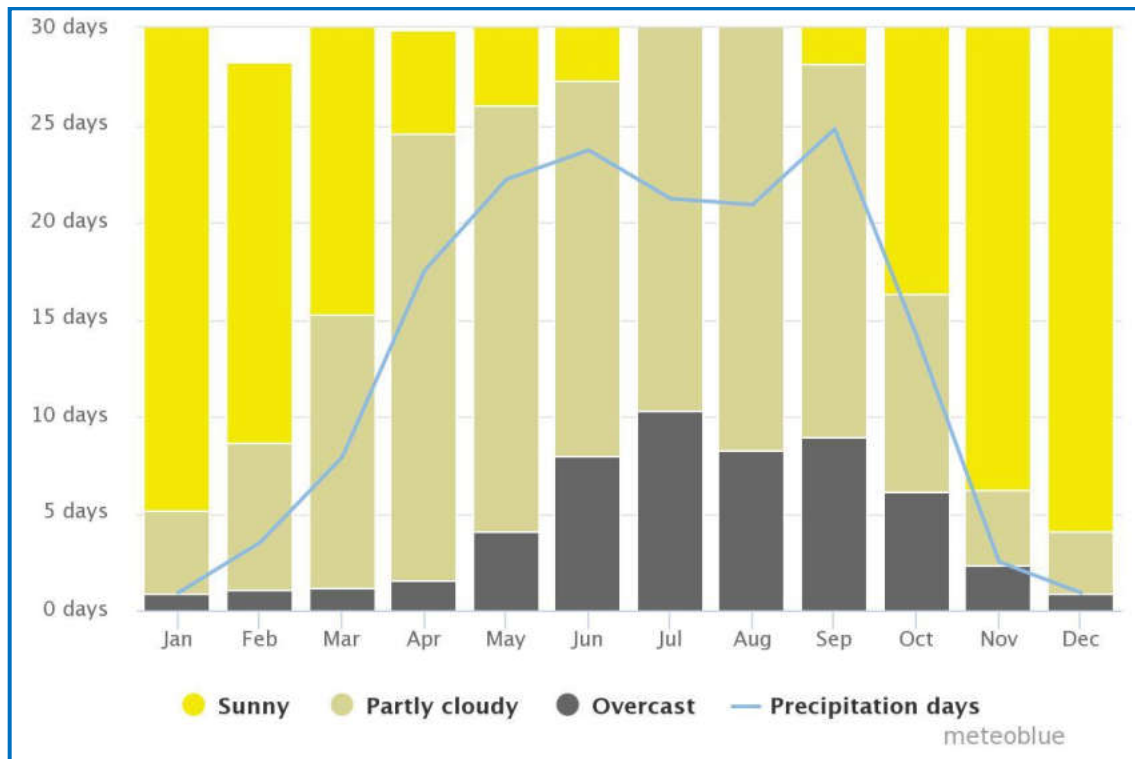
Source: Meteoblue

Figure IV.1: Temperature and Rainfall in Project Area

193. Wind speeds are not displayed per default, but can be enabled at the bottom of the graph. Monthly precipitations above 150mm are mostly wet, below 30mm mostly dry. Note: Simulated precipitation amounts in tropical regions and complex terrain tend to be lower than local measurements.

b) Rainfall

194. Heavy rainfall is characteristic of Bangladesh frequently causing flood across the country or at local scale. With the exception of the relatively dry western region of Rajshahi, where the annual rainfall is about 1,600 mm (63.0 in), most parts of the country receive at least 2,300 mm (90.6 in) of rainfall per year. About 80% of Bangladesh's rain falls during the monsoon season. Maximum rainfall occurs during May to September and the lowest rainfall occurs in November to February during winter season. Figure IV: 1 shows the average monthly precipitation of 30 years of project area. The number of sunny, partly cloudy and nos. of rainy day is given in Figure IV:2.



Source: Meteoblue

Figure IV.2: Number of Sunny, Rainfall and Cloud Coverage Days in Project Area

195. The graph shows the monthly number of sunny, partly cloudy, overcast and precipitation days. Days with less than 20% cloud cover are considered as sunny, with 20-80% cloud cover as partly cloudy and with more than 80% as overcast.

c) Wind Speed and Direction

196. Wind could be the biggest and most influential weather fact. So, it is extremely important to know the direction and velocity. The Wind Rose model is used to understand wind factors. The wind rose (Figure IV:3) provides an overview of prevailing wind conditions within the project area.

197. The wind rose for project area shows how many hours per year the wind blows from the indicated direction. From all the wind rose diagrams it can be said that the region is predominantly characterized by East-Southeast, South-East and South-Southeast wind flow. The average wind speed ranges from 5 to 19 km/h during maximum period in a year.

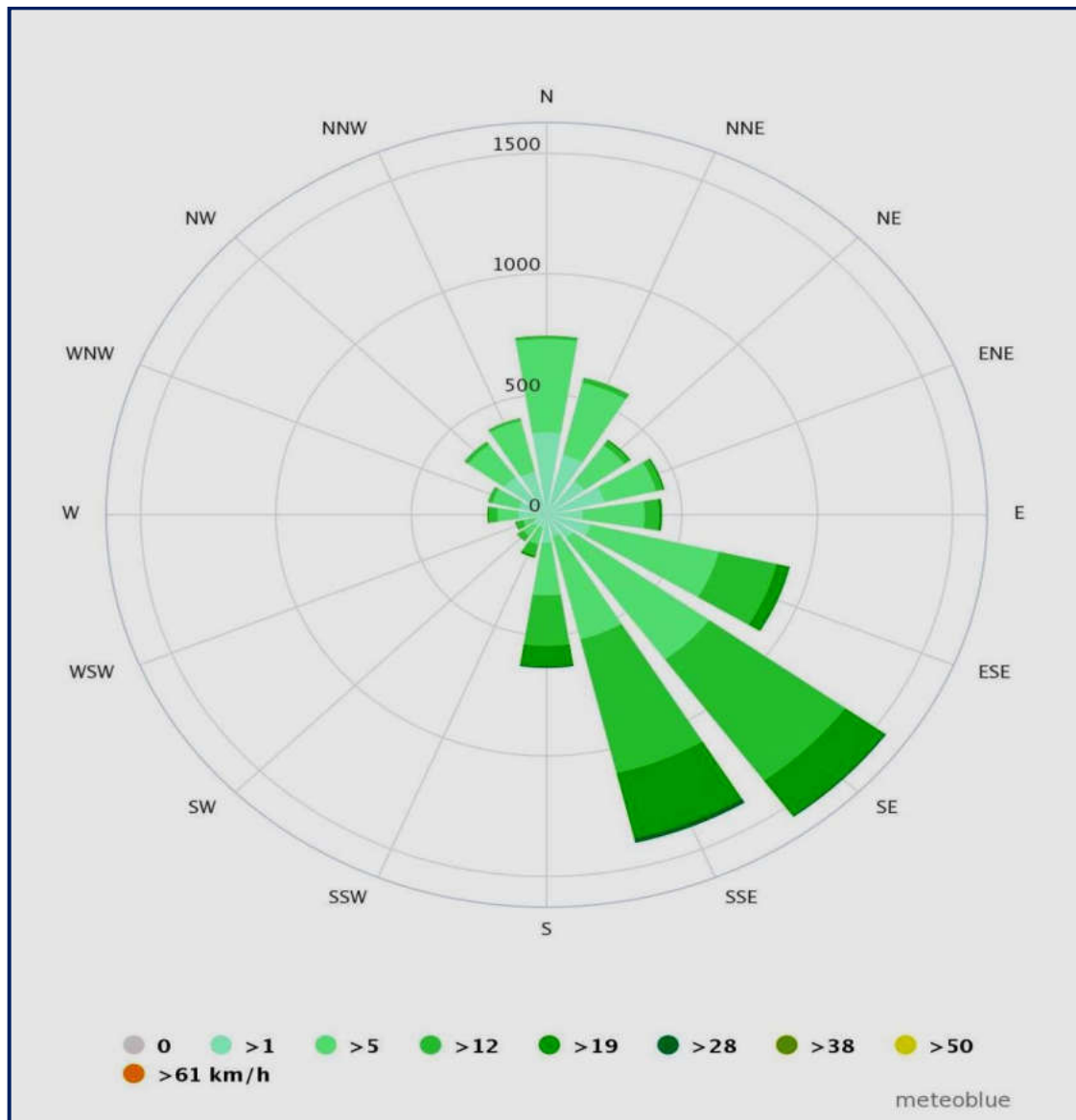


Figure IV.3: Wind rose Diagram in Project Area

2. Topography

198. 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. Nearly 12.5 percent area of Bangladesh in north northeast and south-southeast regions is hilly, 8.5 percent in the north centre and North West is flood free terrace land and 79 percent area is level land prone to seasonal inundation to variable depths.



Figure IV.4: General Topography of the Project Road Area

199. The DBR upgrading program site belongs to the Level Shallowly Weathered terrace land with shallow and deep drainage valleys (bydes). Saucer shaped seepage zone may occur at places like the Nogda, Pubail and Purbachal beels where the run-off channels meet. Seepage and run-off water of the Nagda beel is shedded in the Sitalakkhya near Ghorasal and Turag near Tongi. The accumulated water from the Purbachal beel is shedded to the Balu channel near Ulukhola bazar. Occurrence of the Pubail beel in the west and Savar beel in southwest receive seepage during dry season and run-off from adjacent uplands during the monsoon. The Madhupur Tract uplands extend toward Mymensingh via Gazipur forming a large land mass between Gazipur, Mymensingh and Tangail districts. This upland tract is covered by deciduous sal forest managed by the Bangladesh Forest Department (BFD). The terrace land over which the DBR passes is level and gently sloping toward the southeast (SRDI 1963).

200. This landscape is used for cultivation of irrigated and rain fed paddy, RAJUK and several land developers filling large parts of this landscape along the DBR alignment to expand residential area. Filling of level agriculture land and swamps along the DBR alignment may change the local relief affecting surface drainage locally. Moreover, land filling along the DBR alignment may induce rise of water level in Balu and Shitalakshya channels to inundate the adjacent areas. Unless the storm water from along the DBR alignment is managed properly and coordinated with a drainage system of adjacent residential sites, it may induce water logging in adjacent level land.

3. Physiographic Features

201. The physiography is the form of the earth's surface. In Bangladesh this may be classified into three distinct physiographic regions (a) floodplains, (b) terraces, and (c) hills. Each physiographic region has unique distinguishing characteristics. The three main physiographic regions can be further subdivided into 24 sub-regions and 54 sub-units.

202. The project road alignment area lies in the Jamuna (Young Brahmaputra) floodplain and mostly in Madhupur Tract physiographic unit. Madhupur Tract (is located in the central part of Bangladesh comprising greater Dhaka and Mymensingh districts, between the courses of the Old Brahmaputra and the Jamuna Rivers. Towards the south, this physiographic sub-region extends to as far as Dhaka, the capital of the country. Madhupur Tract measures about 4,105 sq km. Comparable to the Barind Tract, the area belongs to a Pleistocene terrace consisting mainly of red coloured and mottled clays. It is characterised by plateau-like hillocks varying in height from 9 to 18.5m, and a dendritic drainage pattern, typical of all Pleistocene terraces in Bangladesh. The valleys, mostly flat, are cultivated. The Madhupur jungle contains Shal trees (*Shorea robusta*), the hardwood which is second to teak in value.

4. Geology and Soil

203. The Madhupur Tract occurs in the north central hydrological region (WARPO 2000) of Bangladesh. The Madhupur Tract consists of vertically homogeneous unconsolidated clayey sediments down to 10.0m near to the Dhaka city becoming thinner toward east and southeast parts. The dissected deeply weathered sediments show variable drainage patterns, valley width and land type. The sediments of Madhupur tract until the 1960s was known as Pleistocene deposits but later based on findings of others the age-old idea changed. The observation of SRDI indicated that the sediments of the well-drained terrace land resemble the Dupi-Tilla sediments and shallowly weathered imperfectly drained terrace sediments resemble to the Tipam-Surma sediments (FAO 1971). The vertical homogeneity of Madhupur Tract sediments may be an indication that the sediments were probably deposited during the Plio-Pleistocene period under estuarine condition. This assumption cannot be confirmed yet because the sediments lack stratification and/or marine fossils (animal or plant).

204. The soils of Deeply Weathered Madhupur Tract are strong brown, well structured, strongly acidic, fine textured underlain by an unaltered clay layer at several meters depth. Highlands of the Madhupur Tract along N1, N2, N3 and N4 highways are being occupied for industrialization as the landscape is flood free and is linked with the highway network. These soils are suitable for a wide range of land uses like forestry, horticulture, urbanization and recreation. Soil of the level terrace land is weakly structured, acidic clay in subsoil that lies on an unaltered substratum within 50cm from surface. The pioneer grasses probably colonized the landscape that was cleared by early settlers several centuries back to bring the land under agriculture. The upland soils were considered less suitable for sedentary agriculture by early settlers than the imperfectly drained soils. They from consideration of drainage condition preferred the imperfectly drained level land for sedentary agriculture while the indigenous people (Garo and rakhain) preferred the terrace uplands for shifting cultivation (SRDI 1963, 1965).

5. Water Resources and Hydrology

205. Bangladesh and the western portion of the Indian State of Bengal are located within the 'Bengal Basin'. According to Rahman et al (2003), this basin includes the world's largest river delta, which is 140,000 square kilometers (the Ganges-Padma, Jumna-Brahmaputra-Tista and Meghna rivers and numerous tributary complexes) and the world's largest submarine fan complex (the Bengal Fan). These river systems carry a combined annual sediment load of 1.5 to 2.4 billion metric tons.

206. The headwaters of both the Ganges-Padma and Brahmaputra-Jamuna-Tista river systems are situated in the Himalayas ranges. Water in the Meghna River, originates from the Shillong Plateau. It drains one of the heaviest rainfall areas of the world. As a result of these extensive catchments, flooding is an annual occurrence in Bangladesh and occurs mainly during the rainy season between May to October when the rainfall in the catchments is at its maximum intensity.

207. Bangladesh has an average annual surface flow of approximately 1,073 million acre feet (MAF), of which about 870 MAF (93%) are received from India as inflow and the remaining 203 MAF (7%) as rainfall. This water is enough to cover the entire country to a depth of 9.14m. About 132 MAF (65% of rainfall and 12% of total) is lost to evaporation each year (114.30 cm), the remainder flows out to the Bay of Bengal.

208. Bangladesh is located over a subsiding basin of tectonic origin with a great thickness of sedimentary strata. This forms an unconsolidated alluvial deposit of recent age, overlaying marine sediments. The near surface Quaternary alluvium contains good groundwater aquifer characteristics (transmission and storage coefficients). The typical groundwater storage

reservoirs in Bangladesh have three divisions: upper clay and silt layer, a middle composite aquifer (fine to very fine sand) and a main deep aquifer consisting of medium to coarse sand.

209. Average annual rainfall in the country varies from greater than five meters in the northwest to less than 1.5 meters in the west. The majority of Bangladesh receives between 1.5 and 2.5 meters of precipitation annually (Reimann, 1993) and the Project area is located in a relatively high rainfall area. Under natural conditions a large proportion of the precipitation enters surface water as runoff and a large proportion infiltrates through the soils to groundwater aquifers. Most rivers in Bangladesh lose water to groundwater aquifers during the wet season and gain water from February through April (Pitman, 1993). The rate of water transfer depends on the extent which the river is incised into permeable aquifer materials.

210. Groundwater levels in most of Bangladesh are within two meters of the ground surface during July through October. Groundwater levels during the dry season vary across the country depending upon the proximity to surface water, depth and type of aquifer, extent of irrigation, and many other factors.

211. Known as the Towns of Rivers and the Country of Ponds Bangladesh is one of Countries with most densely rivers in the world. Due to Interconnected waterways the river transport is very developed. The total length of Inland river shipping is about 6000km. Bangladesh is one of the estuaries of Ganges Rivers having 230 small and Larges River.

212. Harmony with the natural environment give full consideration to the characteristics of the highways in plain area, do not deliberately pursue a high-standard alignment, follow and make full use of the terrain to reduce the destruction of the natural environment to the greatest extend; consider the water system and agricultural network irrigation along the route ,and properly design the drainage water environment protection; pay attention to the restoration of natural vegetation ,cover up the traces of artificial damage, and implement the concept of environmental protection throughout the design in all aspects.

a) Surface Water

213. The project road alignment crosses Sitalakhya River, Balu River, and Turag River at several locations. There are also significant numbers of beels and canals in and around the project locations. Besides, there are few numbers of ponds and ditches available in the project area. A hydrological map of the project area is given in Figure IV.5.



Figure IV.5: Surface Water Bodies along the Project Road

214. The wetland areas in Bangladesh and at project site have shrunk due to land use conflicts, watershed degradation in catchments within and beyond Bangladesh border and water diversion up stream. Pollution of open water bodies due to use of pesticides in

agricultural land, solid wastes and fish culture affected aquatic bio-diversity and wetland environment. The key issues related to surface water quality at the project area is the use of surface water for domestic, agricultural and industrial uses instead of exhausting the groundwater and disposal of domestic and municipal wastes in the water bodies.

215. The surface water at project site depends on rainfall, run-off from Bhawal-Madhupur tracts that occur at project site. The Bangsi and Banar drain the Madhupur tract that flow toward southeast and merge into the deep gorge (WARPO 2000). The landscape has an overall southeast gradient hence DBR upgrading program along the existing bypass road alignment will not affect local or regional hydrology. Adequate east west openings on road embankment exist already to avoid drainage impedance during a monsoon.

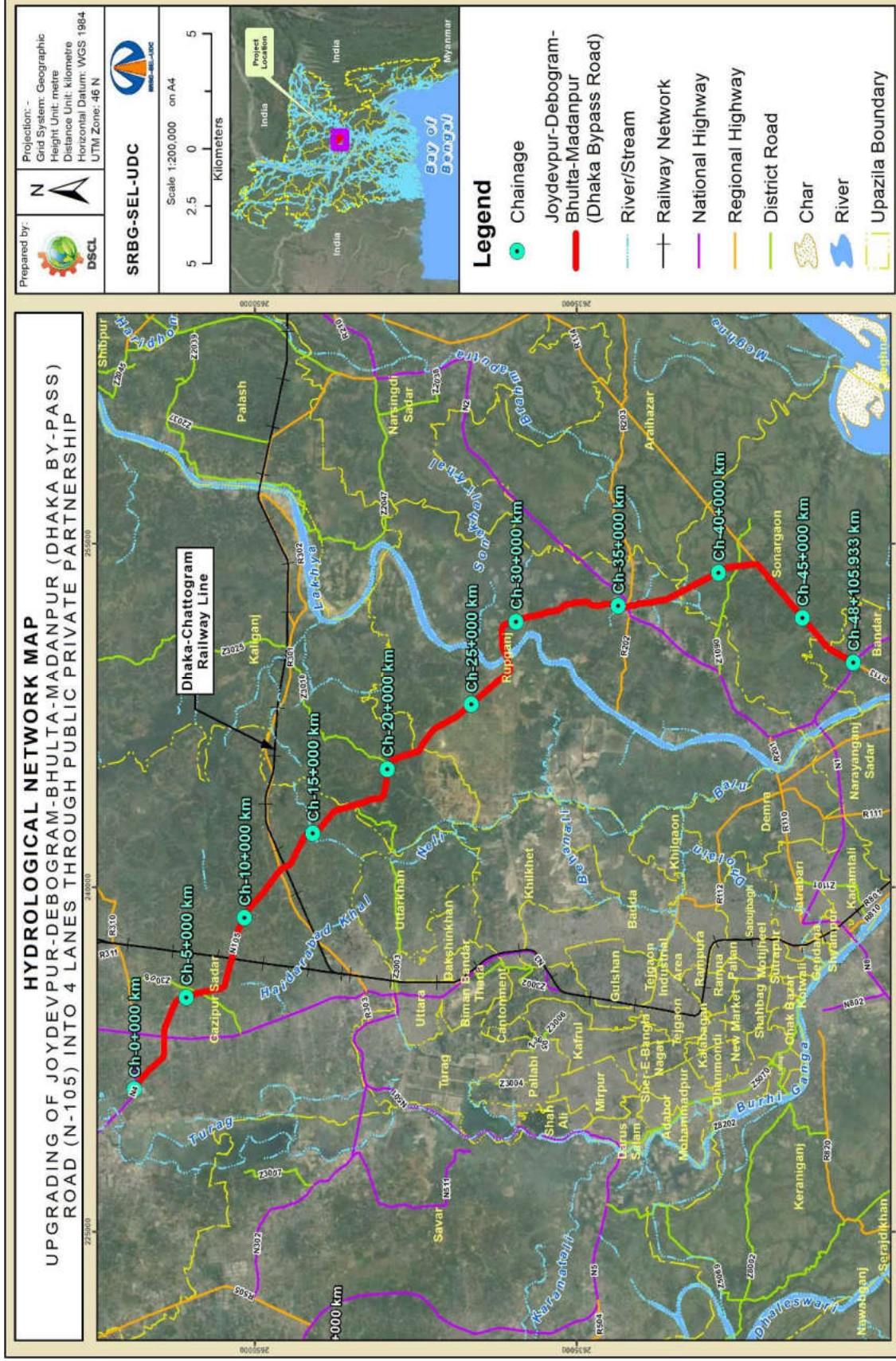


Figure V.6: Hydrological Network of the Project Area

b) Groundwater

216. The recharge of the aquifer in the project area is predominantly from deep percolation of rain and flood water. The actual recharge is apparently much less than its' potential, leading to substantial lowering of the seasonal water table. Reportedly, the ground water level in the Project area during the dry season has been going down every year. Possible causes of this decline are most likely the compound effects of reduced rainfall, pronounced droughts, increased temperature and reduced of river flow in the dry period.

217. Due to continuous depletion of water level many hand tube wells suffer layer failure problems and abandoned or replaced by tap. Some hand tube wells are also abandoned for availability of tap line not for layer failure. Tap is much convenient than hand tube well which need muscle power during water withdrawal, and when groundwater layer stay at minimum level elevation (msl) in dry season water withdrawal become very tedious job by hand tube well for drinking and other domestic purposes. Water supplied to tap from irrigation deep tube well for drinking purpose. But people now use tap water for drinking and for all other domestic and household uses. Ponds and other sources of surface water are now used only for cultivation of fish and animal birds rearing.

218. The deep groundwater table (DGWT) in terrace land (Project area) fluctuates between 15.0m and 20.0m during the dry season and reaches to the surface during rainy season. Groundwater in terrace lands is over exploited due to domestic, industrial and agricultural uses and the draw down is near to 7.0m during dry season. Further exploitation of the DGW table due to increased agricultural and industrial uses may create imbalance between water demand and water recharge at project site to affect the poor people (WARPO 2000).

6. Seismicity

219. 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, based on the ranges of the seismic coefficient (*note: the seismic coefficient is a measure of how strong an earthquake has the potential to be based on a combination of the mass of the plate and the seismic forces acting on it, as well as how frequently these quakes are likely to occur*). Zone 3 is in the most seismically active area with a seismic coefficient on 0.25, and Zone 1 is the least active with a significantly lower seismic coefficient of 0.075 (Zahiruddin, 1993). As per the seismic zone classifications, project road falls in zone II means medium seismic intensity (Figure IV.7).

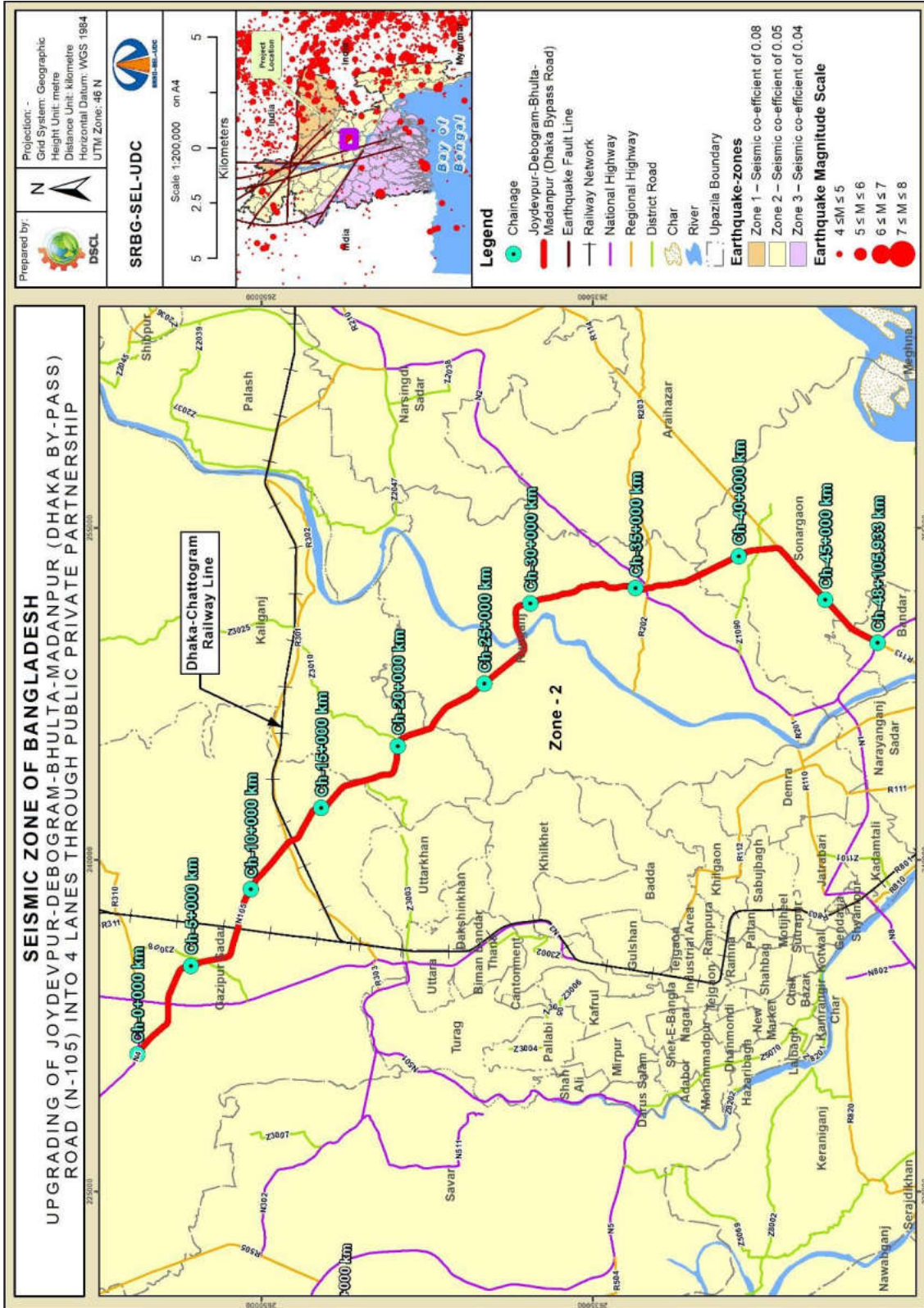


Figure IV.7: Seismic Zone and Activity of the Project Road

7. Natural Hazards

220. In Bangladesh, due to its unique geographic location, suffers from devastating tropical cyclones frequently. The funnel-shaped northern portion of the Bay of Bengal causes tidal when cyclones make landfall due to which thousands of people living in the coastal areas are affected. Some of the most devastating natural disasters in recorded history with high casualties were tropical cyclones that hit the region now forming Bangladesh (Wikipedia, 2015). The project area does not fall under the risk zone of cyclone (Figure IV.8).

221. Due to its geographic location, flood occurs regularly in the project area (Figure IV.9). However, the topography of the surrounding area is being considerably changed due to rapid land filling by land developers and it has been envisaged that the floodplain of the Balu and Lakhya rivers would progressively be encroached by rapid filling. Considering the present land filling trend and future urbanization, the water levels of both Balu and Lakhya will rise. With the rising of the water level of the surrounding rivers and unpredictable local heavy rainfall in a short duration due to climate change, the crest level of the road needs to be determined. Hence, an accurate estimation of high-water level design within the study area is a must. The Lakhya River drains surface runoff from a large catchment area lying in the central forest area and flow of the old Brahmaputra River. Additional inflows to the system originate from Balu, which drains a small catchment to the west of Lakhya. The Lakhya River joins the Dhaleswari, downstream of the Buriganga Confluence. The drainage of the surrounding areas is mostly dependent on the water levels of the peripheral rivers.

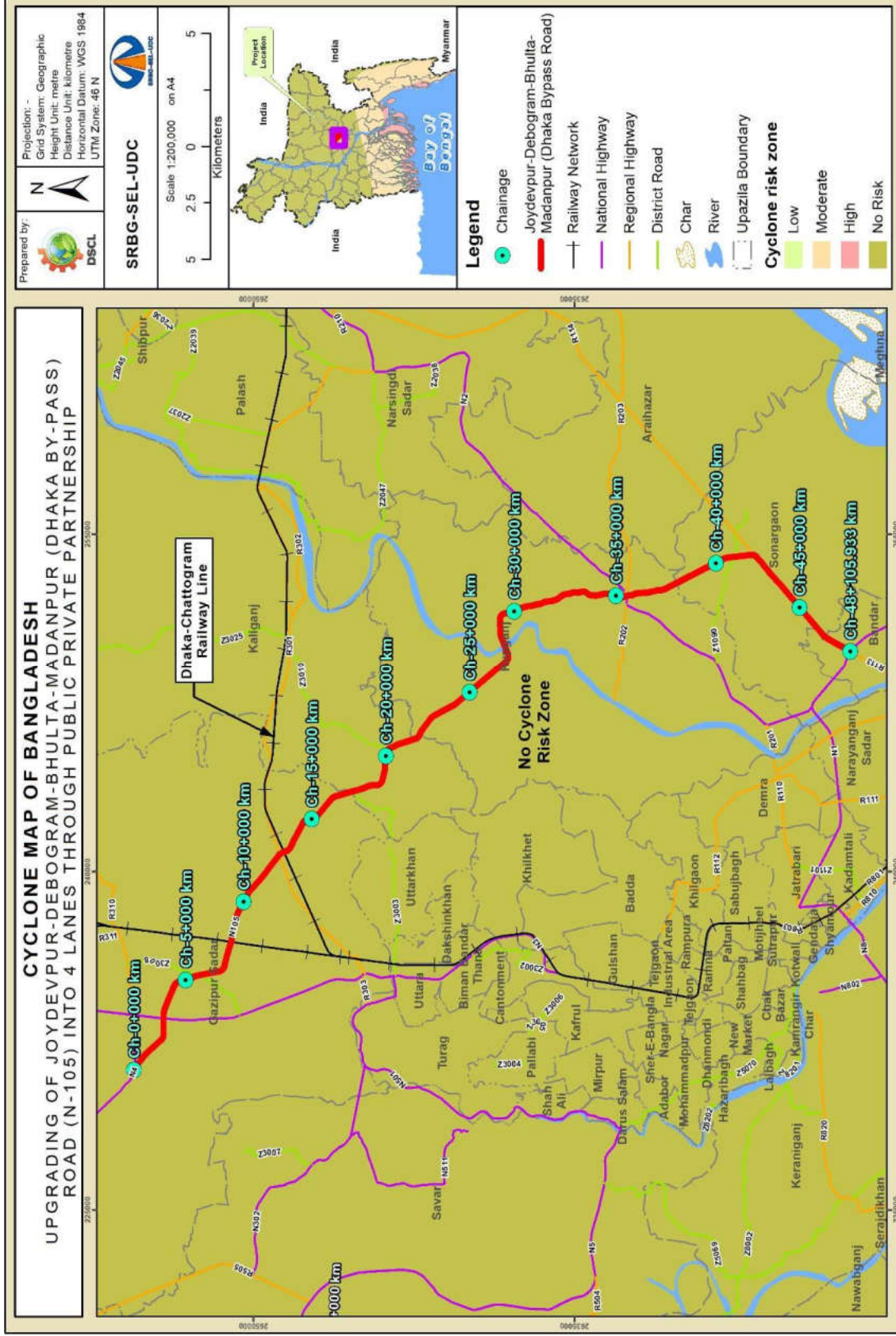


Figure IV.8: Cyclone Risk Zone of the Project Road

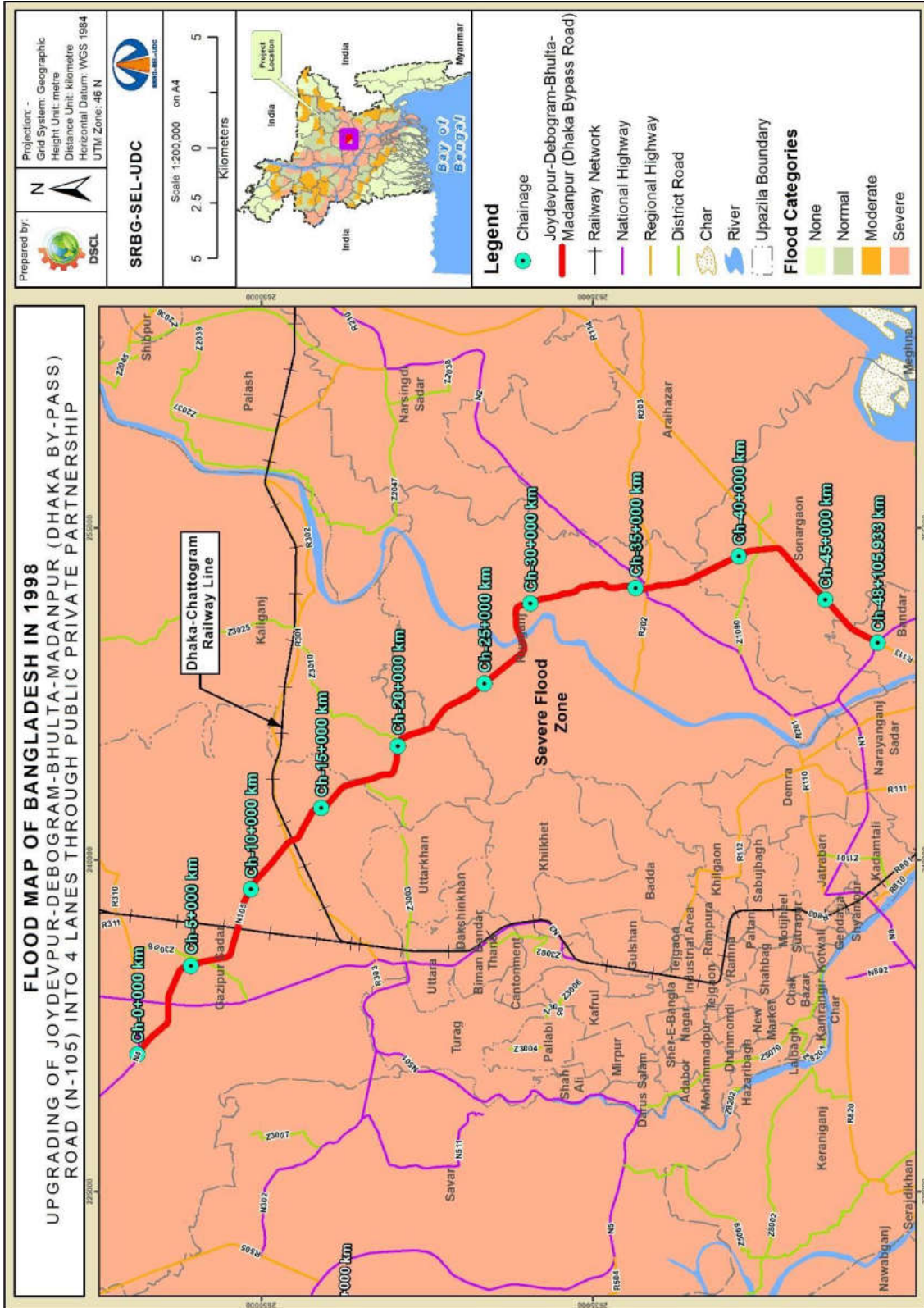


Figure IV.9: Flood Zone of the Project Road

8. Ambient Air Quality

222. The actual contribution that individual developments, actions or sources of air pollutants make to the local air quality is extremely difficult to categorically specify. This is because air, by its nature is very mobile, mixes quickly and is difficult to predict because it is greatly affected by ambient conditions such as the weather and microclimatic conditions.

223. The activities, which generate modify atmospheric air quality, are transportation (i.e., motor vehicle emissions); 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 particulate matters (PM₁₀ and PM_{2.5}), sulphur dioxide (SO₂), nitrogen oxides (NO_x), hydrocarbons (HC), carbon-monoxide (CO), and total volatile organic carbon (TVOC).

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

225. There are several numbers of small and big factories/industries located in the project and this area is also known as industrial zone of Bangladesh. Most of the industries are related to manufacturing of garments, shoes, iron, pharmaceuticals and etc. in addition to these industries there are also some food and beverage factories situated along the project corridor. Moreover, there are significant numbers of brick kilns situated along the project corridor. Therefore, air pollution is localized and comparatively higher at the beginning part of the project corridor than the end segment. 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, and transportations.

9. Noise and Vibration

226. 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 behavioral 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.

227. Three 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 which is recognized as Dhaka City Bypass Road. This highway carries a relatively high volume of both motorized and non-motorized vehicles, resulting in road traffic noise impacts along the road corridors.
- **Industry:** The beginning and the end part of the project area has several industries and factories. Noise are generating from these industries and manufacturing factories in the project area. However, noise from agro based industries are negligible but other type of industries, especially, road side brick crushing plant create severe noise in the influenced area.
- **Commercial Areas:** There are some commercial or refreshment areas where always significant number of people gather and makes chaos continuously. This is another source of noise pollution along the road.

C. Biological Environment

1. Bio-ecological Zones

228. 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.

229. 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. The project road alignment falls in the Madhupur Sal Tract and Brahmaputra-Jamuna Floodplain bio-ecological zone (Figure IV.7).

230. The Madhupur Sal tract extends across the district of Gazipur, Tangail and Mymensingh. The boundary between this ecosystem and its surroundings are generally sharp and well defined. Undulating Sal forest is the main ecological feature of this zone. This region is enriched with high floral diversity, but unfortunately, over 70% of the Sal forest area is either already degraded or encroached. The Madhupur Sal tract is dominated by the presence of Sal (*Shorea robusta*) tree. Records show that the Bengal tiger and One-homed rhinoceros, both of which have become extinct from this zone now, had healthy population in the past. However, due to continuous habitat destruction most of the wildlife of this region are either extinct or in vulnerable condition. The Brahmaputra floodplain situated in greater Mymensingh and Dhaka districts comprises the active channel of the Brahmaputra River and the adjoining areas of the young floodplain lands formed since about 1780, when the river shifted to its present course (i.e. the Jamuna River) to the south of Dewanganj in Jamalpur district. The main river course is strongly braided and consists of several interconnecting channels. This floodplain posse a unique variety of plants, medicinal herbs, fruit yielding trees, many jungle shrubs, creepers and climbers, flowering trees etc., many of which yield valuable products. Bushes of reeds and canes are also found here. The faunal diversity in this zone is also rich. Leopard was frequently sited in this zone. The most common poisonous snake is the Banded krait in this area, which could easily be identified by its broad black and yellow bands (IUCN, 2002f).

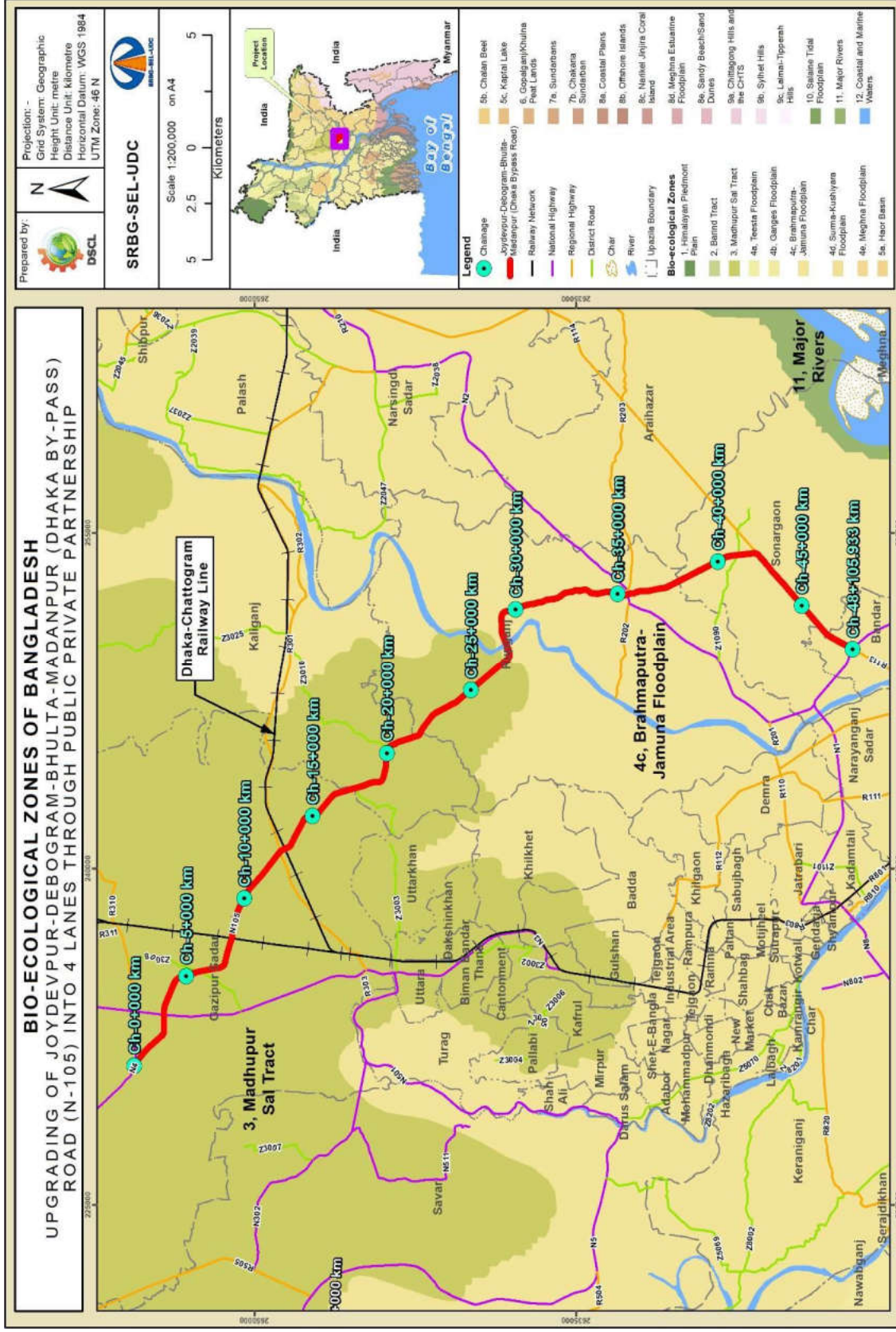


Figure IV.10: Bio-ecological Zone of the Project Road Alignment

2. Biodiversity

231. The status of terrestrial and aquatic 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 command area 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.

a) Diversity of Terrestrial and Aquatic Flora

Terrestrial Flora

232. The project influence area (PIA) is highland with mixed vegetation. Crops, vegetables are cultivated at the surrounding mainly include rice, wheat, tobacco, corn, nut, rabi crops and variety of homestead vegetables. A sizeable number of fruit trees with economic value have been observed in the PIA. The fruit trees include jackfruit, mangoes, litchi, banana, coconut, blackberry etc. and timber trees include mehegoni, neem, epil-epil, koroi etc. Considerable number of trees and bushes in the PIA site provide habitat for birds and other animals. The composition of plant community includes low growing grasses, trees, herbs and shrubs. The data collected from the field survey and suggests that the predominant species are those of cultivated vegetables and trees. A detailed list of terrestrial floral species found in the project area is shown in Table IV-1.

Table IV.1: List of Plants in the Project Area

Common Name	Scientific Name	English Name
Ata	<i>Annona squamosa</i>	Bullock's heart
Akashmoni	<i>Acacia auriculiformis</i>	
Akanda	<i>Calotropis procera</i>	Swallow wort
Ishw Armol	<i>Hemidesmus indicus</i>	Indian sarasaparilla
Ashok	<i>Saraca indica</i>	Ashoka
Aurjun	<i>Terminalia arjuna</i>	Aurjun
Amra	<i>Spondias pinnata</i>	Wild mango
Am	<i>Mangifera indica</i>	Mango
Babla	<i>Acacia nilotica</i>	
Bashak	<i>Adhatoda vasica</i>	Malabar Nut Tree
Bamboo	<i>Bambusa spp.</i>	
Banana	<i>Musa sapientum</i>	
Bel	<i>Aegle marmelos</i>	Wood apple
Bet	<i>Calamus rotung</i>	
Banar Lathi	<i>Cassia fistula</i>	Indian laburnum
BoknaNeem	<i>Melia azadirach</i>	
Boroi	<i>Zizyphus auritiana</i>	
Bot	<i>Ficus benghalensis</i>	Banyan tree
Chatim	<i>Alstonia scholaris</i>	Chatian

Common Name	Scientific Name	English Name
Chalta	<i>Dellenia indica</i>	
Coconut	<i>Cocos nucifera</i>	
Debdaru	<i>Polyalthia longifolia</i>	-
Dhundul	<i>Luffa 65eregrine 65l</i>	Sponge gourd
Dalim	<i>Panica granatum</i>	Pomegranate
EpilEpil	<i>Leucaenaleucocephala</i>	
Eucalyptus	<i>Eucalyptus citriodora</i>	
Gab	<i>Diospytos 65eregrine</i>	River ebony
Jarul	<i>Lagerstroemia speciosa</i>	Giant crepe-myrtle
Jolpai	<i>Elaeocarpus robustus</i>	Olive
Kalpanath/Kalo megh	<i>Andrographis paniculata</i>	Creat
Karamcha	<i>Carissa carandas</i>	Karuanda
Kamranga	<i>Averrhoa carambola</i>	Carambola apple
Kathal	<i>Artocarpus heterophyllus</i>	Jackfruit
Koroi	<i>Albizia procera</i>	Porrot tree
Kodbel	<i>Feronia limonia</i>	
Lebu	<i>Citrus aurantifolia</i>	Lemon
Litchi	<i>Litchi chinenss</i>	
Mehedi/Mendi	<i>Lawsonia inermis</i>	-
Mehogoni	<i>Swietenia mahagoni</i>	
Mochi Ganda/Mochkanda	<i>Pterospermum acerifolium</i>	Hati paila
Nayantara	<i>Vinca rosea</i>	Pri winkle
Nishinda	<i>Vitex negundo</i>	Five leaved caste tree
Papaya	<i>Carica papaya</i>	Papaw tree
Payara	<i>Psidium guajava</i>	Guava
Racta Jaba	<i>Hibiscus rosa-sinensis</i>	Rose of china
Radhachura	<i>Peltophorum pterocarpum</i>	Copperpod
Raktadrun	<i>Leucas sibiricus</i>	
Racta Chandal	<i>Pterocarpus santalinus</i>	Red sanders
Sal	<i>Shorea robusta</i>	
Segun	<i>Tectona grandis</i>	Teak
Shimul	<i>Bombax ceiba</i>	
Shishu	<i>Dalbergia sisoo</i>	
Sofeda	<i>Manilkara zapota</i>	Sapota
Tentul	<i>Tamarindus indica</i>	Tamarind
Venna	<i>Ricinus communis</i>	
Zamrul	<i>Syzygium samarangense</i>	
Ziga	<i>Lan nea coromandelica</i>	

233. The roadside trees along the project corridor are primarily planted by the RHD. Additionally, there are also private plantation along the impacted corridor due to the road up gradation. Therefore, there are different authorities who are the owner of the trees along the project road.



Figure IV.11: Roadside Vegetation along the Project Corridor

Aquatic Flora

234. 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 (*Spirodella* sp.). Numerous algae (e.g. *Spirogyra* and *Scytonema*) and amphibian plant, Dhol kolmi (*Ipomoea fistulosa*) are also found in the road side water bodies.

b) Conservation Status

Both endangered/threatened floral species and exotic species are found in the project AOI. The endangered/threatened species are listed in Table IV.2 and Exotic species (introduced) are listed in Table IV.3.

Table IV.2: Endangered/Threatened Floral Species Found in the AOI (Source: Field Survey 2017)

Sl. No.	Species	Vernacular name	Conservation status	Location of Sighting
1	<i>Hopea odorata</i>	Telsur	VU	Both side of Road
2	<i>Borassus madagascariensis</i>	Tal	EN	Both side of Road
3	<i>Pteris</i> sp	Pteris	CR	Both side of Road
4	<i>Phyllanthus indofischeri</i>	Amloki	VU	Both side of Road
5	<i>Euphorbia vezorum</i>	Bara dudhi	VU	Both side of Road
6	<i>Bambusa nutans</i>	Bash	VU	Both side of Road

*Abbreviation: CR: Critically Endangered; VU: Vulnerable; EN: Endangered

**not all species red listed globally are not red listed in Bangladesh

Table IV.3: Exotic Floral Species Found in The Project AOI (Source: Field Survey 2017)

Sl. No.	Species	Vernacular name	Conservation status	Location of Sighting
1	<i>Acacia auriculiformis</i>	Akashmoni	LC	Both side of Road
2	<i>Acacia nilotica</i>	Babla	LC	Both side of Road
3	<i>Eucalyptus</i> sp.	Eucalyptus	LC	Both side of Road
4	<i>Bombaxceiba</i> L.	Shimul Tula	LC	Both side of Road
5	<i>Leucaena leucocephala</i>	Epil Epil	NE	Both side of Road

*Abbreviation: CR: Critically Endangered; VU: Vulnerable; EN: Endangered

c) *Diversity of Terrestrial and Aquatic Fauna***Terrestrial Fauna**

235. The diversified habitat and ecosystem in the project area support various types of animals as given in Table IV-4. 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. The list of these species with their vulnerability status is given at Table IV-4.

Table IV.4: List of Fauna Identified in and around the Project Area

Scientific Name	English Name	Local Name	IUCN Status
Class: Amphibia			
<i>Bufo melanostictus</i>	Common Toad	Kuno bang	LC
<i>Hoplobatrachus tigerinus</i>	Bull Frog	Kola bang	LC
<i>Euphlyctis cyanophlyctis</i>	Skipper Frog	Kotkoti bang	LC
Class: Reptilia			
<i>Hemidactylus flaviviridis</i>	Common House Lizard	Tiktiki	LC
<i>Calotes versicolor</i>	Common Garden Lizard	Rokto-chosha	LC
<i>Mabuya carinata</i>	Common skink	Anjon	LC
<i>Varanus bengalensis</i>	Bengal monitor	Gui shap	NT
<i>Xenochrophis piscator</i>	Checked keelback	Dhora shap	LC
<i>Amphiesma stolata</i>	Stripped keelback	Dora shap	LC
<i>Enhydria enhydria</i>	Common smooth water snake	Pai na shap	LC
<i>Ahaetulla nasutus</i>	Common vine snake	Laodoga shap	LC
<i>Atretium schistosum</i>	Olive keelback	Maitta shap	LC
Class: Aves			
<i>Phalacrocorax niger</i>	Little cormorant	Paan-kowri	LC
<i>Dendrocygna javanica</i>	Lesser Whistling-duck	Shorali	LC
<i>Ardeola grayii</i>	Indian pond heron	Kani bok	LC
<i>Casmerodius albus</i>	Great egret	Sada bok	LC
<i>Egretta intermedia</i>	Intermediate egret	Mazla bok	LC
<i>Egretta garzetta</i>	Little egret	Choto bok	LC
<i>Bubulcus ibis</i>	Cattle egret	Go-bok	LC
<i>Nycticorax nycticorax</i>	Black-crowned night heron	Nishi bok	LC
<i>Ixobrychus cinnamomeus</i>	Cinnamon Bittern	Lal bok	LC
<i>Ixobrychus sinensis</i>	Yellow Bittern	Holud bok	LC
<i>Anastomus oscitans</i>	Asian Openbill	Shamuk-khol	LC
<i>Haliastur indus</i>	Brahminy kite	Shankho chil	LC
<i>Milvus migrans</i>	Black kite	Bhubon chil	LC
<i>Elanus caeruleus</i>	Black-shouldered kite	Kat ua Chil	LC
<i>Actitis hypoleucos</i>	Common sandpiper	Kada Khocha	LC
<i>Tringa stagnatilis</i>	Marsh Sandpiper	Bil Batan	LC
<i>Glareola lactea</i>	Small Pratincole	Chhoto Babui Batan	LC
<i>Metopidius indicus</i>	Bronze-winged Jacana	Jolpipi	LC
<i>Columba livia</i>	Rock pigeon	Jalali Kobutar	LC
<i>Spilopelia chinensis</i>	Spotted dove	Tila Ghughu	LC
<i>Streptopelia decaocto</i>	Eurasian collared dove	Konthighughu	LC
<i>Streptopelia tranquebarica</i>	Red-collared Dove	Lal Ghughu	LC
<i>Treron phoenicopterus</i>	Yellow-footed Green Pigeon	Holdeypa Harial	LC
<i>Psittacula krameri</i>	Rose-ringed parakeet	Tia	LC
<i>Amaurornis phoenicurus</i>	White-breasted waterhen	Dahuk	LC
<i>Eudynamis scolopacea</i>	Asian cuckoo	Kokil	LC
<i>Centropus sinensis</i>	Greater coucal	Kanakua	LC

Scientific Name	English Name	Local Name	IUCN Status
<i>Cuculus micropterus</i>	Indian cuckoo	Bou-kotha-kao Pakhi	LC
<i>Hierococcyx varius</i>	Common hawk cuckoo	Chokhgelo Pakhi	LC
<i>Cacomantis merulinus</i>	Plaintive Cuckoo	Koroon Papia	LC
<i>Athene brama</i>	Spotted owl	Khuruley Pencha	LC
<i>Tyto alba</i>	Barn owl	Laxmi Pencha	LC
<i>Apus nipalensis</i>	House swift	Ghor Batashi	LC
<i>Cypsiurus balasiensis</i>	Asian palm swift	Nakkati	LC
<i>Alcedo atthis</i>	Common kingfisher	Choto Maachranga	LC
<i>Halcyon smyrnensis</i>	White-throated kingfisher	Sada buk Maachranga	LC
<i>Merops orientalis</i>	Little Green bee-eater	Suichora	LC
<i>Merops leschenaulti</i>	Chestnut-headed Bee-eater	Khoiramaatha Shuichora	LC
<i>Megalaima haemacephala</i>	Coppersmith barbet	Choto Basanta Bauri	LC
<i>Psilopogon asiaticus</i>	Blue-throated barbet	Neelgola Boshonto	LC
<i>Psilopogon lineatus</i>	Lineated barbet	Gurkhod	LC
<i>Dendrocopos macei</i>	Fulvous-breasted woodpecker	Pakra Kaththokra	LC
<i>Dinopium benghalense</i>	Black-rumped flameback	Kaththokra	LC
<i>Lanius cristatus</i>	Brown shrike	Khoira Latora	LC
<i>Lanius schach</i>	Long-tailed shrike	Bagha tiki	LC
<i>Oriolus xanthornus</i>	Black-headed oriole	Holdey Pakhi	LC
<i>Corvus splendens</i>	House crow	Pat i Kak	LC
<i>Corvus leuiscornis</i>	Jungle crow	Dar Kak	LC
<i>Dendrocitta vagabunda</i>	Rufous treepie	Hanrichacha	LC
<i>Dicrurus macrocercus</i>	Black drongo	Fingey	LC
<i>Dicrurus aeneus</i>	Bronze Drongo	Chota, Fingey	LC
<i>Artamus fuscus</i>	Ashy woodswallow	Metey Bonababil, Latora	LC
<i>Pericrocotus cinnamomeus</i>	Small minivet	Sat saili	LC
<i>Copsychus saularis</i>	Oriental magpie robin	Doel	LC
<i>Aegithina tiphia</i>	Common iora	Towfik	LC
<i>Acridotheres fuscus</i>	Jungle myna	Jhuti Shalik	LC
<i>Acridotheres tristis</i>	Common myna	Bath Shalik	LC
<i>Sturnus malabaricus</i>	Chestnut-tailed starling	Kath Shalik	LC
<i>Pycnonotus cafer</i>	Red-vented bulbul	Bulbuli	LC
<i>Pycnonotus jocosus</i>	Red-whiskered Bulbul	Shepahi Bulbul	LC
<i>Orthotomus sutorius</i>	Common tailorbird	Tuntuni	LC
<i>Bradypterus thoracicus</i>	Brown Bush Warbler	Palasi Froringfutki	LC
<i>Nectarinia asiatica</i>	Purple sunbird	Beguni Moutushi	LC
<i>Nectarinia zeylonica</i>	Purple-rumped sunbird	Moutusi	LC
<i>Passer domesticus</i>	House sparrow	Charui	LC
<i>Ploceus philippinus</i>	Baya weaver	Babui	LC
<i>Anthus rufulus</i>	Paddyfield pipit	Dhani Tulika	LC
<i>Motacilla alba</i>	White wagtail	Dhola Khonjon	LC
<i>Parus major</i>	Great tit	Boro Tit	LC
<i>Upupa epops</i>	Eurasian Hoopoe	Hudhud Pakkhi	LC
Class: Mammalia			
<i>Pteropus giganteus</i>	Flying Fox	Badur	LC
<i>Pipistrellus coromandra</i>	Indian Pipistrelle	Chamchika	LC
<i>Megaderma lyra</i>	Greater False Vampire	Badur	LC
<i>Herpestes edwardsii</i>	Common Mongoose	Bara benji	LC
<i>Herpestes auropunctatus</i>	Small Indian Mongoose	Benji	LC
<i>Felis chaus</i>	Jungle Cat	Ban biral	NT
<i>Vulpes bengalensis</i>	Bengal Fox	Khek shial	VU
<i>Viverricula indica</i>	Small Indian Civet	Khatash	NT
<i>Rattus rattus</i>	Common House Rat	Indur	LC

Scientific Name	English Name	Local Name	IUCN Status
<i>Bandicota indica</i>	Bandicoot Rat	Bara indur	LC
<i>Mus musculus</i>	House Mouse	Nengri indur	LC
<i>Suncus murinus</i>	House Shrew	Chicka	LC

Aquatic Fauna

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

237. The ponds and burrow pits within RoW are presently used for fish culture or fish stocking. There is no natural stream or wetland within the RoW so upgrading the DBR will not impact local or regional hydrology. The wetland ecology will not be impacted as the road upgrading program will pass along the alignment of the existing bypass road. Fisheries and natural species of fish will not be affected significantly with the implementation of the DBR. Rather it will facilitate faster transportation of marine fishery catches to different interior markets. Water in Sitalkhaya is heavily polluted from sewerage discharge and effluents from the textile, fertilizer and other industries affecting the aquatic lives. No aquatic mammal like Dolphin was observed in the Rivers along the project road.

3. Environmentally Sensitive Areas

238. The Bio-ecological zones defined by IUCN (2000) for Bangladesh are the protected landscapes considering their ecological importance. The eco-resources of the country depleted chronologically due to demographic pressure, natural calamities, poor enforcement, poor management and land use conflicts. Hence, GoB considered several of the sites as environmentally sensitive and declared as protected areas through gazette notifications. Amongst the notified 29 ecologically sensitive landscapes the estuarine land, wetland, mangrove forest and virgin hill forests are also included. Three sites in the Sundarbans, one Hakaluki Haor in Sylhet and one in Tanguar Haor at Sunamganj and Char kukri mukri at Bhola district have been notified as Ramsar Convention Sites. The historical site and structures, cultural structures, archaeological sites and national monuments are also the declared protected sites. The MoEFCC and other Ministries also declared some sites as protected through notification. The Turag and Shitalakshya River has been declared as Ecologically Critical Area (ECA) which are located along the project corridor.

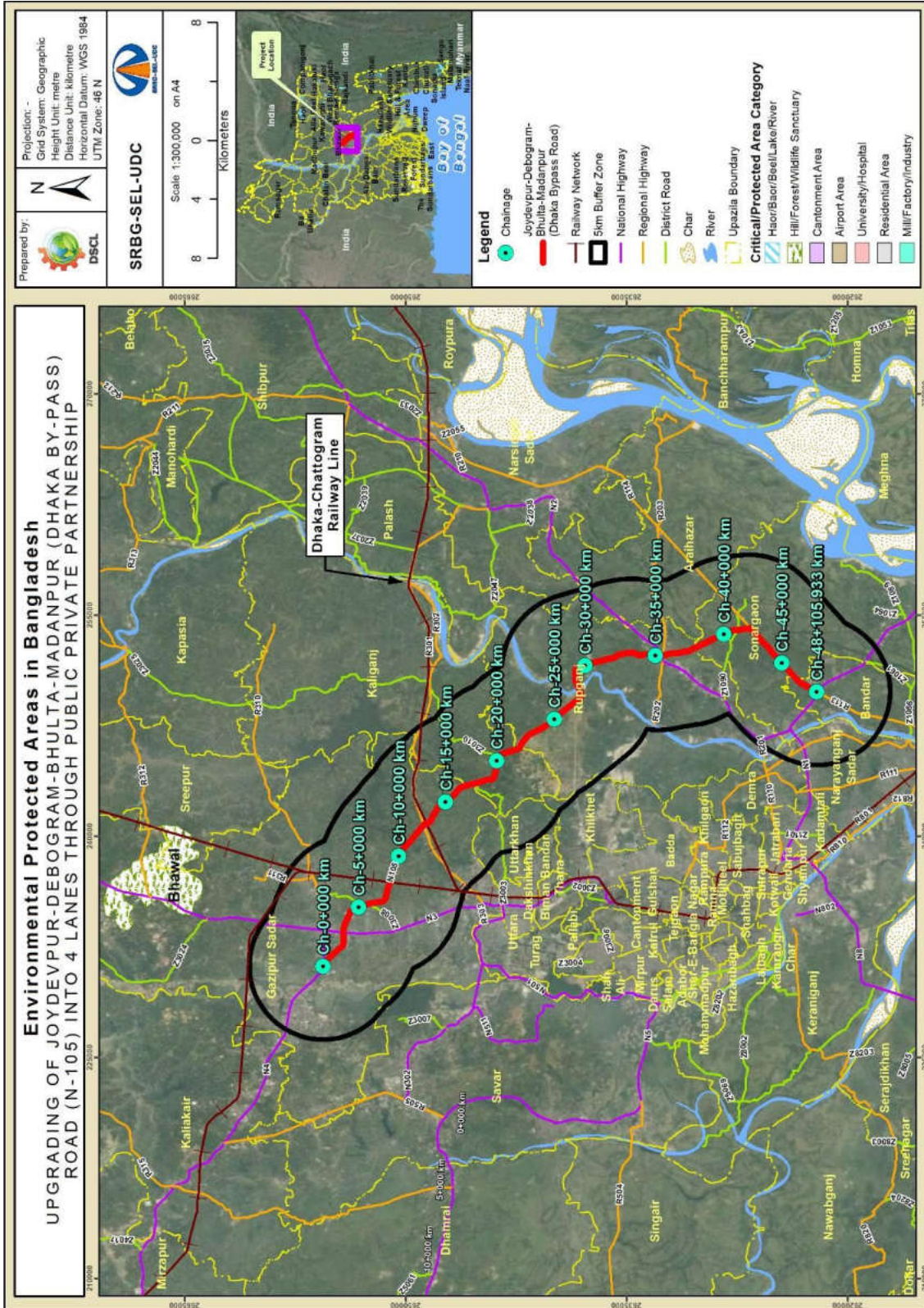


Figure IV.12: Environmental Protected Areas in the Project Location

239. The northwest site of DBR was covered by deciduous sal (*Sorea robusta*) forests hundreds of years ago. Few sparsely distributed evergreen species still exist there within the sal forest. Rain fed paddy used to be cultivated in level terrace lands and valleys of the Madhupur Tract. Bangladesh Forest Department (BFD) planted several indigenous and exotic timber and/or fuel wood species on roadsides under social forestry programs. The natural sal forest of the Madhupur Tract depleted due to over exploitation, mismanagement, demographic pressure and deteriorated law and order situation. In Bangladesh roadside tree planting began after the Moghal period. The British institutionalized the culture of planting trees on roadsides particularly in the west part of Bangladesh and appointed an Arboriculturist in C&B Department. The BFD planted timber and fuel wood species on roadside since the beginning of the 1980s. Few NGOs named CARE, SIDA and Proshika later joined hands with BFD in tree planting culture to generate employment opportunities for the rural poor and to boost timber, industrial raw material and fuel wood production. There are over 50,000 smalls (less than 30 cm girth at waist height), 80,000 mediums (30-50 cm girth at waist height) and over 30,000 large (over 50 cm girth at waist height) trees on DBR side that might be impacted by the project. No natural or planted forest exists along the DBR alignment at present. However, as per the social and resettlement survey only 10782 trees will be impacted due to project intervention.

D. Environmental Quality Test

240. The existing environmental quality in the project influence area serves as the basis for identification, prediction and evaluation of potential environmental impacts of the proposed project interventions. The baseline environmental quality has been assessed through field studies during 16th and 17th July, 2019 within the impact zone and analysis the information for various components of the environment, viz. air, noise, water, and soil. The sampling locations were in the following Figure IV.13.

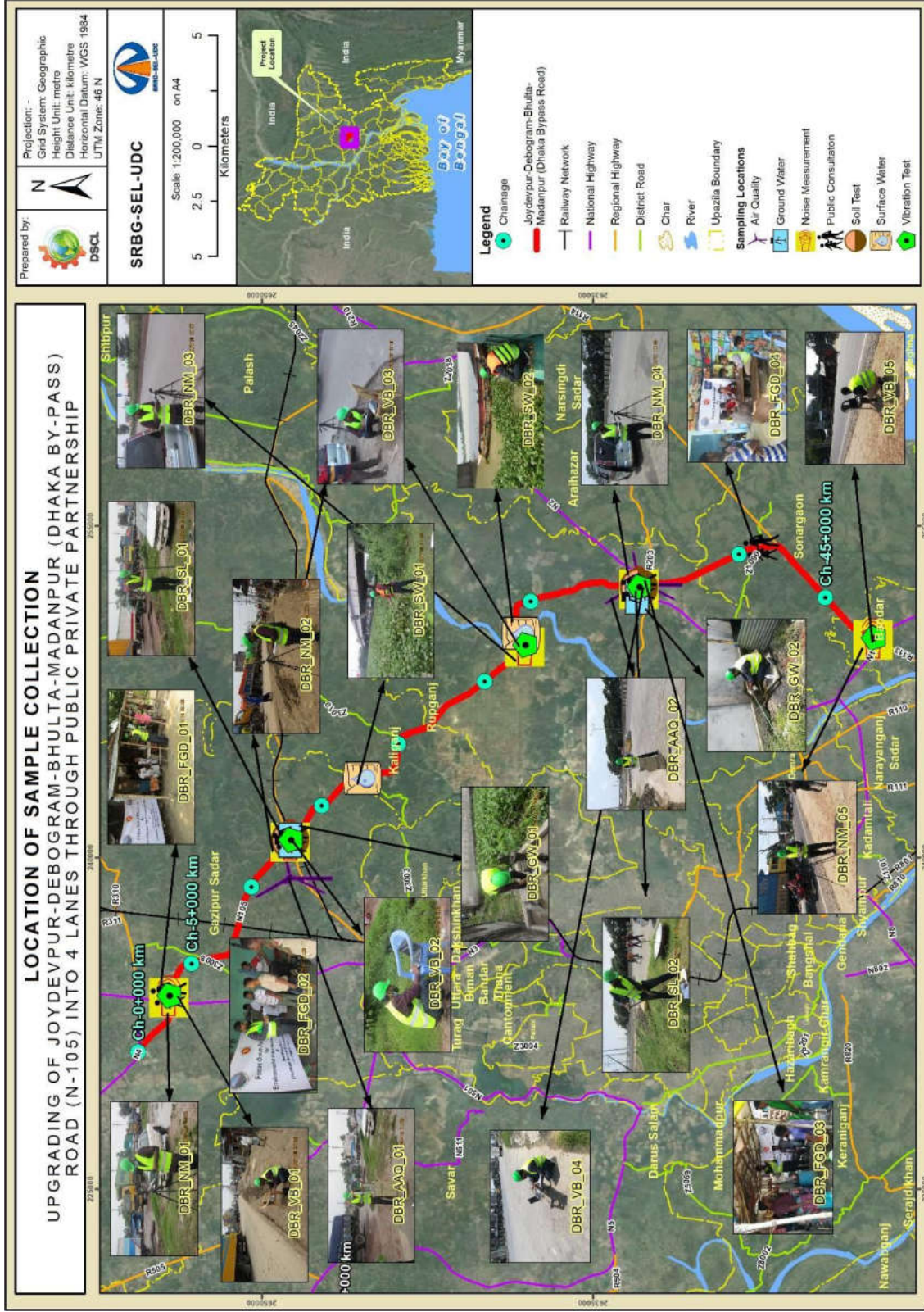


Figure IV.13: Locations of Samples Collection in the Project Area

1. Ambient Air Quality

241. Ambient Air quality measurements carried out during 16th to 17th July 2019 in two locations along the Project road and the monitoring results are given in Table IV.5. The sampling locations were selected mostly at bazar area where many people visit all day long and maximum number of people will be the receptor of air pollution during the road construction. Bangladesh national standards for ambient air quality are followed for the ambient air quality analysis. The key air quality parameters (particulate matter- PM₁₀ and PM_{2.5}, oxides of sulfur - SO_x, oxides of nitrogen – NO_x, carbon monoxide- CO, Ozone-O₃ and SPM) were analyzed from samples collected at each sampling sites. The measurement results showed achievement of all air quality standards. Based on the ambient air quality standard of DoE, air quality in the project areas can be stated as in good condition. Particulate matter PM_{2.5} value was 48 and PM₁₀ value was 68 which are far below the DoE standard.



Figure IV.14: Ambient Air Quality Sampling in the Project Area

Table IV.5: Test Result of Ambient Air Quality Analysis

Parameter	Unit	Project Site		Bangladesh Standard	Duration (hours)	Weather Condition	Method of Analysis
		DBR_AAQ_01	DBR_AAQ_02				
		23.92909°N; 90.45358°E	23.78833°N; 90.36849°E				
SPM	µg/m ³	43	35	200	24	Sunny	Gravimetric
PM _{2.5}	µg/m ³	48	41	65	24		Gravimetric
PM ₁₀	µg/m ³	68	60	150	24		Gravimetric
SO ₂	µg/m ³	3.44	2.74	365	24		West-Geake
NO _x	µg/m ³	38.8	30.8	100	Annual		Jacob and Hochheiser
O ₃	µg/m ³	1.60	1.04	157	8		Spectrophotometric Method
CO*	ppm	<1	<1	9	8		CO Meter

Source: Sampling and Lab Analysis, DSCL, 2019

Table IV.6: Monitoring Results of Weather Data

Sample ID	Location	GPS Location	Time		Humidity (%)	Temperature (°C)	Wind speed and direction (Km/h)
			Start	End			
DBR_AAQ_01	Mirer Bazar, Pubail, Gazipur	23.92909°N; 90.45358°E	9:00	17:00	88%	29°C	24 km/h from North to East
DBR_AAQ_02	Bhulta Mor, Narayanganj	23.78833°N; 90.36849°E	9:00	17:00	62%	34°C	10 km/h from North to East

a) Applicability of Air Pollution Model for the Proposed Road

242. CALINE4 is one of the more popular Gaussian-based line source models. With appropriate input data, simulation models can be used to predict short- and long-term air pollution concentrations at desired locations called “receptors,” and multiple receptors can be used to represent spatial and temporal gradients at regional, urban and local scales. The development of the site-specific emission information that “drives” such models is not trivial. Vehicle emissions depend on many factors, including the number, speed, type and age of vehicles, all of which can vary significantly over the course of a day. Emission/dispersion models do not require data from existing pollutant monitoring sites to estimate near-road concentrations and exposures, although such information may be used to estimate the “background” component of concentrations contributed by other “local” and “regional” emission sources, i.e., those not explicitly modeled because they are distant, too numerous, or too difficult to simulate. The drawbacks of dispersion models include, among others, extensive input data requirements, errors due to unmeasured variability in emissions and other parameters, the need for accurate locational information, simplified and possibly unrealistic model assumptions; the relevance of the background estimates, and a need for validation.

243. CALINE4, a line-source Gaussian plume dispersion model originally developed by the California Department of Transportation to predict 1- and 8-hr CO concentrations at pre-determined receptor positions near roadways. The model can also simulate formation and dispersion of NO₂, using a simple set of reactions to predict its formation from precursors NO and O₃, and PM, using algorithms to model deposition and settling processes. Required inputs include roadway geometry, hourly surface meteorology, traffic volume and emission rates. Individual highway segments are divided into a series of elements, each modeled as an “equivalent” finite line source that is normal to the wind direction and centered at the element’s midpoint, from which incremental concentrations are computed and summed to predict the concentrations at designated receptors.

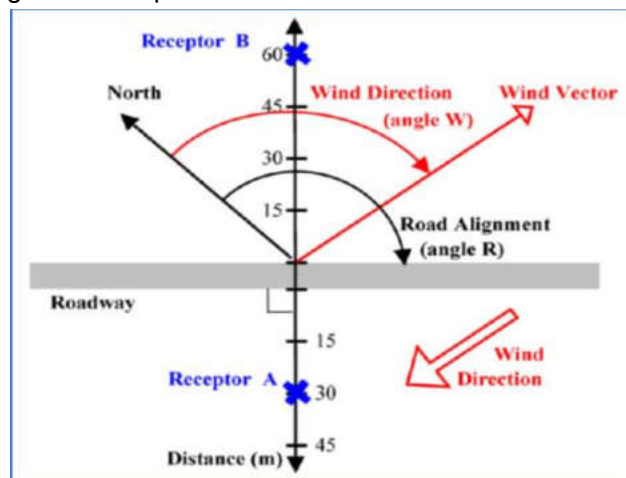


Figure IV.15: Depiction of Road and Receptor Coordinate System

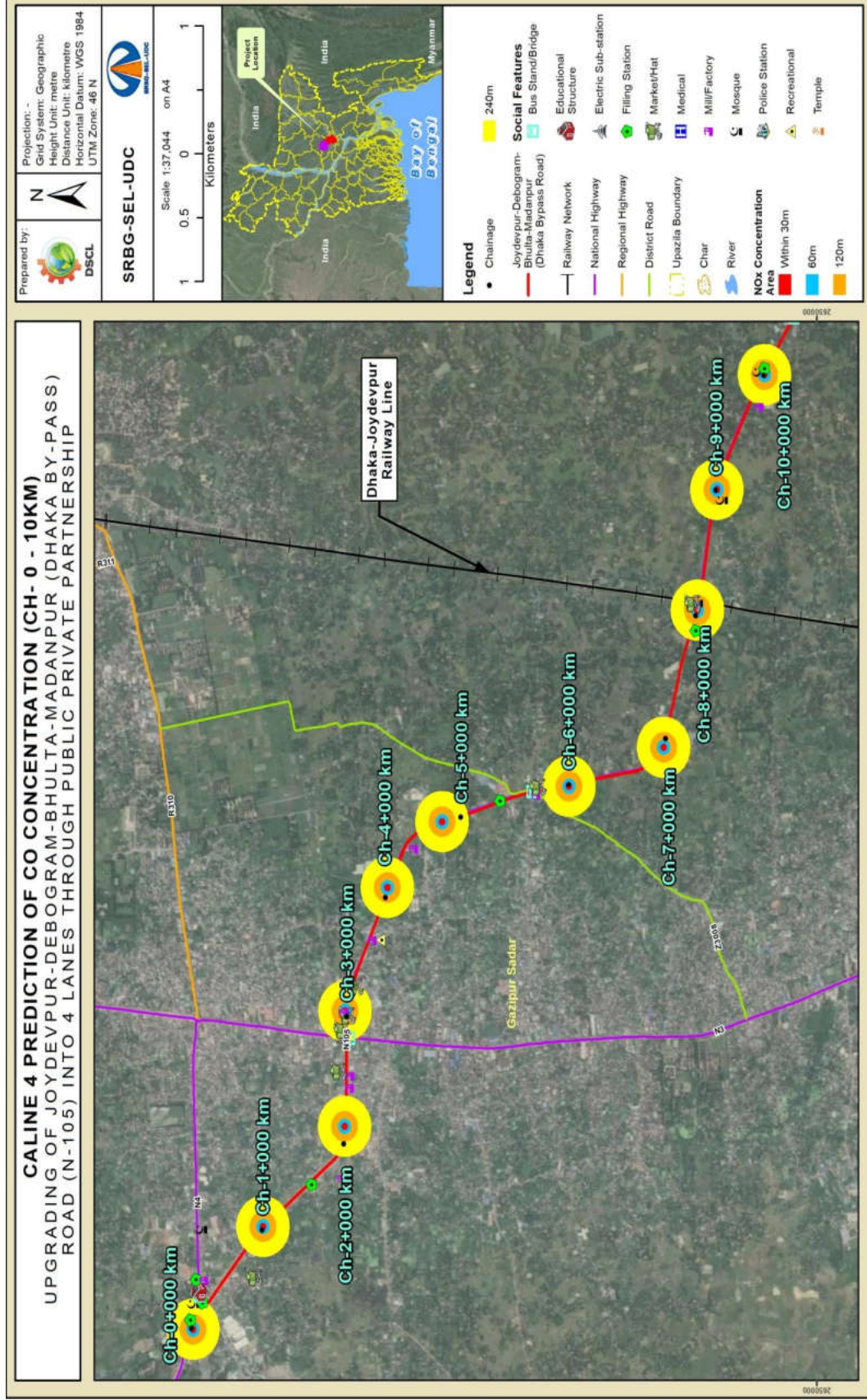
Model setup

244. CALINE4 analyses used 1 hr runs, a straight roadway element 2 km in length, flat surrounding terrain, a set of receptors aligned normal to the road at the segment's center, downwind distances from 15 to 300 m at 15 m intervals, and a receptor height of 1.8 m. The nominal case also assumed: mixing height = 500 m; ambient temperature = 15°C; background concentration = 0 ppm; atmospheric stability category (SC) = D (the most common case); wind speed = 4 m s⁻¹; vehicle volume = 1000 vehicles hr⁻¹; road at grade level; mixing zone width = 30 m, and an artificially high emission rate to obtain sufficient precision in model outputs. Model predictions were subsequently adjusted to derive concentrations for a nominal emission rate of 1 g km⁻¹. The framework CALINE 4 uses is shown in Figure IV.15.

245. CALINE4 predictions strongly depend on wind angle, and the highest concentrations outside the mixing zone are produced by a wind angle of ~10° as measured from the road centerline; the highest concentrations on the roadway occur for winds parallel to the road. The wind rose used for modelling purpose is given in Figure IV.3.

Results

246. The map in Figure III.1 shows the location map of the proposed project. Results of the CALINE 4 model runs of CO and NO prediction for 49 evenly spaced points for 2018 (baseline scenario) and 2043 (future scenario) are given in Figure IV.16 to IV.20 and Table IV.8 to IV.11. None of the segments exceeded the recommended limit for CO (1 hr. conc. 35ppm) and NO_x (none for 1hr. conc.) emission set by DoE.



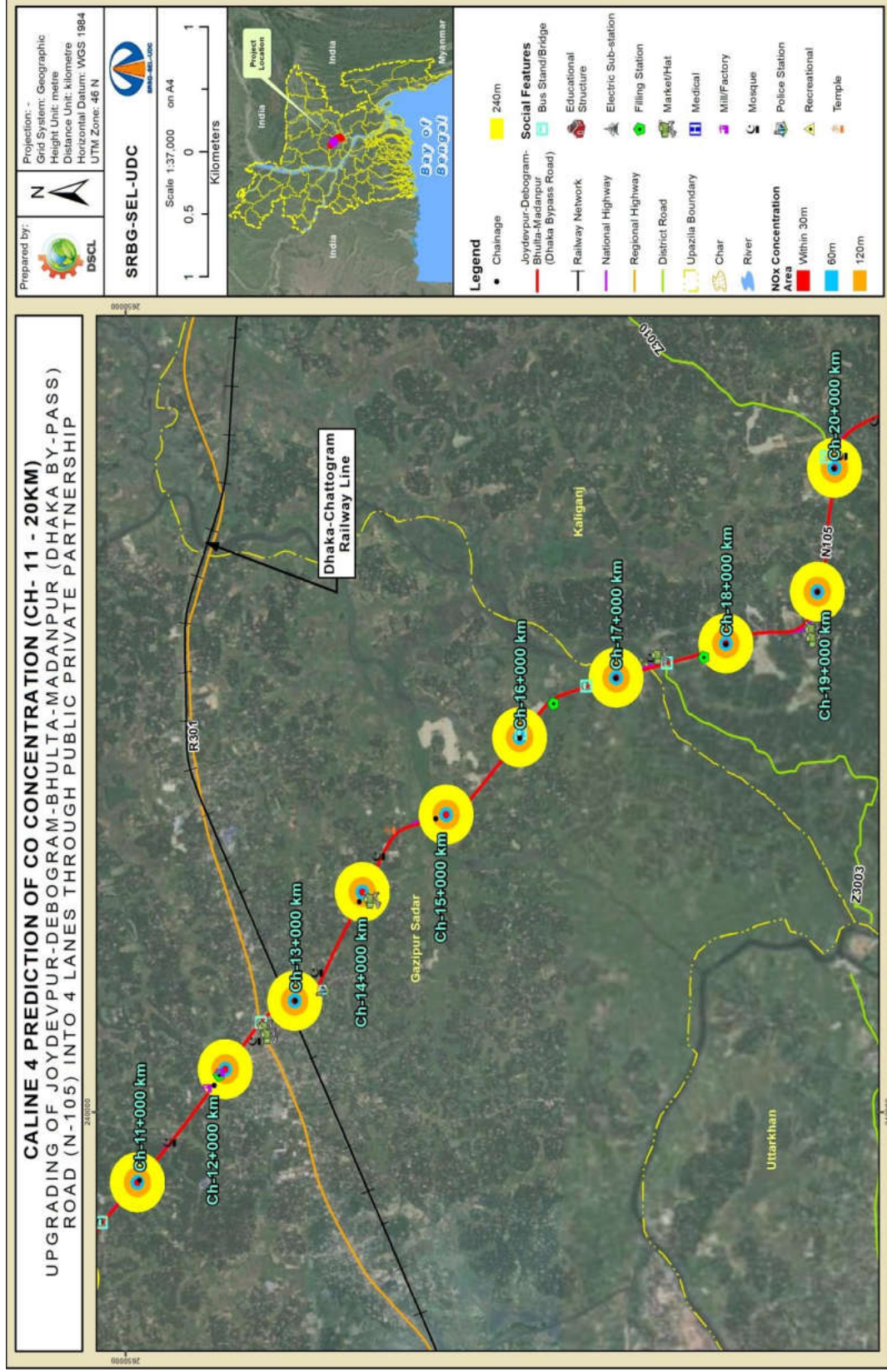


Figure IV.17: CALINE 4 Prediction of CO Concentration (Ch-11 to 20 km)

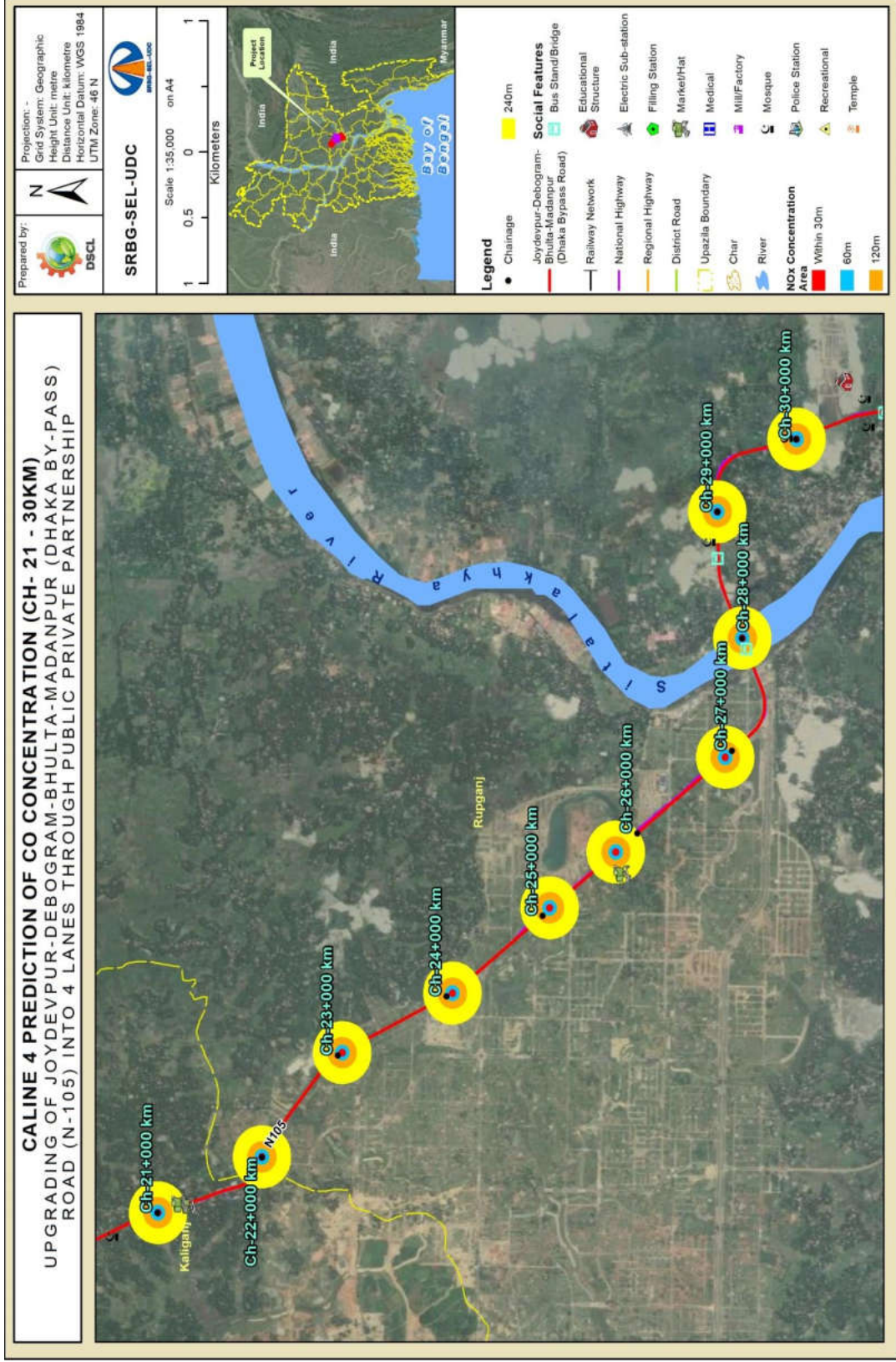


Figure IV.18: CALINE 4 Prediction of CO Concentration (Ch-21 to 30 km)

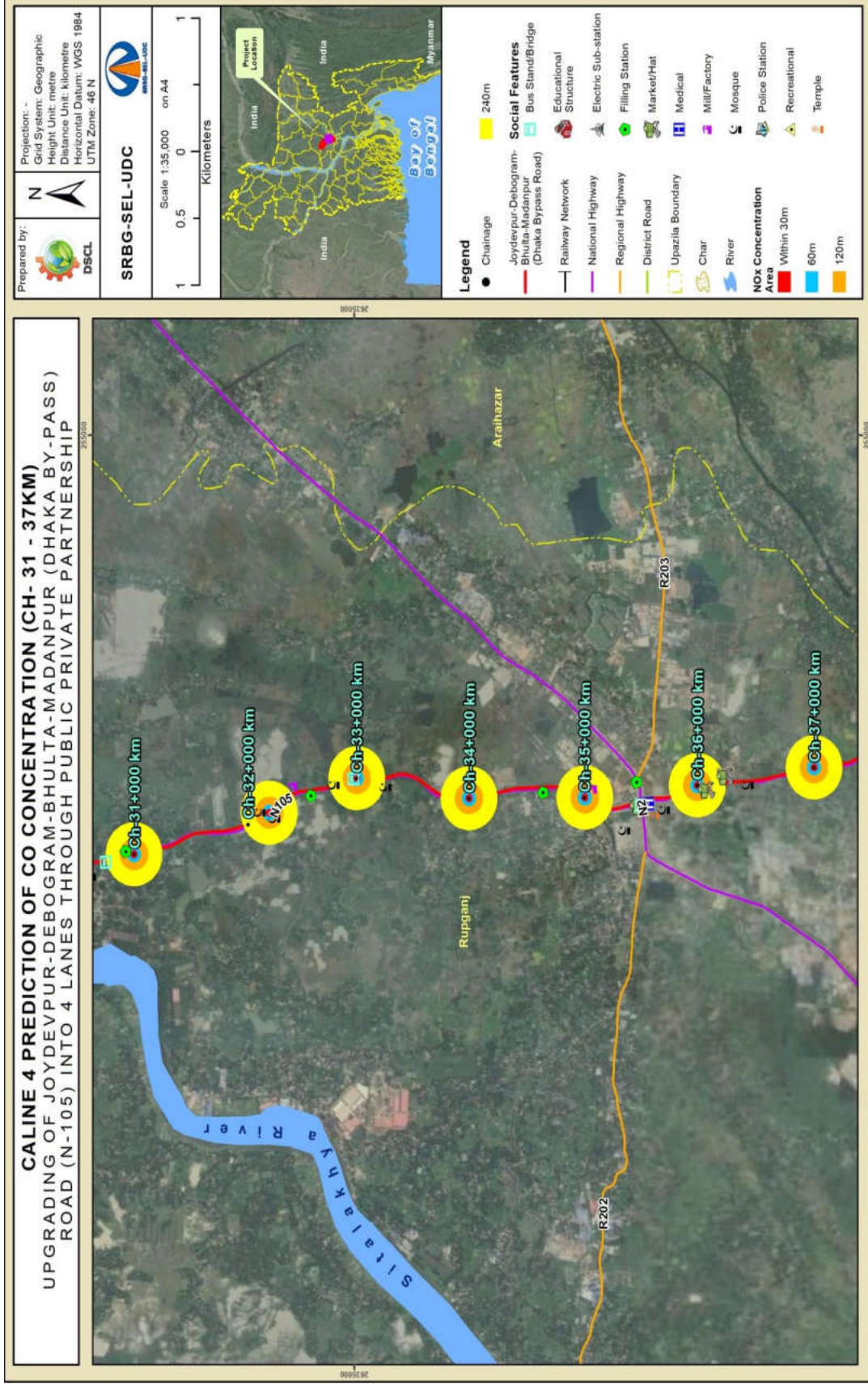


Figure IV.19: CALINE 4 Prediction of CO Concentration (Ch-31 to 37 km)

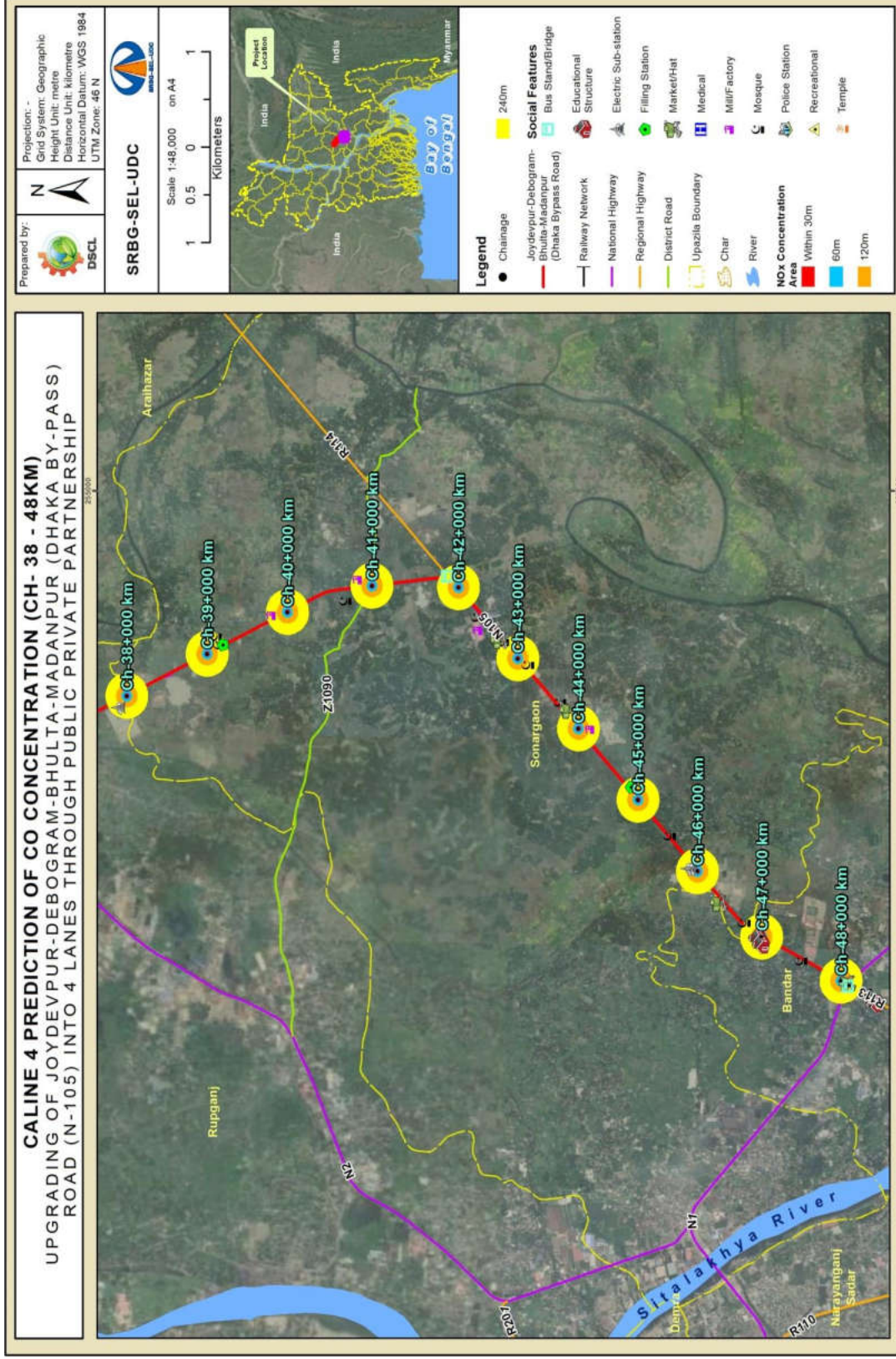


Figure IV.20: CALINE 4 Prediction of CO Concentration (Ch-38 to 48 km)

Table IV.7: CALINE 4 Prediction of CO Concentration (ppm) Based on Baseline (2018) Scenario

SL	Center Line (Road points)		Vehicles/hr	Conc at center (within 30m)	60m	120m	240m
	Lat	long					
1	23°59'22.35"N	90°2'128.64"E	1500	22.863	14.72	8.8601	5.3601
2	23°59'24.45"N	90°2'157.53"E	1524	22.8606	14.7152	8.8577	5.3577
3	23°58'39.19"N	90°2'225.76"E	1523	22.8607	14.7154	8.8578	5.3578
4	23°58'39.58"N	90°2'257.72"E	1573	22.8557	14.7054	8.8528	5.3528
5	23°58'27.85"N	90°2'332.15"E	1578	22.8552	14.7044	8.8523	5.3523
6	23°58'12.27"N	90°2'350.70"E	1537	22.8593	14.7126	8.8564	5.3564
7	23°57'35.50"N	90°2'41.24"E	1588	22.8542	14.7024	8.8513	5.3513
8	23°57'8.14"N	90°2'412.58"E	1489	22.8641	14.7222	8.8612	5.3612
9	23°56'58.95"N	90°2'450.76"E	1563	22.8567	14.7074	8.8538	5.3538
10	23°56'53.83"N	90°2'524.29"E	1632	22.8498	14.6936	8.8469	5.3469
11	23°56'40.53"N	90°2'556.34"E	1638	22.8492	14.6924	8.8463	5.3463
12	23°56'22.39"N	90°2'623.89"E	1633	22.8497	14.6934	8.8468	5.3468
13	23°55'58.00"N	90°2'656.37"E	1785	22.8345	14.663	8.8316	5.3316
14	23°55'38.61"N	90°2'716.10"E	1765	22.8365	14.667	8.8336	5.3336
15	23°55'19.93"N	90°2'747.26"E	1783	22.8347	14.6634	8.8318	5.3318
16	23°54'56.50"N	90°2'89.61"E	1745	22.8385	14.671	8.8356	5.3356
17	23°54'36.00"N	90°2'831.88"E	1756	22.8374	14.6688	8.8345	5.3345
18	23°54'8.89"N	90°2'849.26"E	1744	22.8386	14.6712	8.8357	5.3357
19	23°53'37.89"N	90°2'859.56"E	1743	22.8387	14.6714	8.8358	5.3358
20	23°53'12.16"N	90°2'914.68"E	1766	22.8364	14.6668	8.8335	5.3335
21	23°53'7.87"N	90°2'949.78"E	1812	22.8318	14.6576	8.8289	5.3289
22	23°52'44.04"N	90°3'09.75"E	1834	22.8296	14.6532	8.8267	5.3267
23	23°52'16.56"N	90°3'025.30"E	1822	22.8308	14.6556	8.8279	5.3279
24	23°51'55.63"N	90°3'053.78"E	1832	22.8298	14.6536	8.8269	5.3269
25	23°51'26.50"N	90°3'110.35"E	1832	22.8298	14.6536	8.8269	5.3269
26	23°51'0.97"N	90°3'133.82"E	1855	22.8275	14.649	8.8246	5.3246
27	23°50'43.56"N	90°3'149.16"E	1788	22.8342	14.6624	8.8313	5.3313
28	23°50'14.82"N	90°3'215.22"E	1765	22.8365	14.667	8.8336	5.3336
29	23°50'10.76"N	90°3'247.38"E	1733	22.8397	14.6734	8.8368	5.3368
30	23°50'17.97"N	90°3'321.26"E	1865	22.8265	14.647	8.8236	5.3236
31	23°49'57.16"N	90°3'341.22"E	1863	22.8267	14.6474	8.8238	5.3238
32	23°49'26.11"N	90°3'351.02"E	1855	22.8275	14.649	8.8246	5.3246
33	23°48'49.14"N	90°3'42.70"E	1833	22.8297	14.6534	8.8268	5.3268
34	23°48'25.25"N	90°3'412.28"E	1865	22.8265	14.647	8.8236	5.3236
35	23°47'54.33"N	90°3'47.56"E	1875	22.8255	14.645	8.8226	5.3226
36	23°47'22.54"N	90°3'48.33"E	1865	22.8265	14.647	8.8236	5.3236
37	23°46'51.71"N	90°3'412.16"E	1898	22.8232	14.6404	8.8203	5.3203
38	23°46'19.70"N	90°3'417.47"E	1833	22.8297	14.6534	8.8268	5.3268
39	23°45'49.71"N	90°3'430.01"E	1826	22.8304	14.6548	8.8275	5.3275
40	23°45'20.73"N	90°3'446.08"E	1863	22.8267	14.6474	8.8238	5.3238
41	23°44'51.77"N	90°3'52.11"E	1756	22.8374	14.6688	8.8345	5.3345
42	23°44'21.18"N	90°3'512.38"E	1789	22.8341	14.6622	8.8312	5.3312
43	23°43'49.77"N	90°3'512.41"E	1788	22.8342	14.6624	8.8313	5.3313
44	23°43'27.76"N	90°3'446.51"E	1765	22.8365	14.667	8.8336	5.3336

SL	Center Line (Road points)		Vehicles/hr	Conc at center (within 30m)	60m	120m	240m
	Lat	long					
45	23°43'5.32"N	90°34'20.97"E	1733	22.8397	14.6734	8.8368	5.3368
46	23°42'43.25"N	90°33'55.04"E	1865	22.8265	14.647	8.8236	5.3236
47	23°42'21.20"N	90°33'28.99"E	1863	22.8267	14.6474	8.8238	5.3238
48	23°41'57.49"N	90°33'5.22"E	1855	22.8275	14.649	8.8246	5.3246
49	23°41'28.37"N	90°32'49.46"E	1833	22.8297	14.6534	8.8268	5.3268

Table IV.8: CALINE 4 Prediction of CO Concentration Based on Future (2043) Scenario

SL	Center Line (Road points)		Vehicles/hr	Conc at center (within 30m)	60m	120m	240m
	Lat	long					
1	23°59'22.35"N	90°2'128.64"E	1500	22.263	13.52	8.2601	4.7601
2	23°59'2.45"N	90°2'157.53"E	1524	22.251	13.496	8.2481	4.7481
3	23°58'39.19"N	90°2'225.76"E	1523	22.2515	13.497	8.2486	4.7486
4	23°58'39.58"N	90°2'257.72"E	1573	22.2265	13.447	8.2236	4.7236
5	23°58'27.85"N	90°2'332.15"E	1578	22.224	13.442	8.2211	4.7211
6	23°58'12.27"N	90°2'350.70"E	1537	22.2445	13.483	8.2416	4.7416
7	23°57'35.50"N	90°2'41.24"E	1588	22.219	13.432	8.2161	4.7161
8	23°57'8.14"N	90°2'412.58"E	1489	22.2685	13.531	8.2656	4.7656
9	23°56'58.95"N	90°2'450.76"E	1563	22.2315	13.457	8.2286	4.7286
10	23°56'53.83"N	90°2'524.29"E	1632	22.197	13.388	8.1941	4.6941
11	23°56'40.53"N	90°2'556.34"E	1638	22.194	13.382	8.1911	4.6911
12	23°56'22.39"N	90°2'623.89"E	1633	22.1965	13.387	8.1936	4.6936
13	23°55'58.00"N	90°2'656.37"E	1785	22.1205	13.235	8.1176	4.6176
14	23°55'38.61"N	90°2'716.10"E	1765	22.1305	13.255	8.1276	4.6276
15	23°55'19.93"N	90°2'747.26"E	1783	22.1215	13.237	8.1186	4.6186
16	23°54'56.50"N	90°2'89.61"E	1745	22.1405	13.275	8.1376	4.6376
17	23°54'36.00"N	90°2'831.88"E	1756	22.135	13.264	8.1321	4.6321
18	23°54'8.89"N	90°2'849.26"E	1744	22.141	13.276	8.1381	4.6381
19	23°53'37.89"N	90°2'859.56"E	1743	22.1415	13.277	8.1386	4.6386
20	23°53'12.16"N	90°2'914.68"E	1766	22.13	13.254	8.1271	4.6271
21	23°53'7.87"N	90°2'949.78"E	1812	22.107	13.208	8.1041	4.6041
22	23°52'44.04"N	90°3'09.75"E	1834	22.096	13.186	8.0931	4.5931
23	23°52'16.56"N	90°3'025.30"E	1822	22.102	13.198	8.0991	4.5991
24	23°51'55.63"N	90°3'053.78"E	1832	22.097	13.188	8.0941	4.5941
25	23°51'26.50"N	90°3'110.35"E	1832	22.097	13.188	8.0941	4.5941
26	23°51'0.97"N	90°3'133.82"E	1855	22.0855	13.165	8.0826	4.5826
27	23°50'43.56"N	90°3'149.16"E	1788	22.119	13.232	8.1161	4.6161
28	23°50'14.82"N	90°3'215.22"E	1765	22.1305	13.255	8.1276	4.6276
29	23°50'10.76"N	90°3'247.38"E	1733	22.1465	13.287	8.1436	4.6436
30	23°50'17.97"N	90°3'321.26"E	1865	22.0805	13.155	8.0776	4.5776
31	23°49'57.16"N	90°3'341.22"E	1863	22.0815	13.157	8.0786	4.5786
32	23°49'26.11"N	90°3'351.02"E	1855	22.0855	13.165	8.0826	4.5826
33	23°48'49.14"N	90°3'42.70"E	1833	22.0965	13.187	8.0936	4.5936
34	23°48'25.25"N	90°3'412.28"E	1865	22.0805	13.155	8.0776	4.5776
35	23°47'54.33"N	90°3'47.56"E	1875	22.0755	13.145	8.0726	4.5726
36	23°47'22.54"N	90°3'48.33"E	1865	22.0805	13.155	8.0776	4.5776
37	23°46'51.71"N	90°3'412.16"E	1898	22.064	13.122	8.0611	4.5611

SL	Center Line (Road points)		Vehicles/hr	Conc at center (within 30m)	60m	120m	240m
	Lat	long					
38	23°46'19.70"N	90°34'17.47"E	1833	22.0965	13.187	8.0936	4.5936
39	23°45'49.71"N	90°34'30.01"E	1826	22.1	13.194	8.0971	4.5971
40	23°45'20.73"N	90°34'46.08"E	1863	22.0815	13.157	8.0786	4.5786
41	23°44'51.77"N	90°35'2.11"E	1756	22.135	13.264	8.1321	4.6321
42	23°44'21.18"N	90°35'12.38"E	1789	22.1185	13.231	8.1156	4.6156
43	23°43'49.77"N	90°35'12.41"E	1788	22.119	13.232	8.1161	4.6161
44	23°43'27.76"N	90°34'46.51"E	1765	22.1305	13.255	8.1276	4.6276
45	23°43'5.32"N	90°34'20.97"E	1733	22.1465	13.287	8.1436	4.6436
46	23°42'43.25"N	90°33'55.04"E	1865	22.0805	13.155	8.0776	4.5776
47	23°42'21.20"N	90°33'28.99"E	1863	22.0815	13.157	8.0786	4.5786
48	23°41'57.49"N	90°33'5.22"E	1855	22.0855	13.165	8.0826	4.5826
49	23°41'28.37"N	90°32'49.46"E	1833	22.0965	13.187	8.0936	4.5936

Table IV.9: CALINE 4 Prediction of NOx Concentration (ppm) Based on Baseline (2018) Scenario

SL	Center Line (Road points)		Vehicles/hr	Conc at center (within 30m)	60m	120m	240m
	Lat	long					
1	23°59'22.35"N	90°2'128.64"E	1500	24.863	14.023	10.618	6.1621
2	23°59'2.45"N	90°2'157.53"E	1524	24.8606	13.975	10.6132	6.1597
3	23°58'39.19"N	90°2'225.76"E	1523	24.8607	13.977	10.6134	6.1598
4	23°58'39.58"N	90°2'257.72"E	1573	24.8557	13.877	10.6034	6.1548
5	23°58'27.85"N	90°2'332.15"E	1578	24.8552	13.867	10.6024	6.1543
6	23°58'12.27"N	90°2'350.70"E	1537	24.8593	13.949	10.6106	6.1584
7	23°57'35.50"N	90°2'41.24"E	1588	24.8542	13.847	10.6004	6.1533
8	23°57'8.14"N	90°2'412.58"E	1489	24.8641	14.045	10.6202	6.1632
9	23°56'58.95"N	90°2'450.76"E	1563	24.8567	13.897	10.6054	6.1558
10	23°56'53.83"N	90°2'524.29"E	1632	24.8498	13.759	10.5916	6.1489
11	23°56'40.53"N	90°2'556.34"E	1638	24.8492	13.747	10.5904	6.1483
12	23°56'22.39"N	90°2'623.89"E	1633	24.8497	13.757	10.5914	6.1488
13	23°55'58.00"N	90°2'656.37"E	1785	24.8345	13.453	10.561	6.1336
14	23°55'38.61"N	90°2'716.10"E	1765	24.8365	13.493	10.565	6.1356
15	23°55'19.93"N	90°2'747.26"E	1783	24.8347	13.457	10.5614	6.1338
16	23°54'56.50"N	90°2'89.61"E	1745	24.8385	13.533	10.569	6.1376
17	23°54'36.00"N	90°2'831.88"E	1756	24.8374	13.511	10.5668	6.1365
18	23°54'8.89"N	90°2'849.26"E	1744	24.8386	13.535	10.5692	6.1377
19	23°53'37.89"N	90°2'859.56"E	1743	24.8387	13.537	10.5694	6.1378
20	23°53'12.16"N	90°2'914.68"E	1766	24.8364	13.491	10.5648	6.1355
21	23°53'7.87"N	90°2'949.78"E	1812	24.8318	13.399	10.5556	6.1309
22	23°52'44.04"N	90°3'09.75"E	1834	24.8296	13.355	10.5512	6.1287
23	23°52'16.56"N	90°3'025.30"E	1822	24.8308	13.379	10.5536	6.1299
24	23°51'55.63"N	90°3'053.78"E	1832	24.8298	13.359	10.5516	6.1289
25	23°51'26.50"N	90°3'110.35"E	1832	24.8298	13.359	10.5516	6.1289
26	23°51'0.97"N	90°3'133.82"E	1855	24.8275	13.313	10.547	6.1266
27	23°50'43.56"N	90°3'149.16"E	1788	24.8342	13.447	10.5604	6.1333
28	23°50'14.82"N	90°3'215.22"E	1765	24.8365	13.493	10.565	6.1356
29	23°50'10.76"N	90°3'247.38"E	1733	24.8397	13.557	10.5714	6.1388

SL	Center Line (Road points)		Vehicles/hr	Conc at center (within 30m)	60m	120m	240m
	Lat	long					
30	23°50'17.97"N	90°33'21.26"E	1865	24.8265	13.293	10.545	6.1256
31	23°49'57.16"N	90°33'41.22"E	1863	24.8267	13.297	10.5454	6.1258
32	23°49'26.11"N	90°33'51.02"E	1855	24.8275	13.313	10.547	6.1266
33	23°48'49.14"N	90°34'2.70"E	1833	24.8297	13.357	10.5514	6.1288
34	23°48'25.25"N	90°34'12.28"E	1865	24.8265	13.293	10.545	6.1256
35	23°47'54.33"N	90°34'7.56"E	1875	24.8255	13.273	10.543	6.1246
36	23°47'22.54"N	90°34'8.33"E	1865	24.8265	13.293	10.545	6.1256
37	23°46'51.71"N	90°34'12.16"E	1898	24.8232	13.227	10.5384	6.1223
38	23°46'19.70"N	90°34'17.47"E	1833	24.8297	13.357	10.5514	6.1288
39	23°45'49.71"N	90°34'30.01"E	1826	24.8304	13.371	10.5528	6.1295
40	23°45'20.73"N	90°34'46.08"E	1863	24.8267	13.297	10.5454	6.1258
41	23°44'51.77"N	90°35'2.11"E	1756	24.8374	13.511	10.5668	6.1365
42	23°44'21.18"N	90°35'12.38"E	1789	24.8341	13.445	10.5602	6.1332
43	23°43'49.77"N	90°35'12.41"E	1788	24.8342	13.447	10.5604	6.1333
44	23°43'27.76"N	90°34'46.51"E	1765	24.8365	13.493	10.565	6.1356
45	23°43'5.32"N	90°34'20.97"E	1733	24.8397	13.557	10.5714	6.1388
46	23°42'43.25"N	90°33'55.04"E	1865	24.8265	13.293	10.545	6.1256
47	23°42'21.20"N	90°33'28.99"E	1863	24.8267	13.297	10.5454	6.1258
48	23°41'57.49"N	90°33'5.22"E	1855	24.8275	13.313	10.547	6.1266
49	23°41'28.37"N	90°32'49.46"E	1833	24.8297	13.357	10.5514	6.1288

Table IV.10: CALINE 4 Prediction of NOx Concentration Based on Future (2035) Scenario

SL	Center Line (Road points)		Vehicles/hr	Conc at center (within 30m)	60m	120m	240m
	Lat	long					
1	23°59'22.35"N	90°21'28.64"E	1500	24.263	15.523	9.418	5.5621
2	23°59'2.45"N	90°21'57.53"E	1524	24.251	15.499	9.394	5.5501
3	23°58'39.19"N	90°22'25.76"E	1523	24.2515	15.5	9.395	5.5506
4	23°58'39.58"N	90°22'57.72"E	1573	24.2265	15.45	9.345	5.5256
5	23°58'27.85"N	90°23'32.15"E	1578	24.224	15.445	9.34	5.5231
6	23°58'12.27"N	90°23'50.70"E	1537	24.2445	15.486	9.381	5.5436
7	23°57'35.50"N	90°24'1.24"E	1588	24.219	15.435	9.33	5.5181
8	23°57'8.14"N	90°24'12.58"E	1489	24.2685	15.534	9.429	5.5676
9	23°56'58.95"N	90°24'50.76"E	1563	24.2315	15.46	9.355	5.5306
10	23°56'53.83"N	90°25'24.29"E	1632	24.197	15.391	9.286	5.4961
11	23°56'40.53"N	90°25'56.34"E	1638	24.194	15.385	9.28	5.4931
12	23°56'22.39"N	90°26'23.89"E	1633	24.1965	15.39	9.285	5.4956
13	23°55'58.00"N	90°26'56.37"E	1785	24.1205	15.238	9.133	5.4196
14	23°55'38.61"N	90°27'16.10"E	1765	24.1305	15.258	9.153	5.4296
15	23°55'19.93"N	90°27'47.26"E	1783	24.1215	15.24	9.135	5.4206
16	23°54'56.50"N	90°28'9.61"E	1745	24.1405	15.278	9.173	5.4396
17	23°54'36.00"N	90°28'31.88"E	1756	24.135	15.267	9.162	5.4341
18	23°54'8.89"N	90°28'49.26"E	1744	24.141	15.279	9.174	5.4401
19	23°53'37.89"N	90°28'59.56"E	1743	24.1415	15.28	9.175	5.4406
20	23°53'12.16"N	90°29'14.68"E	1766	24.13	15.257	9.152	5.4291
21	23°53'7.87"N	90°29'49.78"E	1812	24.107	15.211	9.106	5.4061

SL	Center Line (Road points)		Vehicles/hr	Conc at center (within 30m)	60m	120m	240m
	Lat	long					
22	23°52'44.04"N	90°30'9.75"E	1834	24.096	15.189	9.084	5.3951
23	23°52'16.56"N	90°30'25.30"E	1822	24.102	15.201	9.096	5.4011
24	23°51'55.63"N	90°30'53.78"E	1832	24.097	15.191	9.086	5.3961
25	23°51'26.50"N	90°31'10.35"E	1832	24.097	15.191	9.086	5.3961
26	23°51'0.97"N	90°31'33.82"E	1855	24.0855	15.168	9.063	5.3846
27	23°50'43.56"N	90°31'49.16"E	1788	24.119	15.235	9.13	5.4181
28	23°50'14.82"N	90°32'15.22"E	1765	24.1305	15.258	9.153	5.4296
29	23°50'10.76"N	90°32'47.38"E	1733	24.1465	15.29	9.185	5.4456
30	23°50'17.97"N	90°33'21.26"E	1865	24.0805	15.158	9.053	5.3796
31	23°49'57.16"N	90°33'41.22"E	1863	24.0815	15.16	9.055	5.3806
32	23°49'26.11"N	90°33'51.02"E	1855	24.0855	15.168	9.063	5.3846
33	23°48'49.14"N	90°34'2.70"E	1833	24.0965	15.19	9.085	5.3956
34	23°48'25.25"N	90°34'12.28"E	1865	24.0805	15.158	9.053	5.3796
35	23°47'54.33"N	90°34'7.56"E	1875	24.0755	15.148	9.043	5.3746
36	23°47'22.54"N	90°34'8.33"E	1865	24.0805	15.158	9.053	5.3796
37	23°46'51.71"N	90°34'12.16"E	1898	24.064	15.125	9.02	5.3631
38	23°46'19.70"N	90°34'17.47"E	1833	24.0965	15.19	9.085	5.3956
39	23°45'49.71"N	90°34'30.01"E	1826	24.1	15.197	9.092	5.3991
40	23°45'20.73"N	90°34'46.08"E	1863	24.0815	15.16	9.055	5.3806
41	23°44'51.77"N	90°35'2.11"E	1756	24.135	15.267	9.162	5.4341
42	23°44'21.18"N	90°35'12.38"E	1789	24.1185	15.234	9.129	5.4176
43	23°43'49.77"N	90°35'12.41"E	1788	24.119	15.235	9.13	5.4181
44	23°43'27.76"N	90°34'46.51"E	1765	24.1305	15.258	9.153	5.4296
45	23°43'5.32"N	90°34'20.97"E	1733	24.1465	15.29	9.185	5.4456
46	23°42'43.25"N	90°33'55.04"E	1865	24.0805	15.158	9.053	5.3796
47	23°42'21.20"N	90°33'28.99"E	1863	24.0815	15.16	9.055	5.3806
48	23°41'57.49"N	90°33'5.22"E	1855	24.0855	15.168	9.063	5.3846
49	23°41'28.37"N	90°32'49.46"E	1833	24.0965	15.19	9.085	5.3956

2. Noise Level

247. The noise level of the surroundings of the project area is insignificant. However, there is negligible sound pollution from the traffic movement on the nearby road. Noise level has been monitored at five locations along the project road during day and night time (Figure IV.21). Results of the noise level monitored along with details of the sampling locations have been showed in Table IV.11. The results show that time weighted average value of the sound monitored at five different locations of the project influence area exceed the standard fixed for all of the location for day time. But in night time the value was in national standard for most of the locations except Purbachal Interchange and Madanpur Bus Terminal Area.



Figure IV.21: Noise Level Measurement in the Project Area

Table IV.11: Results of Noise Level Measurement

Location	GPS Location	Land Use Category	Time		Noise Level dBA (L _{Aeq})		Bangladesh Standard (dBA)	
			Day	Night	Day	Night	Day	Night
Bhogra Bypass, Mogorkhala, Gazipur	23.97753°N; 90.38335°E	Commercial	10:36	20.05	71.33	45.79	70	60
Mirer Bazar, Pubail, Gazipur	23.92902°N; 90.45354°E		15:24	20.58	72.56	49.44		
Purbachal Interchange, Dhaka	23.834866°N; 90.538945°E		17:39	21.45	72.33	61.45		
Bhulta Mor, Narayanganj	23.78840°N; 90.56852°E		10:54	22.50	73.45	58.89		
Chandpur, Madanpur	23.69226°N; 90.54775°E		13:16	23.58	73.39	64.78		

Notes:

- Land use category is based on the classification provided in the Noise Pollution Control Rules (2006)
- Shaded cells indicate noise levels in excess of Noise Pollution Control Rules ambient noise limits for a given land use area
- The sound level standard for commercial area at day and night time is 70 dBA & 60 dBA respectively.
- Noise Level is the average noise recorded over the duration of the monitoring period

Source: DSCL, 2019

a) TNM model and its Applicability in the Current Project

248. The proposed project will upgrade the existing two-way road to four-way road. This will generate additional traffic and consequently alter the noise environment along the route of the roadway. We used the FHWA Traffic Noise Model popularly known as TNM (version 2.5) software for noise pollution modeling for the assessment of the noise pollution propagation generated from traffic. The TNM Software allows us to create robust and useful numeric simulations. TNM combines these full-throttle noise emission levels with its internal speed computations to account for the full effect (noise emissions plus speed) of roadway grades and traffic-control devices. TNM computes the effect of intervening ground (defined by its type, or optionally by its flow resistivity) with theory-based acoustics that have been calibrated against field measurements. In addition, TNM allows sound to propagate underneath selected intervening roadways and barriers, rather than being shielded by them.

249. TNM computes three measures of highway traffic noise:

- L_{Aeq1h} : hourly A-weighted equivalent sound level (1HEQ);

- L_{dn} : day-night average sound level (DNL); and
- L_{den} : Community Noise Equivalent Level (CNEL), where "den" stands for day/evening/night.

250. The TNM model was used in this project in combination with GIS application software to graphically represent modelling results.

Basic Data and Assumptions

251. Noise emission from vehicles along the route is modelled as steady-state line source. Such modelling needs traffic projection for next few planning years. Unfortunately, there is no traffic projection study available for this project. However, according to a recent study (Ullah et al. 2015)¹ annual growth rate of traffic volume in major three highways of Bangladesh is about 20%. Given the annual growth rate, for this modelling exercise, projections were prepared for the year 2035 and 2045 based on the baseline scenario of 2018 derived from DSCL survey data at five major intersections of the proposed road. The major intersections and traffic counts are given in Table IV.12 below.

Table IV.12 Surveyed Sections of The Road and Traffic Volume Counts

Location	GPS Location	Day time (avg. nos)					Nighttime (avg nos.)				
		Auto	Medium Truck	Heavy Truck	Buses	Motorcycle	Auto	Medium Truck	Heavy Truck	Buses	Motorcycle
Bhogra Bypass, Mogorkhala, Gazipur	23.97753°N; 90.38335°E	500	200	150	250	1250	250	350	350	150	50
Mirer Bazar, Pubail, Gazipur	23.92902°N; 90.45354°E	480	200	100	350	1250	105	306	300	120	40
Purbachal Interchange, Dhaka	23.834866°N; 90.538945°E	550	200	170	250	1200	102	301	208	110	30
Bhulta Mor, Narayanganj	23.78840°N; 90.56852°E	570	108	200	320	1220	80	300	290	150	30
Chandpur, Madanpur	23.69226°N; 90.54775°E	600	109	300	350	1500	90	300	500	170	50

Model setup

252. In the TNM, the reference level is the Vehicle Noise Emission Level, which refers to the maximum sound level emitted by a vehicle pass-by at a reference distance of 15 meters (50 feet). Adjustments are then made to the emission level to account for traffic flow, distance, and shielding.

These factors are related by the following equation:

$$L_{Aeq1h} = EL_i + A_{traff(i)} + A_d + A_s \tag{1}$$

where EL_i represents the vehicle noise emission level for the i-th vehicle type,

$A_{traff(i)}$ represents the adjustment for traffic flow, the vehicle volume and speed for the i-th vehicle type,

A_d represents the adjustment for distance between the roadway and receiver and for the length of the roadway, and

A_s represents the adjustment for all shielding and ground effects between the roadway and the receiver.

¹Ullah MA, Nikraz H. and Hoque MH 2015. Comparison of Traffic Growth Factors in Three Major Highways of Bangladesh: A Case Study. *Journal of Traffic and Transportation Engineering* 3 (2015) 111-117.

TNM requires a generic environment setup. In this generic environment the following parameters were considered:

- Temperature: 30°C
- Humidity: 65%
- Road width: 24m
- Building Blocks: Identified from google earth imagery
- Tree and terrain zone: identified from google earth imagery
- Pavement: Average (default by TNM)

The setup environment is shown in Figure IV.22. The output environment is presented in Figure IV.23.

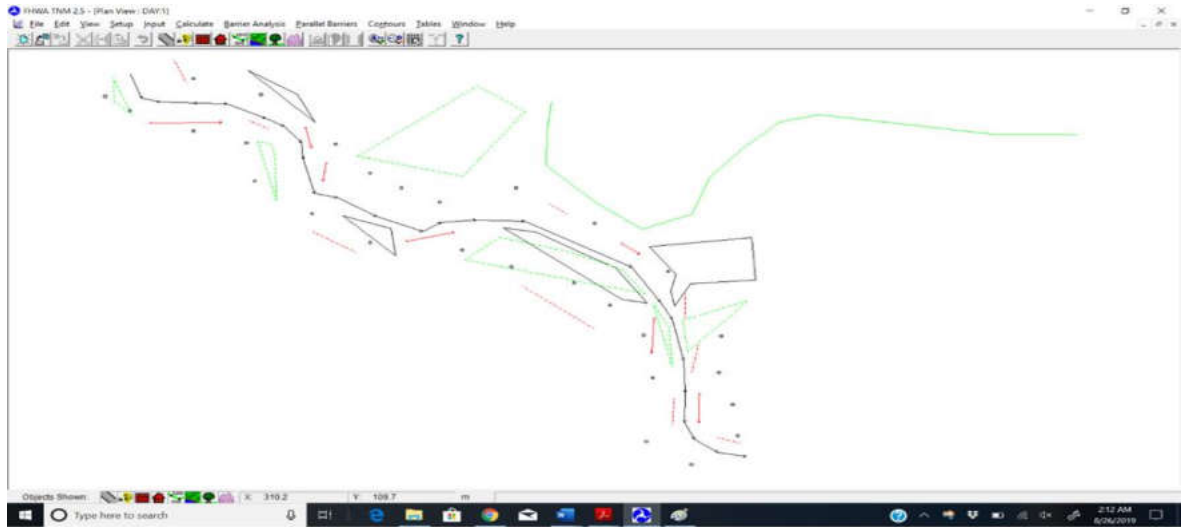


Figure IV.22: Setup environment of the TNM for this project

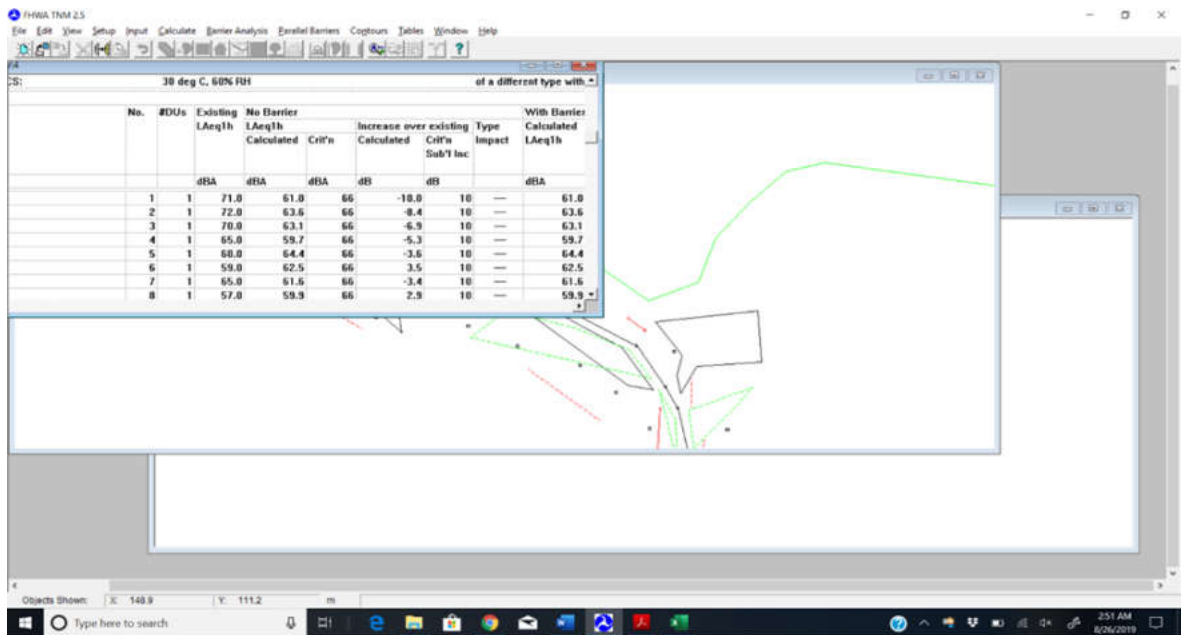


Figure IV.23: Result Output of TNM

Results

253. Figure III.1 shows the location setting of the proposed project. Figure IV.24 to IV.28 shows the sensitive receptors identified during field study. 28 of these sensitive receptors were randomly chosen and used in the modelling exercise and results are given in Table IV.13 to IV.15.

254. Since the TNM predicts 8 sensitive receptors that might be substantially impacted by the year 2045, the barrier analysis was done which proposes a 2.6m high noise barrier at the designated chainages. A further detail analysis during design may tell exact place and length of the barrier to place.

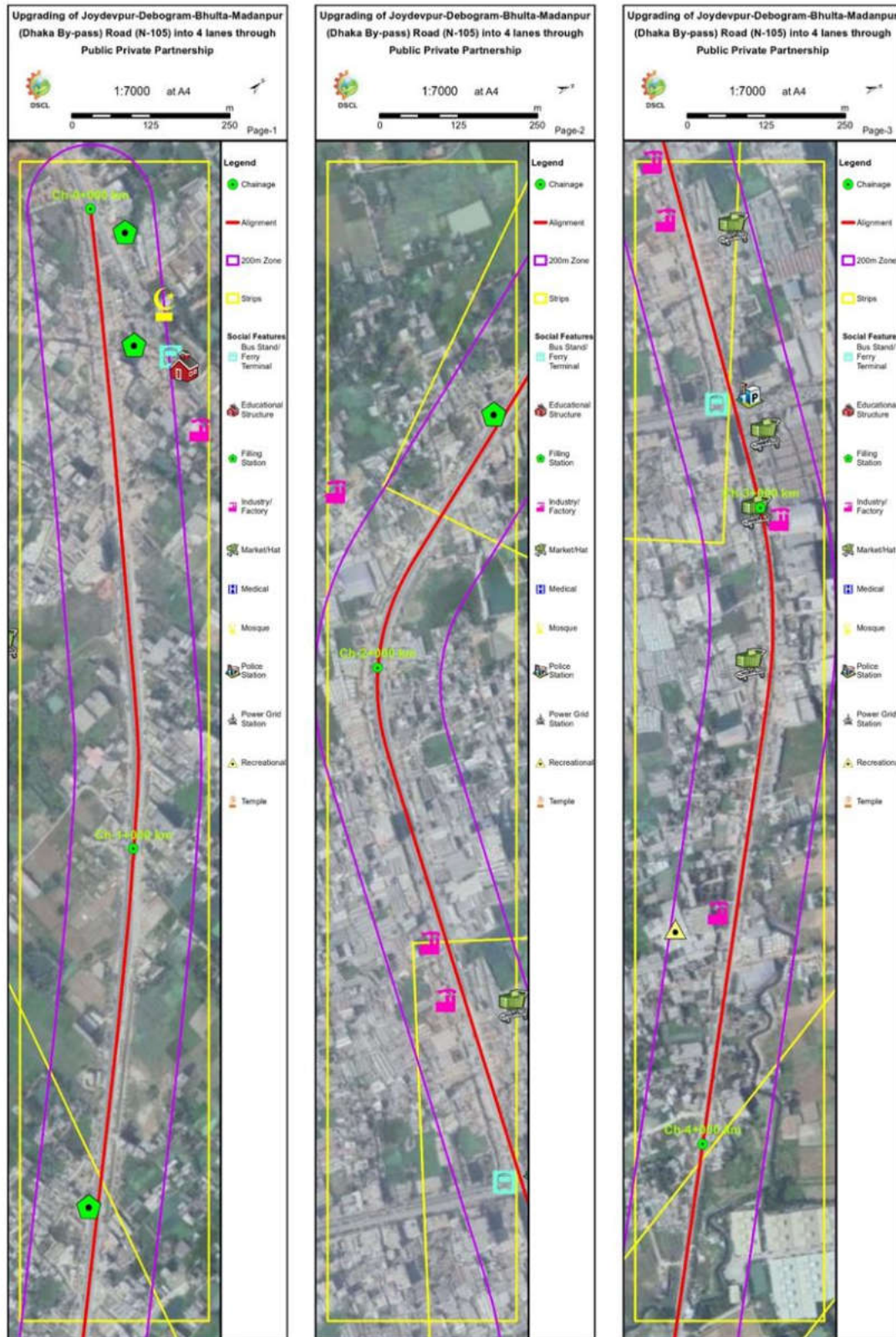


Figure IV.24: Sensitive Receptors at First Segment

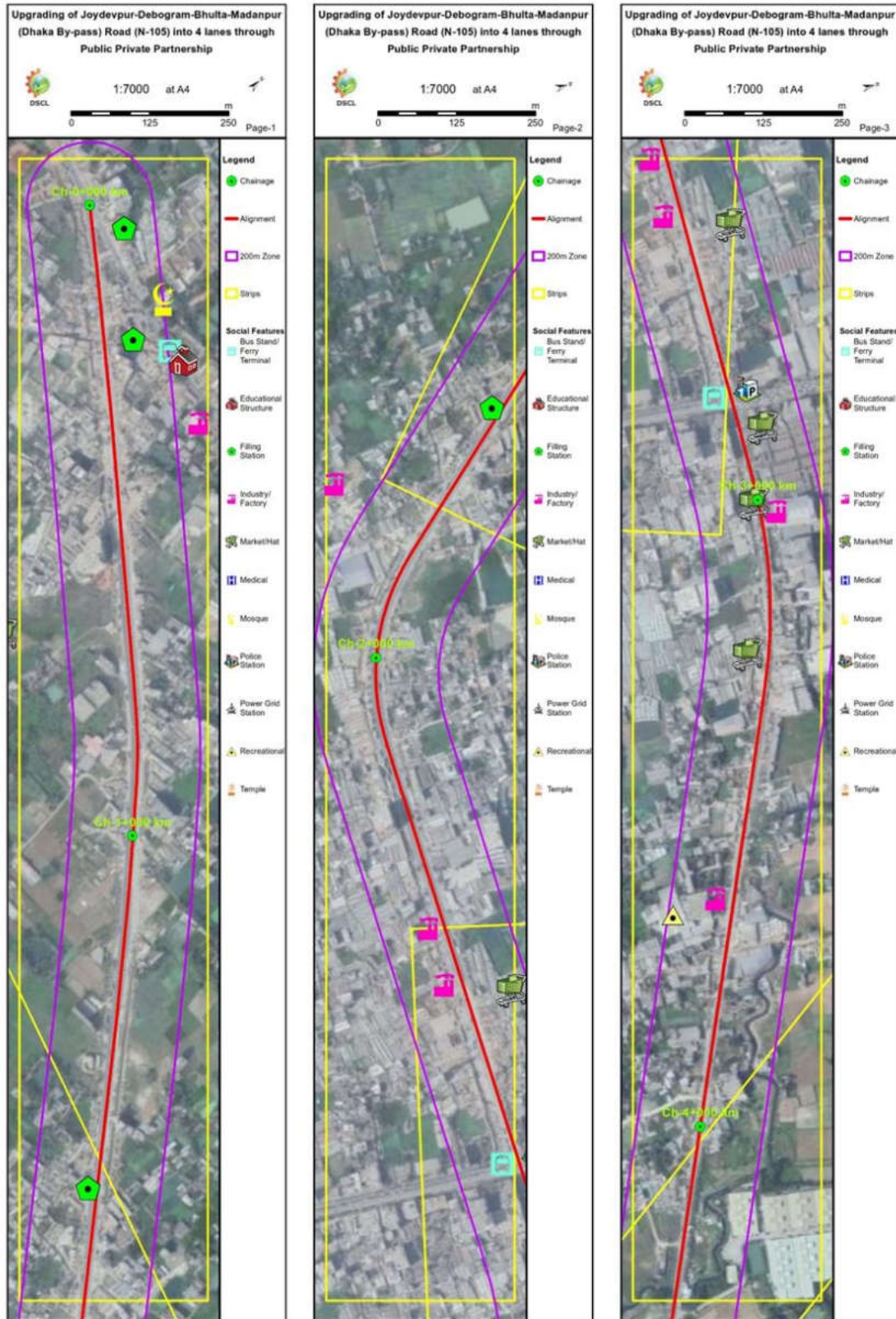


Figure IV.25: Sensitive Receptors at Second Segment

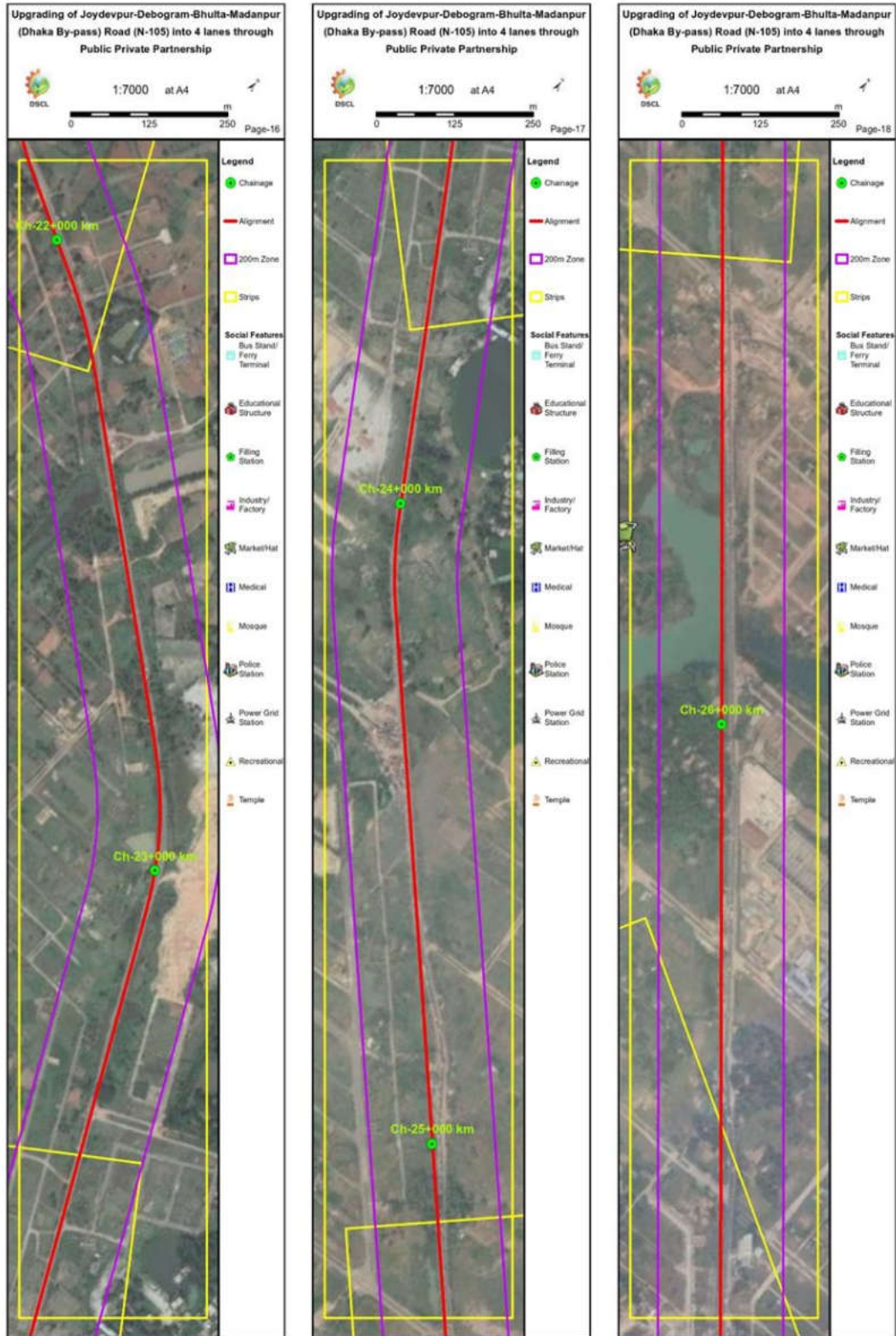


Figure IV.26: Sensitive Receptors at Third Segment

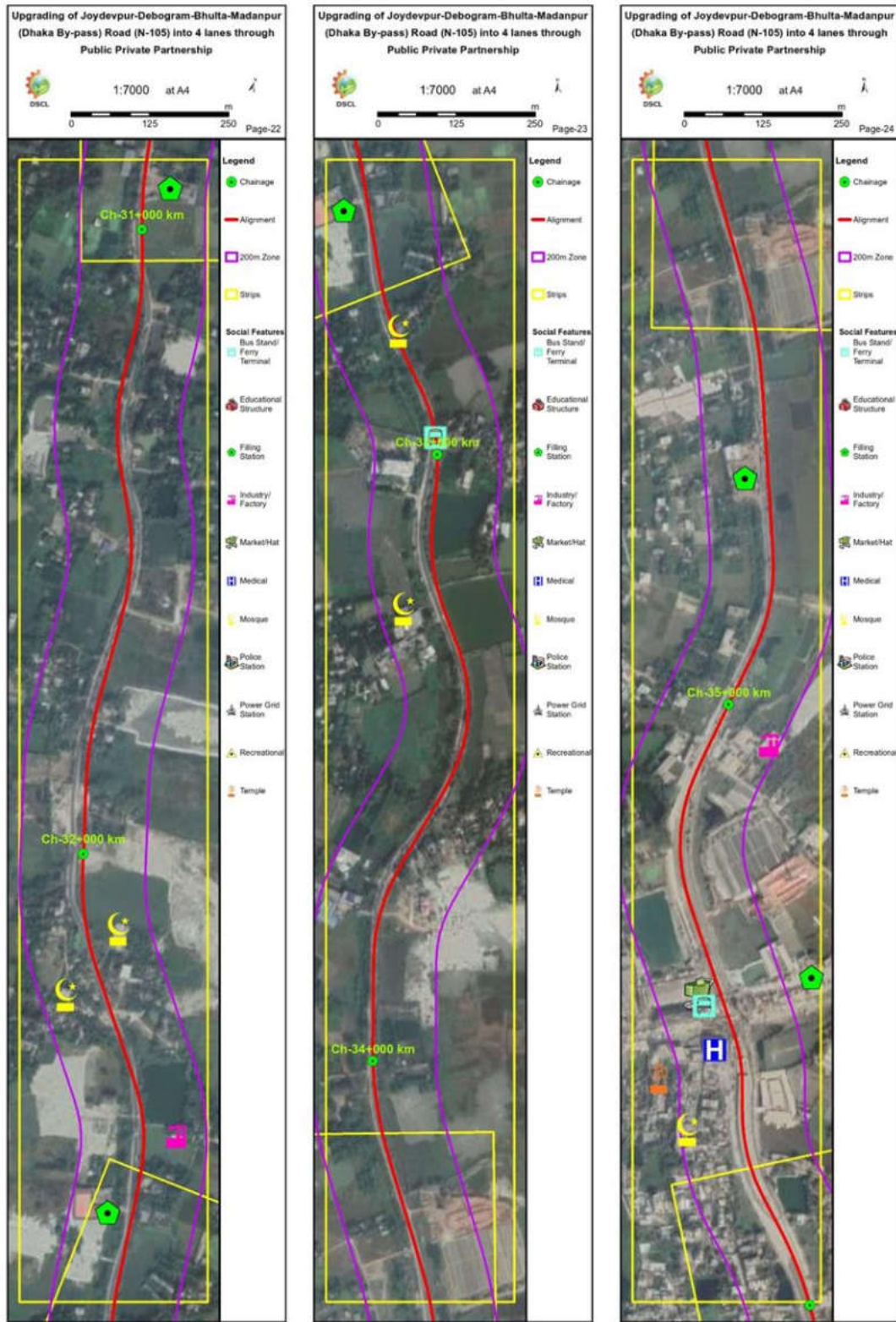


Figure IV.27: Sensitive Receptors at Fourth Segment

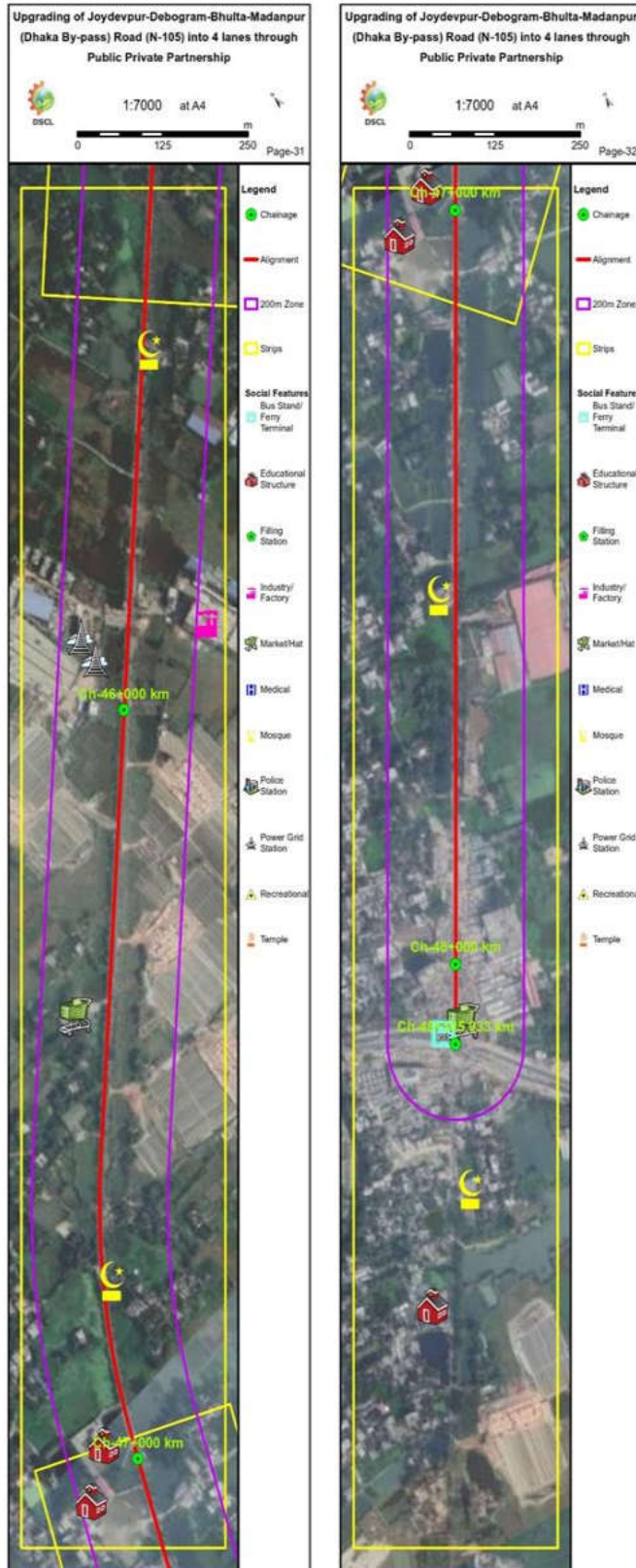


Figure IV.28: Sensitive Receptors at Fifth Segment

Table IV.13: Modelling Results of Baseline Scenario (2018) of Daytime Noise Prediction

Receiver name	No.	Dwelling unit	Existing L _{Aeq1h}	No barrier				Type Impact	With barrier
				L _{Aeq1h}		Increase over existing			
				Calculated L _{Aeq1h}	Critical value	Calculated L _{Aeq1h}	Critical value		
Sch 01	1	1	71	61	66	-10	10	Nominal	No barrier considered
Baz 01	2	1	72	63.6	66	-8.4	10	Nominal	
Mad 01	3	1	70	63.1	66	-6.9	10	Nominal	
Res 01	4	1	65	59.7	66	-5.3	10	Nominal	
Res 02	5	1	68	64.4	66	-3.6	10	Nominal	
Res 03	6	1	59	62.5	66	3.5	10	Nominal	
Mad 02	7	1	65	61.6	66	-3.4	10	Nominal	
Baz 02	8	1	57	59.9	66	2.9	10	Nominal	
Baz 03	9	1	65	61.6	66	-3.4	10	Nominal	
Sch 02	10	1	70	63.9	66	-6.1	10	Nominal	
Res 04	11	4	53	62.2	66	9.2	10	Nominal	
Res 05	12	2	56	63	66	7	10	Nominal	
Res 06	13	5	57	64.2	66	7.2	10	Nominal	
Res 07	14	6	64	61.5	66	-2.5	10	Nominal	
Res 08	15	5	56	61.4	66	5.4	10	Nominal	
Res 09	16	8	57	59.5	66	2.5	10	Nominal	
Res 10	17	2	55	63.4	66	8.4	10	Nominal	
Res 11	18	6	64	60.8	66	-3.2	10	Nominal	
Res 12	19	4	52	64	66	12	10	Substantial	
Sch 03	20	1	53	61.6	66	8.6	10	Nominal	
Res 13	21	4	57	60.8	66	3.8	10	Nominal	
Res 14	22	8	63	60.9	66	-2.1	10	Nominal	
Res 15	23	9	57	61.9	66	4.9	10	Nominal	
Res 16	24	2	59	63.1	66	4.1	10	Nominal	
Res 17	25	4	67	59.9	66	-7.1	10	Nominal	
Res 18	26	3	53	59.1	66	6.1	10	Nominal	
Res 19	27	1	54	62.2	66	8.2	10	Nominal	
Res 20	28	1	55	62.6	66	7.6	10	Nominal	

Note: Temperature was set to 30oC with 60%RH. Receivers were taken randomly from alignment. Receiver types indicated in the table are: SCH = School; RES = Residence; BAZ = Bazar; MAD = Madrasa

Table IV.14: Modelling Results of 2035 Scenario of Daytime Noise Prediction

Receiver name	No.	Dwelling unit	Existing L _{Aeq1h}	No barrier				Type Impact	With barrier
				L _{Aeq1h}		Increase over existing			
				Calculated L _{Aeq1h}	Critical value	Calculated L _{Aeq1h}	Critical value		
Sch 01	1	1	71	65.8	66	-5.2	10		No barrier considered
Baz 01	2	1	72	68.4	66	-3.6	10		
Mad 01	3	1	70	67.9	66	-2.1	10		
Res 01	4	1	65	64.6	66	-0.4	10		
Res 02	5	1	68	69.1	66	1.1	10		
Res 03	6	1	59	67.2	66	8.2	10	Substantial	
Mad 02	7	1	65	66.4	66	1.4	10		
Baz 02	8	1	57	64.9	66	7.9	10		
Baz 03	9	1	65	66.5	66	1.5	10		
Sch 02	10	1	70	68.7	66	-1.3	10		
Res 04	11	4	53	67.1	66	14.1	10	Substantial	
Res 05	12	2	56	67.9	66	11.9	10	Substantial	
Res 06	13	5	57	69.2	66	12.2	10	Substantial	
Res 07	14	6	64	66.4	66	2.4	10		
Res 08	15	5	56	66.3	66	10.3	10	Substantial	
Res 09	16	8	57	64.4	66	7.4	10		
Res 10	17	2	55	68.2	66	13.2	10	Substantial	
Res 11	18	6	64	65.5	66	1.5	10		
Res 12	19	4	52	68.7	66	16.7	10	Substantial	
Sch 03	20	1	53	66.2	66	13.2	10	Substantial	
Res 13	21	4	57	65.5	66	8.5	10		
Res 14	22	8	63	65.7	66	2.7	10		
Res 15	23	9	57	66.8	66	9.8	10		

Receiver name	No.	Dwelling unit	Existing L _{Aeq1h}	No barrier				Type Impact	With barrier
				L _{Aeq1h}		Increase over existing			
				Calculated L _{Aeq1h}	Critical value	Calculated L _{Aeq1h}	Critical value		
Res 16	24	2	59	67.7	66	8.7	10		
Res 17	25	4	67	64.9	66	-2.1	10		
Res 18	26	3	53	64	66	11	10		
Res 19	27	1	54	67.7	66	13.7	10		
Res 20	28	1	55	67.7	66	12.7	10		

Note: Temperature was set to 30oC with 60%RH. Receivers were taken randomly from alignment. Receiver types indicated in the table are: SCH = School; RES = Residence; BAZ = Bazar; MAD = Madrasa. 08 Substantial impact zones were found.

Table IV.15: Modelling Results of 2045 Scenario of Daytime Noise Prediction

Receiver name	No.	Dwelling unit	Existing L _{Aeq1h}	No barrier				Type Impact	With barrier
				L _{Aeq1h}		Increase over existing			
				Calculated L _{Aeq1h}	Critical value	Calculated L _{Aeq1h}	Critical value		
Sch 01	1	1	71	66.3	66	-4.7	10		No barrier considered
Baz 01	2	1	72	68.9	66	-3.1	10		
Mad 01	3	1	70	68.4	66	-1.6	10		
Res 01	4	1	65	65	66	0	10		
Res 02	5	1	68	69.6	66	1.6	10		
Res 03	6	1	59	67.7	66	8.7	10	Substantial	
Mad 02	7	1	65	66.9	66	1.9	10		
Baz 02	8	1	57	65.4	66	8.4	10		
Baz 03	9	1	65	67	66	2	10		
Sch 02	10	1	70	69.2	66	-0.8	10		
Res 04	11	4	53	67.6	66	14.6	10	Substantial	
Res 05	12	2	56	68.4	66	12.4	10	Substantial	
Res 06	13	5	57	69.7	66	12.7	10	Substantial	
Res 07	14	6	64	66.8	66	2.8	10		
Res 08	15	5	56	66.8	66	10.8	10	Substantial	
Res 09	16	8	57	64.9	66	7.9	10		
Res 10	17	2	55	68.7	66	13.7	10	Substantial	
Res 11	18	6	64	66	66	2	10		
Res 12	19	4	52	69.2	66	17.2	10	Substantial	
Sch 03	20	1	53	66.7	66	13.7	10	Substantial	
Res 13	21	4	57	66	66	9	10		
Res 14	22	8	63	66.2	66	3.2	10		
Res 15	23	9	57	67.3	66	10.3	10		
Res 16	24	2	59	68.2	66	9.2	10		
Res 17	25	4	67	65.4	66	-1.6	10		
Res 18	26	3	53	64.5	66	11.5	10		
Res 19	27	1	54	68.2	66	14.2	10		
Res 20	28	1	55	68.2	66	13.2	10		

Note: Temperature was set to 30oC with 60%RH. Receivers were taken randomly from alignment. Receiver types indicated in the table are: SCH = School; RES = Residence; BAZ = Bazar; MAD = Madrasa. 08 Substantial impact zones were found.

Table IV.16: Modelling Results of 2045 Scenario of Daytime Noise Prediction

No.	Chainage	Type of receptor	Proposed height of the barrier	Proposed Length (m)	Proposed height of the barrier, (m) material and density
01	0+12km	Residence	2.6	100	2.6, Aluminum sheet, 1.59mm
02	0+22km	Residence	2.6	100	2.6, Aluminum sheet, 1.59mm
03	0+24km	Residence	2.6	100	2.6, Aluminum sheet, 1.59mm
04	0+26km	Residence	2.6	100	2.6, Aluminum sheet, 1.59mm
05	0+30km	Residence	2.6	100	2.6, Aluminum sheet, 1.59mm
06	0+34km	Residence	2.6	100	2.6, Aluminum sheet, 1.59mm
07	0+38km	Residence	2.6	100	2.6, Aluminum sheet, 1.59mm
08	0+40km	School	2.6	150	2.6, Aluminum sheet, 1.59mm

3. Vibration Level

255. The vibration level of the surroundings of the project area is insignificant. However, there is negligible vibration level from the traffic movement on the nearby road. Noise level has been monitored at five locations (same as noise) along the project road during day time (Figure IV.29). Results of the vibration level monitored along with details of the sampling locations have been showed in Table IV.16. The result shows that the maximum velocity was 42.57 m/s in Mirer Bazar and minimum velocity was 0.05 m/s in for Bhulta Mor and Purbachal Interchange. Maximum acceleration occurred in Purbachal which was 12.9 m/s². Minimum acceleration was mostly 0.1 m/s² for most of the location. Maximum displacement occurred in Purbachal and the value was 0.052 mm while the minimum acceleration was 0 for most of the location.



Figure IV.29: Vibration Level Measurement in the Project Area

Table IV.17: Results of Vibration Level Measurement

Sample ID	Location	Velocity (mm/s)			Acceleration (m/s ²)			Displacement (mm)					
		Max.	Min.	Standard Deviation	Mean Value	Max.	Min.	Standard Deviation	Max.	Min.	Standard Deviation	Mean Value	
DBR_VB_01	Bhogra Bypass, Mogorkhala, Gazipur	26.77	1.21	10.299	9.235	8.3	0.1	2.862	2.367	0.039	0	0.005	0.007
DBR_VB_02	Mirer Bazar, Pubail, Gazipur	42.57	0.31	18.794	16.170	7.6	0.1	3.099	2.325	0.011	0	0.002	0.002
DBR_VB_03	Purbachal Interchange, Dhaka	0.71	0.05	0.259	0.270	12.9	0	3.134	6.438	0.012	0	0.005	0.002
DBR_VB_04	Bhulta Mor	3.51	0.05	1.236	1.130	19.7	1.9	7.285	10.433	0.030	0	0.007	0.007
DBR_VB_05	Chandpur, Madanpur	28.83	0.47	9.999	8.205	0.1	0.1	0	0.1000	0.011	0.004	0.003	0.009

Source: DSCL, 2019

4. Groundwater Quality

256. The groundwater quality parameters, measured in the project area during the field survey (Figure IV.30), were found to comply with the drinking water quality standards set by DOE. The groundwater samples were collected near from selected locations where several numbers of worker will be deployed due to heavy construction activities. The reason of the selection was to compare the existing water quality with national standard and to ensure good potable water for the workers during construction period. The collected samples were submitted to Department of Public Health and Engineering (DPHE) for further parameters analysis. The groundwater quality of the area is presented in Table IV. 17.



Figure IV.30: Sampling and Onsite Test of Groundwater Quality in the Project Area

Table IV.18: Test Results of Groundwater Analysis

Parameters	Unit	Concentration Present		Standards for Potable water**	Analysis Method
		Mirer Bazar, Pubali, Gazi pur	Bhulta Mor Near Bypass, Narayanganj		
		DBR_GW_01	DBR_GW_02		
		23.92902°N; 90.45329°E	23.78904°N; 90.56419°E		
pH*	-	7.53	7.54	6.5-8.5	Multimeter
Total Dissolved Solids (TDS)*	mg/L	279	333	1000	Multimeter
ORP*	mg/L	44.0	36.2	NYS	Multimeter
Electric Conductivity (EC)*	µs/cm	422	506	NYS	Multimeter
Temperature*	°C	28.9	29.8	20-30	Multimeter
Dissolve Oxygen	mg/L	1.2	1.1	5 or Less	DO Meter
Chloride	mg/L	15	12	150-600	Titrimetric
Arsenic	mg/L	0.001	0.002	0.05	AAS
Iron	mg/L	0.49	0.38	0.3-1	AAS
Manganese	mg/L	0.05	0.03	0.1	AAS
Lead	mg/L	0.003	0.001	0.05	AAS

Note:

*On-site Test Result

**Standards for Groundwater is followed Environmental Conservation Rule (ECR)'97

NYS- Not Yet Standardized

Source: DSCL & DPHE, 2019

5. Surface Water Quality

257. The surface water quality assessment in the project influence area has been carried out for the most important parameters. The sampling was undertaken from the road side water bodies (Turag River and Shitalakshya River) during the field survey and the detailed analyses are incorporated with the standard values set by the DoE are shown in Table IV.18. The surface water samples were collected and submitted to Department of Public Health and Engineering (DPHE) and DU Laboratories for further parameters analysis.



Figure IV.31: Sampling and Onsite Test of Surface Water Quality in the Project Area

Table IV.19: Test Results of Surface Water Analysis

Parameters	Unit	Concentration Present		Standards for Inland Surface water**	Analysis Method
		Turag River, Ulukhola Bridge	Shitalakshya River, Kanchan Bridge		
		DBR_SW_01 23.90060°N; 90.48111°E	DBR_SW_02 23.83619°N; 90.54707°E		
pH*	-	9.27	8.02	6.5-8.5	Multimeter
Total Dissolved Solids (TDS)*	mg/L	2203	1997	NYS	Multimeter
ORP*	mg/L	23.7	49.5	NYS	Multimeter
Electric Conductivity (EC)*	µs/cm	307	145.5	NYS	Multimeter
Temperature*	°C	28.5	30	20-30	Multimeter
Dissolve Oxygen*	mg/L	1.8	4.9	6 or more	DO Meter
Total Suspended Solids (TSS)	mg/L	24	20	NYS	Gravity Multimeter
Biochemical Oxygen Demand (BOD)	mg/L	19	17	6 or less	5 days incubation
Turbidity	NTU	143	78	NYS	Turbidity Meter
Chemical Oxygen Demand (COD)	mg/L	68	56	NYS	CRM
Oil and Grease	mg/L	Less than 5	Less than 5	NYS	5520.B

Note:

*On-site Test Result

**Standards for Inland Surface Water is followed Environmental Conservation Rule (ECR)'97

NYS- Not Yet Standardized

Source: DSCL & DPHE, 2019

258. The surface water quality standard is yet not developed in the ECR 1997 except for few parameters. Among the tested parameters the pH value at Turag River exceeded the national standard. Additionally, the DO and BOD values for all the tested locations were below the standard value set by ECR 1997.

6. Soil Quality

259. The quality of the local soil was identified to characterize the baseline status. During the survey period, soil samples were collected from the possible camp site locations. The samples were sent to the laboratory of Dhaka University. The results of the test are shown in Table IV.19.



Figure IV.32: Soil Sampling from the Project Area

Table IV.20: Test Results of Soil Analysis

Sl. No.	Test parameters	Unit	Test results		Dutch Standards for Soil
			DBR_SL_01	DBR_SL_02	
			Mirer Bazar	Bhulta More	
01	pH	-	7.58	7.02	NYS
02	Zinc (Zn)	mg/kg	68.24	56.24	140
03	Iron (Fe)	%	1.55	1.67	NYS
04	Sulphate	mg/kg	128.46	98.32	NYS
05	Organic Matter	%	1.07	0.98	NYS
06	Nitrate	mg/kg	12.10	10.32	NYS
07	Phosphate	mg/kg	9.53	8.86	NYS

Source: DU Laboratory, 2019

260. There is no Bangladesh regulation/standard for soil. In the absence of local country standards, it is the environment consultant's practice to use globally recognized 'Dutch Ministry of Public Housing, Land-use and Environmental Guidelines - Soil and Groundwater Standards' to assess soil quality and to determine the need, if any, for remedial action. Parameters analyzed in baseline quality of soil were observed to be well below the threshold limits for Intervention as per the Dutch Standards where almost most of the parameters are not yet standards according Dutch Standards.

E. Socio-economic Environment

1. General

261. 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;
- Group discussion; and
- Informal meeting with various professionals.

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

263. 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).

2. Administrative Structures

264. Bangladesh is divided into eight administrative Divisions. Each Division is divided into Districts/Zilas; there are 64 Districts within Bangladesh. Districts/ Zila's are subdivided into Upazilas (there are 483 Upazilas in Bangladesh), which consist of a number of Union Parishads. Union Parishads of which there are 4486 in Bangladesh are the locally elected governments at the village level.

265. The Project area is located in Gazipur and Narayanganj districts within Dhaka Division. This 48-kilometer-long Road connects Joydevpur-Tangail National Highway (N4) in the North to the Dhaka- Chittagong National Highway (N1) in the South. The roads also traverse Dhaka-Sylhet National Highway (N2), Dhaka-Mymensingh Highway (N3) and numerous regional highways and zilla roads.

3. Demography

266. 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 Joydebpur-Madanpur area are presented below Table IV-20. The demographic information collated from Social Survey, 2018 are given at Table IV-21.

267. The demographic information collected from the Population Census. Being an important place for trade and commerce these areas have larger population density.

Table IV.21: Populations in the Project Road Area

District	Area (Acres)	Households	Population	Population Density (per sq. km)
Gazipur	1806.36	826458	3403912	1884
Narayanganj	684.35	675652	2948217	4308

Source: Population Census, 2011

Table IV.22: Populations along the Project Road

Age Group (Yrs)	Gazipur	Narayanganj	Total
Up to 7 years	111	297	408
8 -15	234	783	1017
16-30	239	1716	1955
31-45	1317	2513	3830
46-60	732	954	1686
Total	2633	6263	8896

Source: Census and IOL survey, 2019

4. Settlement and Housing Pattern

268. The project is located in comparatively less densely settlements area than the other parts of the country. Housing condition along the project alignment 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 commercial structures remain higher in the semi-urban area comparing to the rural areas of the project road. According to the social survey, total 1147215.09 sq.ft 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 IV.23.

Table IV.23: Quantity of Affected Structure along the Project Road

SL. No.	Loss Type	Gazipur	Narayanganj	Total
1	Total quantity of residential structure affected (in sqft)	193320.57	249204.93	442525.50
2	Total quantity of commercial structure affected (in sqft)	200520.11	426718.10	627238.21
3	Total quantity of Common Property Structure (in sqft)	4831.38	72620.00	77451.38
Total quantity of structure affected (in sqft)		398672.06	748543.03	1147215.09

Source:Socio-economic Survey, 2019

5. Land Use Patterns

269. 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 urban 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.

270. 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.

6. Water Supply and Sanitation

271. Tap Water is the most common source of drinking water in both the urban and rural areas. Most households do not treat water prior to drinking. Sewage facilities are available in most of the urban areas. According to the observations during field survey it can be said that the sanitary facilities are better in the urban areas than the rural areas.

7. Agricultural Environment

272. Agriculture is the backbone and single largest producing sector of Bangladesh. It is the major source of livelihood in the rural areas, where some 80 percent population lives. It contributes about 20.24% to the total Gross Domestic Product (GDP) of the country (BBS, 2012). Rice is the staple food of Bangladeshi people. Approximately two-thirds of the labour force is employed in agriculture. With irrigation covering only around 42 percent of the potentially irrigated area, agriculture is still weather dependent and has grown slower than was earlier expected, particularly because of the predominantly small farmer holdings in Bangladesh. Agricultural environment consists of agricultural land, seeds and crops, chemical inputs, irrigation water, pests, sun light etc. For more production from a unit land area, protection and conservation of agricultural environment is very important.

273. According to the most recent assessment was completed by the Soil Resource Development Institute (SRDI, 1998) which classified Bangladesh into 30 AEZs. The project area contains mostly 3 AEZs; namely, Old Himalayan Piedmont Plain, Active Teesta

Floodplain, and Teesta Meander Floodplain. 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.

274. The crop-growing period is divided into three seasons like other regions of the country: Kharif-1, Kharif-2 and Rabi. Kharif-1 season starts from March-April and ends in May-June. Kharif-2 season extends from May through October, while the Rabi seasons starts from November and continues up to April.

275. Along the project road different type of crop cultivation practice has been observed. Though the roadside agricultural practices are very minimum and up to Dhamrai upazila roadside land are mostly being used for commercial purposes. Farmers at the project are mainly cultivate Paddy during the dry season and vegetables during winter period.

8. Cultural and Common Property Resources

276. Cultural Property means those have a regional and or national cultural heritage, e.g., ancient mosque, historic buildings, works of art, archaeological sites, libraries and museums and Common Property Resources mean the property usually used by the local communities, e.g., educational institutes, religious institutes, Eid-Gah, Crematory etc. These properties require to be protected as they contribute to local culture and will remain in the Project area during operational period of the Project. Along the project road there are several numbers of mosques, temples, church, schools, colleges, madrashas, etc. There is no archaeological or historical site along the project corridor that might be impacted due to the road improvement. A map showing different socio-cultural features within 100m buffer of the project road is given in Appendix 8.

V. ANALYSIS OF ALTERNATIVE

A. Background

277. Analysis of alternatives involves the examination of optional solutions, e.g., road improvement, or air service, instead of rail, and alternative alignments and/or technologies to be applied, such as electric versus diesel locomotives. Optional solutions have been assessed by RHD during the early stages of the Project planning with ADB. Location of Project alignment is being identified during feasibility study (FS) by analysis of various possible alignments through technical, economic, social and environmental considerations.

B. Alternatives to the Project

278. The road alignment is predominantly urban for most of its length though there are some semi-urban and rural uses and development at the township. Some disturbance to adjacent uses will be inevitable. It is assumed that the right of way is adequate for a 4-lane highway with SMVT in both sides mostly, but this needs to be confirmed.

279. In order to widen the carriageway some encroachment of adjacent agricultural land will be necessary, and this will need to be strictly managed during the construction phase. This is an existing road and there is likely to be cuttings of many roadside trees and vegetation. In addition, the social/resettlement issues are likely to be substantial in many areas where there are villages and markets adjacent to the road. Since the RoW is probably wide enough for 4 lanes, there may be less significant land acquisition resettlement problems at the market locations. There are a number of sensitive uses near to the project road such as schools, graveyards and other sensitive structures alongside the alignment. Some localized problems may occur and special management will be necessary during the construction phase.

1. The Without-Project Alternative

280. From a purely physical and environmental point of view, the 'do-nothing' approach is preferable to any project implementation since it would avoid creation of any of the adverse impacts associated with a new road. The without project alternative is not acceptable since this will strongly reduce the potential for socio-economic development of the country. Despite having great potential, the industrial and commercial growth is retarded mainly due to absence of safe and reliable transportation facility. Further, the project area is very close to the capital of Bangladesh but yet not have the required transportation infrastructure to give it the momentum to reach that status. A new highway to the rest of Bangladesh and to the region will help realize this objective.

281. Therefore, the 'no-build' alternative is unacceptable, and the potential socio-economic benefits of implementation of such Project far outweigh the adverse impacts, all of which can be controlled and minimized to an acceptable level.

C. The Alternatives Alignments

282. The proposed road development will be followed along the present ROW and there is no major route alternative. However, there are some minor alternative alignment options for ensuring the road safety.

D. Conclusions

283. The preferred alignment, taking into consideration not just environmental and social considerations, but also financial, economic and engineering requirements. There are also a number of road intersections. No bypass is required for the development of the project road and the route will use the existing alignment with required land acquisition and clearance.

VI. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. General

284. 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.

B. Project Corridor

285. 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.

1. Project Right of Way (RoW)

286. The proposed project corridor will have a well-defined RoW that will be approximately 32.2m to 37.2m 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.

2. Corridor of Impact (CoI)

287. 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.

288. According to the type of impacts the project 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 1 km radius around the site during IEE preparation. However, due to the nature of the project, the direct or indirect impact will not go beyond 200m from the RoW of the road alignment. In this project 200m from the RoW have been considered as core impact zone and 1 km as buffer zone (as per DoE guideline) for better understanding.

C. Anticipated Adverse Impacts and Mitigation Measures

1. Design/Pre-construction Stage

289. Following is a brief description of impacts envisaged during the Preconstruction/ Design Phase:

a) Climate

Impact

290. Bangladesh is one of the most vulnerable countries in the world in terms of global warming and climate change considerations. The two most important factors relevant to the road project are changes to rainfall patterns and sea level rises. It is noted, that due to Global Warming and Greenhouse gas impacts the trends of rainfall, temperatures and humidity are changing. The design of the road will therefore need to take into account changes and potential increases in rainfall, temperature, and wind speed.

Mitigation

291. More intensive and prolonged rainfall will need to be considered during the design phase and special design measures will need to be included in the final design.

292. Ensure road design, embankment height, pavement design and filling material selection are designed to withstand unusually high rainfall patterns. Design must include increased height of road surface and increased sizes of drainage channels and culverts to accommodate additional rainfall and potential flooding. Bridge/culverts construction should be scheduled so that they are constructed during pre-monsoon season to avoid potential disaster caused by excessive rainfall and consequent flooding.

b) Landscape/Topography

Impact

293. Adverse impacts on the topography /landscape of the project area may occur. Since the project road mostly passes through flat terrain with no major changes of height, impacts on topography is likely to be minimal and no special design requirements are needed.

294. 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.

Mitigation

295. During the pre-construction phase, harmonization with the surrounding natural scenery was taken into consideration when designing flyovers, underpasses, bridges, auxiliary facilities, etc. 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.

c) Land Acquisition and Resettlement

Impact

296. One of the major project related impact will be the land acquisition for the Project RoW that will result in causing disturbance to the affected residents of the project area. The project activity involves widening of road. The required RoW of 50m is not available with RHD along the major sections of the project alignment. The total land to be acquired is 37.60 acre of which 39.74% are crop lands (high), 28.35% are crop lands (low), and 31.25% are homestead lands.

297. Land acquisition will cause removal of cultural and commercial structures, resettlement of affected people, removal of vegetation, relocation of utilities and inconvenience to the local people and animal living in and around the land area to be acquired. The resettlement is anticipated to cause mainly three types of social impacts such as psychological stress, split of communities, and loss of livelihoods or business opportunities. The adjacent crop land and water bodies will also be affected because of land acquisition.

Mitigation

298. 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 within RoW /minimizing the width to be acquired.
- Land acquisition and resettlement plan has to be prepared by the social and resettlement specialists following the national legal frameworks and ADB's Safeguard Policy Statement in order to deliver proper compensation and resettlement of the affected people.
- Developing proper judicious compensation package for affecters and giving compensation amount before the affecters shifting.

d) Loss of Agriculture Production

Impact

299. A total of 37.60acre of land will directly occupied by the project road construction and its 25.60acres agricultural land. Different quantity of land and production of various crops from this agricultural land will be permanently lost. Rather a strip of land along proposed road and their subsequent production of standing crops will be hampered or destroyed. Moreover, this strip may remain unproductive for 1-2 years during construction period. Various vehicles, machineries, sheds etc. will need extra land which is mentioned here as a strip land.

Mitigation

300. A significant amount of land including agricultural land will be lost permanently; a few poor and marginal farmers will become vulnerable to meet their food security and livelihoods. An indirect negative impact will happen in nearby agricultural fields in the project corridor. A compensation program for creation of employment for victim family, initiatives to reduce negative impact on agricultural lands and increased crop production from limited land will keep the loss at an agreeable limit.

e) Removal of Commercial Infrastructure

Impact

301. The construction of the embankment of the road will require removal of 787 commercial infrastructures located within the RoW which is 51.61% of the total structures. As a result, commercial infrastructure such as shops, filling station, industries and so on located within the RoW will be essential to relocate and/or demolish. There are commercial infrastructures (627238.21 sqft) within RoW which will be directly affected because of the construction of the road's embankment. There are number of filling stations, industries; and factories within ROW of the road alignment. Removal of commercial structure will cause financial loss of the businessman and the owner(s).

Mitigation

302. Emphasis has to be given on the appropriate selection of the alignment so that less destruction of commercial infrastructure can be ensured. However, some infrastructure felled within the ROW of the proposed alignment has to be demolished and relocated where possible. In this case, proper compensation must be provided at first as per the national legal frameworks and ADB's SPS. It should be kept in mind that consultation with the affected people has to be made before relocating any infrastructure.

f) Removal of Community Property Resources

Impact

303. In order to construct the embankment for the proposed Joydebpur-Madanpur Road project, total 31 cultural and community property resources (e.g. mosque, eidgah, grave yard, shrine, school, college, hospital/clinic and so on) located within the ROW will be partially/fully affected. This will cause relocation and/or demolition of the physical cultural and other community structures.

Mitigation

304. The selection of the alignment should be such that there have fewer impacts on the cultural structure. However, the cultural structure felled within the ROW of the proposed road to be relocated/or demolished as per the existing condition through proper planning. In this case, the community using the structure shall be informed at the beginning. Through the consultation with the community, proper place for the relocation of the structure has to be selected. Before relocating and/or demolishing the structures like mosque, school, and temple temporary structure including required facilities have to be provided alternatively nearby the site as per the requirement of the community. The cost for the assets of the community infrastructure has to be paid as per the national legal frameworks and ADB's SPS.

g) Damage to Public Utilities

Impact

305. 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.

Mitigation

306. 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.

h) Tree Cutting and Wildlife

Impact

307. Widening of the two-lane project road to four lanes will require felling of 10782 existing planted roadside trees and homestead trees along the ROW. Most of the trees and vegetation, now present in the affected stretches of lands are within the present ROW, but most will outside of the ROW.

308. It has been estimated that a significant number of small (less than 30 cm girth at waist height), medium (30-60 cm girth at waist height), and large (over 60 cm girth at waist height) trees from roadsides may be felled during the construction phase. Tree felling will affect timber and bio-mass production potential directly at local level. Ecological impacts can be reversed planting site-specific tree species as per the directives of Social Forestry Act (2004).

309. Any loss of trees will impact on other flora and may affect wildlife, particularly birds and mammals that rely on trees their food source. In addition, the loss of tree may increase soil erosion from rain cut. Apart from trees and undergrowth other vegetation affected will be agricultural crops, bamboo bush and other native vegetation. Excavation of borrow pits will add to the destruction of flora.

Mitigation

310. Mitigation measures will include:

- No trees shall be felled unless they are directly in the path of the project road and clearly defined, or unless they created a safety hazard to the future operation of road;
- Upon completion of embankment works turfing and planting should be done on embankment and slopes. Dense and well rooted growth of permanent grasses should be planted to eliminate dust and erosion;
- Replanting of 32346 trees along the roadway, should consist of a multi-species mix of local vegetation including fruit trees, fast growing (fuel) trees and timber trees;
- 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. three 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 private 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;
- 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;
- Forestation programmes should be initiated, covering the road ROW, any embankments, and land near bridges and culverts to compensate for the loss of vegetation, to reduce the risk of erosion of the banks, and finally as a noise reducing wall.

i) Change of Local Hydrology/Drainage Congestion

Impact

311. No major impacts are expected on hydrological aspects of the river due to bridge construction. However, river hydrological, morphological, and ecological aspects have direct bearing on bridge location selection. Bridges already exist over the rivers and the new bridges will be constructed beside the existing bridges.

312. 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.

313. The proposed project area is free from devastating flood/cyclone/storm surge and 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 rivers/canals and therefore no change in water flow pattern will be caused. The major bridges (>100m) will be constructed beside the existing bridges. Moreover, water flow of this river is not vigorous and water flow of these rivers significantly reduced 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. 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 Col of the surface water bodies will be confined within the RoW of the project, and it will be minor and temporary in nature.

Mitigation

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

- Proper design of bridges on the rivers to accommodate design flows; special attention should be given to protect Shitalakshya and Turag rivers from any pollution, as these rivers are designated as Ecologically Critical Area.
- 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 of in a controlled manner.
- The dredged material from the riverbank shall be tested for presence for heavy metals and other pollutants before its reuse.

j) Water Bodies and Fisheries

Impact

315. The Joydebpur-Madanpur Road will cross several surface water bodies (e.g. rivers, canals, ponds, ditches). The wetland and ponds on both sides of the road where culture fish farming is a common practice. The bridge construction activities particularly during the in-river pile driving operations will temporarily affect the capture fisheries at the bridge sites. Fan formation at pier sites might impact the capture fisheries in the long run unless properly managed. The wetlands (ponds, ditches, canals) are located within ROW of the project alignment contain water round the year and are being used for fish culture. The water bodies will be directly affected because of earth filling for road's embankment which will cause permanent loss of large amount of fish production.

Mitigation

316. For any construction/engineering work over the water bodies, proper measures need to be taken to keep the existing water flow as usual as possible. Moreover, to protect the fisheries habitat, erosion and siltation have to be kept in control at bridge and culvert sites. In order to minimize the production loss of fish, production capacity in the existing fish ponds in the Col can be enhanced through excavating the ponds. Fallow lands can be prepared into fish ponds through excavation work. Farmers can be encouraged to practice of integrated fish farming (e.g. fish farming in the paddy field). However, in order to minimize the production loss of fish, production capacity in the existing fish enriched ponds in the Col can be enhanced through excavating the ponds. Majority of the species recorded from the project area are common to less common within the project area. Again, these species are widely distributed throughout the country. Therefore, the project impact area (100 m on each side of the proposed road) is not essential for the survival of the species.

2. Construction Stage

a) Landscape/Topography

Impact

317. As a result of construction, topography of the project area will be changed. One of the important activities during construction will be the cutting and dismantling of existing infrastructure will have impact on the topography of the Project Area. Moreover, excavations of ponds/ditches for the filling materials may affect the nearby agricultural land. Clearing

vegetation from the ROW will cause appearance change of the landscape. This impact is temporary and minor negative in nature.

Mitigation

318. Mitigation measure for this impact is proper landscaping. Construction camps should be constructed at suitable place to minimize this impact. Vegetation clearing has to be at minimum level as possible. After completion of road construction, trees shall be planted along sections of road near the populous residential areas to mitigate impact of traffic noise to residents living along the road, and to improve landscape along the road. All the affected areas will be restored to their original levels.

b) Loss Top Soil

Impact

319. The potential impacts on top soil are:

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

Mitigation

320. 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.

c) Dredging and Dredged Materials

Impact

321. Dredging will be required to source borrow material for the construction of road embankments. It is estimated that about 4,823,083m³(4.8 million m³ approx.) of embankment materials (mostly dredged sand) will be required due to the construction of road embankments. These amounts of dredged materials will be collected from riverbed during the construction period after having required permission from relevant authorities and RHD. Disposal of the dredged materials on the land for stockpiled and filling up of the project sites above HFL, generates a huge outflow from wet dredged materials that contain high turbidity and potentially impact of the soil quality of nearby agricultural lands, crops and other vegetation. Dredging of riverbed materials has physical and ecological impacts on the river. Dredging may cause increased river bank erosion and flood at downstream of the particular river. The quality of the surface water will be degraded because of dredging and spilling/seepage of oil and lubricants from the dredging machines. Local people will be temporarily disturbed due to noise during dredging.

Mitigation

322. Mitigative measures defined for this activity are (i) obtaining permits for extraction sites and quantities from appropriate authorities and adhering to the prescribed extraction volume limits per site, (ii) conducting a survey at each dredging site to establish water quality conditions while the dredging is on-going, and (iii) obtaining required permission and approval if dredging site is located in Turag and Shitalakshya river as these are ECA under Ministry of Environment Forests and Climate Change (MOEF&CC). Moreover, a dredged materials management plan (DMMP) should be prepared to manage potential environmental impacts associated with the dredging, stockpiled of dredged materials and filling of the project sites by dredged materials. Prior to start dredging and disposal of dredged materials on land, the contractor should prepare site wise method statement (MS) in which environmental issue and its mitigation will be included. However, dredging must not be carried out when the fish are likely to be breeding in the affected surface water bodies, or in the period normally from April to August between spawning and the subsequent emergence of juvenile fish. To the end, water samples will be collected upstream and downstream of the dredger while in full operation and tested for nutrient, sediment loads, heavy metals as well as oil and grease concentrations, and river bed dredged materials of the selected rivers need to be tested by the contractor.

d) Soil Erosion and Siltation

Impact

323. Rainfall is often considered to be one of the triggering elements for soil erosion at gravity which include water erosion, collapse and landslide. As the project is located in an area with adequate rainfall which often concentrates in a certain period, proper measures such as well construction and improvement of drainage system might considerably reduce the soil erosion that would occur due to land disturbance by road construction.

324. Erosion will be taken place at the slope of the proposed road embankment if slope protection measures are not taken immediately. Erosion can be happened at the bridge and culvert construction sites. The silt from erosion if run into the nearby surface water streams, the aquatic life living in the water body and the water body itself will be affected. The accumulation of suspended particulate matters will increase the turbidity of the water and will decrease the depth for navigation. In the highly turbid aquatic ecosystem normal photosynthesis is disrupted. Moreover, if eroded materials run into the agricultural land then crop production will be hampered.

Mitigation

325. The following mitigation measures are proposed to alleviate or avoid the impacts:

- 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.

e) Soil Contamination

Impact

326. 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.

327. 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.

Mitigation

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

329. 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.

f) Air Pollution and Dust

Impact

330. 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.

331. 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.

Mitigation

332. 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 Project Company 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.

g) Noise and Vibration

Impact

333. During construction, noise is likely to be generated from 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 sites². Under the worst-case

²The 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/Trucks (82-94), Concrete mixers (75-83), Concrete pumps (75-83), Concrete pumps (81-83), Cranes (movable) (75-86), Vehicular Traffic (construction material &

scenario, it is assumed that all this 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.

334. 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.

Mitigation

335. 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:

- 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.

h) Surface Water Quality

Impact

336. There are large number of ponds and borrow pits currently being used for fishing likely to be affected. Most of these ponds are seasonal in nature and become waterless during dry season. Most of these ponds are used for unorganized fishing. Project design has made provisions of about many lesser bridges and culverts. A total of 49 box culverts and minor bridges (in addition to 03 major bridges) will be sized to pass 50-year and 100-year model storms, respectively). In addition to this design action, the next mitigative action will be undertaken. Hence, no significant impact is anticipated on these water bodies during this phase.

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 Drivers (peak) (95-105).

337. The project road crosses three important rivers. Three major bridges (>100m) are proposed on these rivers. Construction activities may have localised impact in terms increase in TSS level in river water. Since this will be a temporary phenomenon, no significant adverse impact is anticipated during this phase.

338. Surface water might get contaminated due to the disposal of construction waste generated from 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 ditches 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 not likely during operation period.

Mitigation

339. The Project Company shall undertake at all times to prevent water pollution as a result of his activities, and shall implement the measures to control water pollution that shall include, but not be limited to the followings:

- The Company shall comply with the national legislation and other regulations currently applied in Bangladesh as they relate to water pollution control.
- Protection of the water environment shall be recognized as a key constraint for any construction work. The Company shall devise and arrange methods of working to minimize water quality impacts to the satisfaction of the RHD.
- The Company shall at all times ensure that all existing water courses and drains within, and adjacent to, the site are kept safe and free from any debris and any excavated materials arising from the works.
- The Company shall take strong pollution control measures to protect surface water quality of ECA sites (Turag and Shitalakshya rivers) due to construction activities.
- For construction of the bridge piers bundled site boundaries shall be established to prevent any wastewater discharging directly to the water body environment.
- The earthwork sites where exposed land surface is vulnerable to runoff, etc. shall be consolidated and/or covered;
- The Company shall ensure that rain run-off from the construction sites is not deposited directly into any watercourse.
- All drainage facilities and erosion and sediment control structures shall be regularly inspected and maintained to ensure proper and efficient operation at all times and particularly following rainstorms.
- Wastewater shall be collected, re-used and/or disposed of off-site after oil/grease removal and settlement of suspended solids. Sediment tanks of sufficient capacity (6-8m³) shall be constructed and used at all sites for settling waste-waters prior to disposal.
- Construction wastes shall be collected and re-used wherever possible. Otherwise should be disposed in the small deposit area invulnerable to surface run-off, along with soil erosion prevention measures.
- The material stockpile sites shall be located far away from water bodies and areas prone to surface run-off. If placed near bridge construction sites, the stockpiles should be surrounded by interception ditches or retaining structures to prevent the erosion and materials into the water bodies. The loose materials should be bagged and covered.
- The fuel storage and equipment maintenance yard should have weather/rain protection and should be on concrete pads to prevent dripping and leaking oils from entering the water bodies via surface runoff. All spoil soil disposal sites should only be allowed in the dedicated areas where will be erosion control measures and landscaping plan following the disposal operations.

- For construction for bridges, there should be strict waste control plan to restrict discharge or dumping of any directly discharge of wastewater, slurry, waste, fuels and waste oil into the water. All these materials should be collected and disposed at the banks. The slurry and sediment should be pumped to the banks for disposal and should not be allowed to discharge to the rivers directly.
- Drainage from vehicle maintenance areas, plant servicing areas and vehicle wash bays shall be passed via a petrol interceptor prior to discharge.
- The Company shall ensure that no tools or machinery are washed in any water source or areas that drain into an existing watercourse.
- The Company shall weekly check all equipment for prevention of oil and or lubrication leaks and ensure that all equipment oil and lubrication replacements are performed only in bounded maintenance and repair areas.

i) Groundwater Quality

Impact

340. 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.

341. Construction of bridges may cause impact to groundwater level and quality. The piles driven into the ground with multi layers to the depth of about 40 ~ 50 m (bottom of the quaternary deposits), would penetrate the aquiclude/aquitared and then cause the risk to pollute the water quality of the aquifer.

Mitigation

342. Mitigation measures will include

- Pumping of groundwater should be from deep aquifers of more than 300 m to supply arsenic free water. Safe and sustainable discharges are to be ascertained prior to selection of pumps.
- Tube wells will be installed with due regard for the surface environment, protection of groundwater from surface contaminants, and protection of aquifer cross contamination.
- All tube wells, test holes, monitoring wells that are no longer in use or needed shall be properly decommissioned.
- Install monitoring wells both upstream and downstream areas near construction yards and construction camps to regularly monitor the water quality and water levels.
- Protect groundwater supplies of adjacent lands.

j) Drainage Congestion

Impact

343. 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 many smaller 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.

344. The landscape has an overall southeast gradient hence DBR upgrading program along the existing bypass road alignment will not affect local or regional hydrology. Adequate east west openings on road embankment exist already to avoid drainage impedance during a monsoon. The DBR upgrading will not impact hydrology of the site instead the existing impacts on hydrology (if any) can be removed taking care during implementation of DBR upgrading program. The DBR upgrading program will not affect hydrology at project site and in command area. However, the rate of urbanization if enhanced due to DBR implementation may induce construction of service roads on both sides. This may affect the local and regional hydrology unless due mitigation measures are taken in the design phase.

Mitigation

345. 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. The road elevation level in the project area should be designed considering the flood threat levels. Provision of 1m free board is proposed.

k) Clearing of Vegetation

Impact

346. 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.

347. The affected trees (10782 nos.) on both sides of the proposed road alignment of different fruit, timber and medicinal trees have proportionate economic, eco-functional and aesthetic significance. However, none of the plant species (as listed in Table IV.1) will be of conservation and ecological significance. Trees to be logged out are available locally and there will be no loss for nature. Removal of trees will affect the local ecosystem, habitat of local birds, animals and wildlife. Particularly, the wildlife that is living by the affected trees will permanently lose the ecological services from those trees. Therefore, removal of mature trees will cause ecological loss to the environment.

Mitigation

348. Road design engineer will select the best option 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.

349. RHD will be responsible for the compensatory tree planting (three times of each tree cutting and total 32346 trees) program by forming an 'Environmental and Social Team' in coordination with the Forest Department (FD). RHD will inform the Upazila 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. 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.

350. The vulnerable medicinal trees most suited to the tract like Arjun, Amloki, Hortoki, and Bohera will not be felled but uprooted and transplanted in close consultation with the Forest Department. If it is not avoidable to be felled then it will be planted.

351. The suitable trees for planting on homestead platforms are am (Mangifera indica), jam (Syzygium 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.

352. 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.

D) Terrestrial Fauna

Impact

353. The vibration of equipment, noise, wastewater and exhausts gas are often considered to be disturbances to animals. These could drive animals away from their current habitats. However, impacts caused by construction works to terrestrial animals are considered manageable, due to the fact that the amphibians found along the project road inhabit mainly in the cultivated farmlands or brooks.

354. During the construction phase, trees around the construction sites may be cut down and cause damage to the habitat of wild animals. Illegal hunting may also occur and pose the threat to wild animals. The practice of consuming wild animals as food may widespread. It promotes catching and hunting wild animals such as reptiles (frogs, snakes), birds and beasts (hare). Biodiversity loss is usually observed as one or both of: (1) reduced area occupied by species and community types and (2) reduced abundance of species or condition of communities and ecosystems. The likelihood of any biodiversity component persisting or surviving in the long term declines with both lower abundance and reduced habitat area. If biodiversity loss is out of control, it will trigger off over-exploitation of the natural biological resources and even exhaust the resources.

355. Ditching and construction of temporary construction sites and access roads may lead to damage and deterioration of local ecosystems. It is likely that the development of the expressway will generate significant quantities of spoil materials which will be required to be removed off-site and either disposed-of or contained in stable storage and dumping areas.

356. This will include temporary and permanent dumping areas, which will need to be managed with respect to landslide stability, embankment stability, drainage control, erosion protection (wind and water) and sediment. Spoil stockpiling in small valleys or river banks will directly affect the habitat of animals. However, these animals may find alternate habitats in the areas around the project road, and return to their previous habitat when the vegetation is recovered after the completion of construction.

357. During construction phase, air pollution, wastewater, and solid waste generated by the construction works may also deteriorate the animals' habitat, and may force them to evacuate to another habitat. As an example, the construction of bridges may cause degradation of river water quality, loss of habitat, loss of food sources for reptiles, amphibians, fishes, etc.

Mitigation

358. In total of 69 and 38 species of wildlife are included in the Schedule 1 and 2 respectively under Wildlife (Conservation and Security) Act, 2012. Therefore, conservation activities need to be included without causing harm to the species. Almost all protected species are widely distributed and are less common to common within the area. Therefore, the species will not be at further risk due to much localized intervention. However, Company shall

- Setting up and implementation code of conducts to workers, including no catching or hunting fish and wildlife, and no consumption of wildlife products.
- Provision of environmental training with information on the importance of biological diversity, and its relationships with sustainable development.
- Limit the construction works within the designated sites allocated to the Project Company.
- Minimize the tree removal during the bird breeding season. If works must be continued during the bird breeding season, a nest survey will be conducted by a qualified biologist prior to commence of works to identify and located active nests.
- Minimize the release of oil, oil wastes or any other substances harmful to migratory birds to any waters or any areas frequented by migratory birds.
- Provide adequate knowledge to the workers regarding protection of flora and fauna, and relevant government regulations and punishments for illegal poaching.

m) Aquatic Species

Impact

359. The water courses may be contaminated by the pollutants generated from the construction sites and workers' camps, such as sediments in wastewater discharged from excavated areas, nutrients and biological contents in domestic sewage discharged from worker's camps, and oil and grease leaked from construction machineries. Water pollution may change the dominance and the composition of the plankton. Water pollution will reduce species numbers and relative abundances of populations. Construction materials stored near the watercourses, uncovered excavated soil, stone dumps, and construction wastes may be easily washed out and flow into the water sources by rainfall, thus pollute the watercourses, change the water's pH value and deteriorate the aquatic animals' habitats. This can lead to plankton and benthos deaths and aquatic biomass reduction in the construction areas. However, impacts to plankton and benthos are considered insignificant. Plankton organisms can easily survive in water bodies with marginal water quality requirements, and benthos may move to other similar habitat near the bridge piers.

Mitigation

360. Mitigation measures will include

- The ponds and burrow pits could be netted before filling for removing aquatic fauna and its subsequent safe release elsewhere;
- Provision of environmental training with information on the importance of biological diversity, and its relationships with sustainable development;
- Ensure the riverine transports, vessels and ships are well maintained and do not have oil leakage to contaminate river water;
- Contain oil immediately on river in case of accidental spillage from vessels and ships and in this regard, make an emergency oil spill containment plan to be supported with enough equipment, materials and human resources;
- Do not dump wastes, be it hazardous or non-hazardous into the nearby water bodies or in the river.

n) Fisheries

Impact

361. The proposed project will include three long bridges crossing several rivers and small bridges and culverts over undefined water bodies. The construction of bridges and culverts may lead to the loss of fish habitat due to increased turbidity, decreased dissolved oxygen in the water, and reduction of food sources including temporary decline of plankton and benthos organisms. Increase in suspended solids in the rivers would drive fishes away from the bridge construction sites during the construction phase. However, these impacts are short-term, reversible, and happen only during the construction phase. Fish populations would be restored after the bridges are built.

- Loss of floodplain areas and burrow pits/ponds with consequent loss of aquatic fauna and flora
- Ponds are used for exotic fish culture which has little conservation significance.
- Earth/sand filling activities may produce fine dust particle which affect the physiological functioning of plants and animals, in addition to respiratory disturbances to human.

Mitigation

362. Mitigation measures will include

- Ensure the riverine transports, vessels and ships are well maintained and do not have oil leakage to contaminate river water.
- Contain oil immediately on river in case of accidental spillage from vessels and ships and in this regard, make an emergency oil spill containment plan to be supported with enough equipment, materials and human resources.
- Do not dump wastes, be it hazardous or non-hazardous into the nearby water bodies or in the river.
- Activities that are subject to cause pollution to Shitalakshya and Turag rivers and hence deteriorate habitats of Fisheries and other fauna must be avoided.
- Inspect any area of a water body containing fish that is temporarily isolated for the presence of fish, and all fish shall be captured and released unharmed in adjacent fish habitat.
- Install and maintain fish screens etc. on any water intake with drawing water from any water body that contain fish.
- Ensure the earth filling is done in dry season to avoid killing of the floodplain and many burrow pits fishes.

o) Loss of Agricultural Production

Impact

363. A significant amount of land including agricultural land will be lost permanently; a few poor and marginal farmers will become vulnerable to meet their food security and livelihoods. An irreversible conversion of a large agricultural land (25.60 acre) into road will happen. Thus 25.60 acre agricultural land will be converted permanently into non-agricultural land.

364. The construction of the road will impact on agricultural land and crop production permanently; some impact will be for a time being. Some indirect negative impact will also happen in nearby agricultural fields in the project corridor.

- Earth filling may alter the soil development and soil structure, damage soil texture, lead to loss of organic matter and inorganic nutrients in soil, reduce soil fertility and water-holding capacity, deteriorate soil quality, cause soil erosion and limit soil production.

- Soil may be disturbed heavily by road construction activity, such as slope fill and slope cut, invasion of a huge number of artificial soils and destruction of organic soil and humus layer.
- Loss of floodplain areas and burrow pits with consequent loss of crops.
- Sand removal with wind blow and rain water runoff from road construction place to nearby agricultural field will result in increased sand percentage which will ultimately change the soil composition i.e. its texture. Thus, it may affect soils fertility level to the adjacent lands.
- Most of the burrow pits will be filled; winter cropping will face some difficulties as water retention area will be shrunk.
- Various types of heavy vehicles and machineries will go also on the besides agricultural land; thus, soil compaction and direct loss of standing crop of one season will be completely or partially destroyed.
- Soils of adjacent area of the project road may be changed in texture and fertility with mixing up with external sand and soils, sometimes oil spills, pitch, dust, ash etc.
- Increased movement of construction laborers will have adverse impacts on adjacent crop fields.
- Some marginal and landless farmers may become unemployed due to loss of agricultural land and water logging.
- Fencing will obstruct cattle movement across the road and thus may cause adverse impacts on agricultural activity like ploughing and cow grazing.
- Photosynthesis of nearby crops in the corridor may become slower due to regular deposition of dust and smoke on leaves surfaces created in by vehicles movement.

Mitigation

365. During construction phase, the Company shall implement the measures to mitigate the loss of agricultural production that shall include, but not be limited to the followings:

- Fertile land where two or more crops grow at present or the land which has such potentiality, that land could be avoided. Non-agriculture khash land should be considered on a priority if non-agriculture khash land becomes available.
- Top soils of adjacent land could be preserved as these are most fertile and suitable for crop production.
- Install drainage system to drain out excessive water during rainy season. Irrigation and drainage system should be installed and reconstructed for a sustainable agricultural production.
- Shallow and deep tube well could be used for irrigation to cultivate Boro rice and Rabi crops. Winter cropping area may be increased by installing of deep tube wells.
- Movement of heavy vehicles and machineries should be confined within the right of way; if necessary, a minimum strip of land can only be used.
- Precaution should be maintained to keep soil erosion and flight of dust at a minimum level, wetting of soil may be helpful.
- Ensure maximum possible cleanliness of construction activity.
- There might have a provision of cattle pass at a regular interval, each width should be enough for cattle movement and agricultural machinery movement.

p) Pollution from Wastes

Impact

366. The construction process will take at least 3 years and as a result, the construction camps will take a semi-permanent appearance. The majority of waste generated will include construction wastes (solid wastes: piece of rods, woods, bricks, stones, containers, electric wire, pipes etc. liquid waste: paint, bitumen, oil etc.) and general wastes (solid wastes: papers, plastic containers, residues of food, fruits etc. and liquid waste: from kitchen and bathroom etc.). These wastes will be generated due to construction camps, construction activities and

materials used for construction. If inadequate arrangements exist for the disposal of above mentioned wastes, there will be negative impact on the soil, aesthetic beauty of area and workers' health and safety. Possibilities of bitumen and oil leaks spread of contaminants brought through material transport including invasive species, etc.

Mitigation

367. Mitigation measures will include

- Develop waste management plan for various specific waste streams (e.g., reusable waste, flammable waste, construction debris, food waste etc.) prior to commencing of construction and submit to RHD for approval.
- Prepare spill control procedures and submit the plan for RHD approval.
- Train the relevant construction personnel in handling of fuels and spill control procedures.
- Store dangerous goods in bunded areas on a top of a sealed plastic sheet away from watercourses.
- Refueling shall occur only within bunded areas.
- Make available MSDS for chemicals and dangerous goods on-site.
- Place a high emphasis on good housekeeping practices.
- Store hazardous materials above flood plain level.
- Put containers and drums in temporary storages in clearly marked areas, where they will not be run over by vehicles or heavy machinery. The area shall preferably slope or drain to a safe collection area in the event of a spill.
- Put containers and drums in permanent storage areas on an impermeable floor that slopes to a safe collection area in the event of a spill or leak.
- Take all precautionary measures when handling and storing fuels and lubricants, avoiding environmental pollution.

q) Asphalt Hot Mix Plant, Rock Crushing, and Bitumen Supply

Impact

368. Rock crushing activities will generate noise and dust, and asphalt hot-mix plant and pavement works will generate gas and odour while compaction of the pavement will also generate noise and dust. Notwithstanding those emissions from powered mechanical equipment that supply crushed rock and asphalt will be rapidly dispersed, they will need to be sited carefully to avoid complaints. It is also possible that soil may be contaminated by oils and chemicals at asphalt/bitumen plant sites, workshop areas, and equipment washing yards. The contamination may limit the future use of the land for agricultural purposes.

Mitigation

369. Although emissions from powered mechanical equipment that supply crushed rock and asphalt will be rapidly dispersed, they will need to be sited carefully to avoid complaint. In order to maintain the existing air quality of the project area in a condition acceptable to the local population, compliance with the following mitigation measures will be needed:

- Cement batching and aggregate mixing plant will be located as far as possible (at least 500 m from settlements and habitation near the project corridor, or as required by environmental regulations;
- All conditions of DoE permits and local guidelines will be observed;
- Dust suppression equipment will be installed at cement and aggregate mix plants;
- Areas of construction, as well as the haul road, will be kept damp by watering. The construction area where local roads are used for hauling, they shall be kept in serviceable condition, and any damage will be repaired promptly without interference to local travel routes;

- All hot-mix plants, crushers, and batching plants will be located in agreement with the local district or municipality, and installed in a sealed area only after receiving approval from the relevant local authority and DoE.

r) Construction Waste Disposal

Impact

370. Due to construction activities waste will be generated at construction and Company's camp site. The construction waste will include wastewater, oil spillage from machinery, hazardous waste and solid waste etc. This will result in unhygienic conditions, health risk to work force and general public at the camp site. Following are the types and sources of construction waste:

- Oil, grease etc. from construction machinery;
- Hazardous and solid waste from waste construction material and food;
- Waste water from washing and sprinkling; and
- Sanitary waste from staff toilets.

Mitigation

371. Mitigation measures will include

- Organize disposal of all wastes generated during construction in an environmentally acceptable manner. This will include consideration of the nature and location of disposal site, so as to cause less environmental impact.
- Transport waste of dangerous goods, which cannot be recycled, to a designated disposal site approved by DoE. Vehicles transporting solid waste shall be covered with tarps or nets to prevent spilling waste along the route
- Train and instruct all personnel in waste disposal practices and procedures as a component of the environmental induction process.
- Provide absorbent and containment material (e.g., absorbent matting) where hazardous material is used and stored and personnel trained in the correct use.
- Provide protective clothing, safety boots, helmets, masks, gloves, goggles, to the construction personnel, appropriate to materials in use.
- Make sure all containers, drums, and tanks that are used for storage are in good condition and are labeled with expiry date. Any container, drum, or tank that is dented, cracked, or rusted might eventually leak. Check for leakage regularly to identify potential problems before they occur.
- Minimize the production of waste materials by 3R (Reduce, Recycle and Reuse) approach.
- Segregate and reuse or recycle all the wastes, wherever practical.
- Prohibit burning of solid waste.
- Provide reuse containers at each worksite.
- Request suppliers to minimize packaging where practicable.
- Avoid the use of material with greater potential for contamination by substituting them with more environmentally friendly materials.
- Maintain all construction sites in a cleaner, tidy and safe condition and provide and maintain appropriate facilities as temporary storage of all wastes before transportation and final disposal.

s) Construction Yard

Impact

372. The precise locations of construction camps and other facilities such as workshops, equipment washing yards, construction material storage areas, haul routes and disposal sites for construction waste will be finally decided by RHD in consultation with Project Company.

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. 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: pollution risk of soil and surface water due to sanitation of the labour camps and wastes from the camps.

Mitigation

373. The Company shall

- Locate the construction camps at areas which are acceptable from environmental, cultural or social point of view.
- Consider the location of construction camps away from communities in order to avoid social conflict in using the natural resources such as water or to avoid the possible adverse impacts of the construction camps on the surrounding communities.
- Submit to the PIU for approval a detailed layout plan for the development of the construction camp showing the relative locations of all temporary buildings and facilities that are to be constructed together with the location of site roads, fuel storage areas (for use in power supply generators), solid waste management and dumping locations, and drainage facilities, prior to the development of the construction camps.
- Local authorities responsible for health, religious and security shall be duly informed on the set up of camp facilities so as to maintain effective surveillance over public health, social and security matters.
- Adequate housing, safe and reliable water supply for all workers.
- Hygienic sanitary facilities and sewerage system. The toilets and domestic waste water will be collected through a common sewerage. Provide separate latrines and bathing places for males and females with total isolation by wall or by location. The minimum number of toilet facilities required is one toilet for every ten persons.
- Paved internal roads. Ensure with grass/vegetation coverage to be made of the use of top soil that there is no dust generation from the loose/exposed sandy surface. Pave the internal roads of at least haring-bond bricks to suppress dusts and to work against possible muddy surface during monsoon.
- Provide in-house community/common entertainment facilities. Dependence of local entertainment outlets by the construction camps to be discouraged/prohibited to the extent possible.
- Ensure proper collection and disposal of solid wastes within the construction camps.
- Insist waste separation by source; organic wastes in one pot and inorganic wastes in another pot at household level.
- Locate the garbage pit/waste disposal site min 500 m away from the residence so that peoples are not disturbed with the odour likely to be produced from anaerobic decomposition of wastes at the waste dumping places. Encompass the waste dumping place by fencing and tree plantation to prevent children to enter and play with.
- Provide adequate health care facilities and first aid facility round the clock within construction sites. Maintain stock of medicines in the facility and appoint fulltime designated first aider or nurse.
- Train all construction workers in basic sanitation and health care issues and safety matters, and on the specific hazards of their work.
- Provide adequate drainage facilities throughout the camps to ensure that disease vectors such as stagnant water bodies and puddles do not form. Regular mosquito repellent sprays during monsoon.
- Provide appropriate security personnel (police/home guard or private security guards) and enclosures to prevent unauthorized entry in to the camp area.

- Maintain register to keep a track on a head count of persons present in the camp at any given time.
- Dismantle camps in phases and as the work gets decreased and not wait for the entire work to be completed
- Reuse the demolition debris to a maximum extent. Dispose remaining debris at the designated waste disposal site by RHD.
- Handover the construction camps with all built facilities as it is if agreement between both parties (contractor and land-owner) has been made so.
- Restore the site to its condition prior to commencement of the works or to an agreed condition with the landowner.

t) Occupational Health and Safety (OHS)

Impact

374. Construction workers are more likely to face occupational health hazards such as minor or major injuries due to lack of general safety requirements and precautions applicable while working at construction sites, and handling with machines and equipment, use of equipment and driving vehicles and so on. Poorly designed temporary labour camp and sanitation facilities may pose a health threat and nuisance to the workers. Uncontrolled vending of food and drinking water at the work site may also pose a risk with respect to the transmission of contagious diseases like Typhoid, Diarrhoea, Malaria, and Dengue in particular. Construction workers will be required to handle hazardous materials such as cement, bitumen, chemicals, fuels, and so on which will increase health risks of the workers if personal protective equipment are not used. Although presently total ratio of the affected people in Bangladesh by HIV/AIDS is far less than 0.1%, however this percentage is slowly being increased due to injection drug users and overseas migrant workers returned to Bangladesh.

Mitigation

375. 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 Company, 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.

u) Community Health and Safety

Impact

376. 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.

Mitigation

377. 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.

v) Traffic Congestion/Road Accidents

Impact

378. The existing Dhaka bypass road is one of the busiest roads. The influx of heavy construction vehicles used for the construction work may cause road accident if they are not moved following traffic rules. The construction work beside the existing highway road will impede regular movement of the vehicles. The construction workers, pedestrians and onlookers are also prone to accidents. Road accident may also occur at road crossing during construction work.

379. 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 proposed interchanges due to movement of vehicles carrying construction materials. The construction vehicles will add more traffic and as a result, traffic congestion and road accidents will be increased.

Mitigation

380. The Company shall

- Prepare and submit a traffic management plan to the RHD for his approval at least 30 days before commencing work on any project component involved in traffic diversion and management.
- Include in the traffic management plan to ensure uninterrupted traffic movement during construction: detailed drawings of traffic arrangements showing all detours, temporary road, temporary bridges temporary diversions, necessary barricades, warning signs / lights, road signs etc.
- Provide signs at strategic locations of the roads complying with the schedules of signs contained in the Bangladesh Traffic Regulations.
- Restrict truck deliveries, where practicable, to day time working hours.

- Restrict the transport of oversize loads.
- Operate road traffics/transport vehicles, if possible, to non-peak periods to minimize traffic disruptions.
- Enforce on-site speed limit
- Install and maintain a display board at each important road intersection on the roads to be used during construction, which shall clearly show the project information in both Bangla and English.

381. The project is mainly the reconstruction of existing road which has heavy traffic volume at present, bearing the important economic exchanges in Dhaka, so traffic maintain is the highlight of the project. According to the conditions of other reconstructed or widened roads under construction in Bangladesh, segmental or semi-segmental construction shall be adopted. The road cannot be blocked completely, and a detailed traffic maintain scheme should be developed before construction.

w) Income/Employment

Impact

382. 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.

383. 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 Company's office would be available for local people.

Mitigation

384. In order to minimize the income loss, Company 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 Company 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.

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

x) Tree Plantation

Impact

386. During the construction work of the road the compensatory tree plantation (32346 numbers of trees) will be conducted which will provide positive impact on the natural environment. Inappropriate selection of tree species and plantation location may not ensure the inherent objective of the tree plantation plan. Moreover, lack of proper care (e.g. watering, securing with fence) by the respective authority will also hinder the process of proper growth of the planted trees.

Mitigation

387. Different species as per the tree plantation plan can be planted at the road shoulder (whereas possible), to substitute the ecological loss occurred because of the tree cutting for the road construction. Moreover, Company will be responsible to take measures of protecting the planted seedlings until the seedlings grow enough to survive independently. Scope of natural rehabilitation of the local wildlife to the habitat will be created in result of the tree plantation and growth of the vegetation. If possible, shifted homesteads may be compensated through providing seedlings. Especial care should be taken for biodiversity rich areas during construction.

3. Specific Impacts due to Bridge Construction

388. Joydebpur-Madanpur road will cross several rivers and therefore three large bridges (>100m) will be required to construct at different locations. However, these bridges are within the same activities of Joydebpur-Madanpur road construction thus there is no separate environmental impact assessment for these bridges. But details impact and mitigation measures for major bridges has been covered in this IEE and additionally this section will discuss some major impacts and mitigation measures due to these bridge constructions. Since construction of such bridges will involve earthwork, piling, concrete structures across rivers and over both the river-banks protection, restriction to plying of country boats, blockage of aquatic biodiversity movement, etc., 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. Additionally, the Turag and Shitalakshya river is Ecologically Critical Area (ECA) and therefore, construction of bridge on these rivers need special protection measures. Along with the below mitigation measures, the Company will prepare a separate SEMP considering the ecological values of these rivers prior to construction of bridges.

a) Drainage Congestion

Impact

389. Inadequate waterway opening of the new bridges will cause drainage congestion and this may cause river bank erosion simultaneously. Run off from storage of construction material near water bodies, or uncontrolled disposal may cause temporary drainage congestion, especially near service areas, and construction sites. 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.

Mitigation

390. Careful attention has to be given so that no negative impacts caused by the road at the bridge construction site. Adequate number and size of box culverts has been provided at the culvert sites to avoid drainage congestion. The opening of cross structures including bridges and culverts shall be kept as wide as possible to ensure the back water in the upstream is negligible. The list of cross structures is shown in the Chapter-III of this report. Care should also be taken so that there is no loss to navigability or reduction to water flow in the rivers or canals. Proper slope protection measures are required to avoid any drainage congestion caused by siltation/sedimentation from the road embankment. Drainage works can also be designed with the provision of lower volume of water to drain in other low-lying areas. The road elevation level in the project area should be designed considering the flood threat levels.

b) Soil Erosion and Siltation

Impact

391. Soil erosion depends on various factors like slope of an area, geological structure, soil type, and climatic variation. Slope though is predominant factor amongst these. During

construction phase, some trees, shrubs, grasses and will need to be cleared. This may create localised soil erosion problems during the rains. The potential risk of river erosion will increase after implementation of the project 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 project is not expected to worsen the erosion risk particularly in areas where soil and topography are less vulnerable to erosion.

Mitigation

392. The following mitigation measures are proposed to alleviate or avoid the impacts:

- Adopt good engineering and construction practices;
- 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;
- 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 road is in contact with river, channel and canal will be provided with slope protection measures.

c) Disruption of Water Transport and Navigation

Impact

393. No classified navigation route in Shitalakshya exists at present on the upstream side of the DBR, hence will not be disrupted during implementation stages. Dredging of the Shitalakshya to collect fill material for road embankment construction will impact navigation temporarily. The Bansi and Banar channels drain the upland of Madhupur Tract and merge with Turag in a downstream region that finally meets the Lakkhya and Balu channels. These channels are used for movement of motorized water transports, engine boats and non-motorized boats to carry freight and passengers. Several other channels like Nagda fed by seepage that runs-off to the Shitalakshya near Ghorasal and Balu near Tongi. This channel can seasonally be used for movement of engine and country boats to carry passengers and freight to local markets.

394. Implementations of the DBR upgrading program will not disturb navigation except at dredging site in Shitalakshya. The Shitalakshya bed is subject to exhaustive dredging by different land developing companies and by RAJUK to collect fill materials for the Purbachal R/As and adjacent swampy lands. The Shitalakshya receives only limited volume of silt each year, therefore, unless the channel is dredged in a planned manner for fill material collection, there may be induced river bank erosion causing loss to local residents. On the other hand, the dredging of these rivers will facilitate improved navigation, retention of more waters in the Channel for irrigation and increased quality of river fish in the rivers.

Mitigation

395. Company shall

- Not obstruct other normal riverine transport while doing riverine transport and works.
- Identify the channel to be followed clearly using navigation aids such as buoys, beacons, and lighting
- Provide proper buoyage, navigation lights and markings for bridge and dredging works to guide the other normal riverine transport.
- Keep regular and close contacts with Bangladesh Inland Water Transport Authority (BIWTA) regarding their needs during construction
- Plan the river transport and transportation of large loads in coordination with BIWTA to avoid traffic congestions.
- Provide signage for river traffic conforming to the BIWTA requirements.

- Position the dredge and pipeline in such a way that no disruption to the channel traffic will occur

d) Water and Soil Quality

Impact

396. Spillage of hazardous materials such as fuel, solvents, lubricants and paint by leakage of tanks, careless handling or disposal of hazardous wastes and washing of construction vehicle/equipment in the rivers can cause severe pollution of water (groundwater and surface water) and soil. Soil and water pollution by liquid waste can cause serious impact on the community health and safety and aquatic animals (fish, snakes, frogs etc.) of the rivers.

Mitigation

397. The Company should prepare waste management plan (WMP) and follow it. Handling and storage of all the hazardous materials and wastes as well as washing of vehicles/equipment will be organized under strict conditions through construction management plan to avoid water and soil pollution during construction of the bridge.

e) Noise and Vibration

Impact

398. It is expected that the noise level would increase due to other construction activities, transportation and loading, unloading of construction materials, placing box girders, dredging and electricity generation. It is expected that the noise caused by these activities will still be within acceptable levels. However, in placing the box girders the noise level is expected to exceed DoE specified levels. Movement of the heavy construction equipment and vehicles, pile driving operations, operation of crushing, and aggregating plants, and power generation plants will cause vibration.

Mitigation

399. The Company should prepare proper construction management plan and follow it during construction of the piling activities. The workers will be provided with suitable ear muffs and community in the vicinity of will be informed of the period the excessive noise will be generated.

f) River Ecology

Impact

400. The construction of bridges may lead to the loss of aquatic animal habitat due to increased turbidity, decreased dissolved oxygen in the water, and reduction of food sources including temporary decline of plankton and benthos organisms. Increase in suspended solids in the rivers would drive fishes away from the bridge construction sites during the construction phase. The water courses may be contaminated by the pollutants generated from the bridge construction sites and workers' camps, such as sediments in wastewater discharged from excavated areas, nutrients and biological contents in domestic sewage discharged from worker's camps, and oil and grease leaked from construction machineries. Water pollution may change the dominance and the composition of the aquatic species.

Mitigation

401. In order to avoid impacts on these species, the construction works will be limited within the designated sites allocated to the Project Company. Regular monitoring of the worksite for animals trapped in, or in danger will be done and Company will use a qualified person to relocate the animal. Monitor work areas for endangered reptile and bird species to ensure they are well away from the piling site – scare them away if they are too close to the site. Acoustic enclosure will be placed to cover the hammer and the exposed pile to reduce the air noise.

4. Operation Stage

a) Landscape/Topography

Impact

402. New infrastructure (e.g. residential and commercial building, shop, market etc.) are expected to be established beside the project road. The settlements in the immediate vicinity of the road will be directly affected which would be minor negative impact. Structures attached with the road, such as interchanges, flyovers, underpasses, bridges, etc. would cause slight negative effect on landscape.

Mitigation

403. This can be mitigated by tree plantation along the corridor. It would also serve as physical barrier between the road and the existing settlements as well as future developments. On the other hand, aesthetic beauty plays an important role. The construction of new structures such as flyovers, bridges and culverts as well as new improved road with side plantation will improve the aesthetics view of the project area.

b) Air Quality

Impact

404. The bad road conditions, the idling of vehicles and congestions are the main causes of the air and noise pollution at present. The improved road conditions will change this scenario, which will result in the improved ambient air quality. However, in the longer run, increased traffic levels and congestion will lead to PM₁₀ and PM_{2.5} pollution levels above the national/international standards, which may result in causing public health risks, nuisance and other impacts on bio-physical environment.

405. These conditions will result in the rise of vehicular emissions (CO, NO_x, SO_x, PM₁₀, PM_{2.5}) 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.

Mitigation

406. 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 checks 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.

c) Noise and Vibration

Impact

407. During the operational phase, the noise levels are anticipated to increase due to traffic related noise pollution; vibrations from engines and tires and mainly use of pressure horns. The

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

Mitigation

408. 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 is 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.

d) Water Pollution (Surface and Groundwater)

Impact

409. 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.

410. 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/minor route alternatives. This will exert stress on the availability of groundwater in the project area.

Mitigation

411. 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.

e) Cultural/Sensitive Structure

Impact

412. Loss of cultural/sensitive structures such as mosques, prayer grounds, temples and madrasa, school and hospital will cause stress/tense on the PAPs. Cultural/sensitive structures (mosque, grave yards, temple, college, school, and madrasa) adjacent up to 250 m away from the ROW boundary will not be affected due to the noise and dust pollution.

Mitigation

413. 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.

f) Road Accident/Road Safety

Impact

414. 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.

Mitigation

415. 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 travelers in the night time. Proper lighting arrangement on the RoW will be done at required places.

g) Split of Communities

Impact

416. The existing Dhaka Bypass Road from Joydebpur-Madanpur will be improved and widened into four lanes. Thus, the community and residence will be divided due to the access controlled wide highway. The residential areas and agricultural land of the villages along the road would be divided into fragmented areas due to the proposed improvement. Local residents' daily activities, production activities, etc. would be significantly affected. In several cases, the expressway would not only split the communities, but also cause hindrance to people in accessing to the schools, hospitals, markets, administrative agencies, mosques etc. This is considered as a major impact of the road during operation phase.

Mitigation

417. During the Detail Design study, efforts have to be paid to avoid split of communities by modification of road alignment. Besides, a number of cross structures (underpass and overpass) for local residents and local vehicles are designed. The locations of underpasses/overpasses have been carefully determined based on existing and future

condition of local areas, and result of consultation with local communities. There are 30 structures (underpass, overpass, flyover) designed under the Project.

h) Income/Job Opportunities

Impact

418. The operation of the improved road would lead to opening up new markets to rural economic activities by reducing the production and transportation cost thereby stimulating agricultural production. The proposed Project will promote better business opportunities such as new petrol pumps and hotels. Due to increase of traffics, more people will be involved to operate the additional traffics.

Mitigation

419. As a regulatory authority RHD will monitor of the road. Illegal infrastructure development and encroachment along the road have to be checked and controlled by RHD. No infrastructure should be built just adjacent to the road.

VII. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

A. Purpose of Public Participation

420. The development and construction of any project will impact on the surrounding human and physical environment and will have beneficial or adverse effects. It is therefore essential that the community can fully understand the project, have the opportunity to express their views and to become directly involved in the project's overall decision-making process.

421. Public authority developers must take account of the community's views and include any useful suggestions to improve the project. This may include suggestions to help further develop environmental protection measures thereby reducing environmental pollution, reducing the loss of environmental resources and improve the project's environmental and social benefits, thus helping achieve more sustainable development.

422. In accordance with the requirements of the ADB as defined in the SPS 2009 Appendix 1, the "borrower will carry out meaningful consultation with affected people and other concerned stakeholders, including civil society, and facilitate their informed participation" The following activities have therefore been carried out in his project in accordance with the ADB requirements.

B. Consultation and Participation during Feasibility Stage

423. During the environmental assessment the level of consultation and participation has been limited to the Focus Group Discussions (FGD) with the local people:

1. Focus Group Discussions (FGDs)

424. A focus group is a group of individuals were selected and assembled by the environmental survey team to discuss and comment on, from personal experience. Central to successful group discussion was to capture a wide range of opinions about the impact and mitigation because of the road project. The groups were consisted of more than 10 people and they were discussed for approximately one hour to gather information and opinion they have. During the field survey, significant efforts were made to identify the possible categories of stakeholders and their stakes. The participants were the villagers, local residents, government officials, shop owners, and public. The FGDs were conducted at three locations along the project corridor at certain intervals or at bazaar areas to confirm more participants. The details of the consultations are given in the below Table VII.1.

Table VII.1: Details of Consultations with Local People

Sl. No.	Location	Date	Time	Comments/Suggestions
01	Bhogra Bazar Bypass	16.07.2019	11.00am to 12.00pm	<ul style="list-style-type: none"> Improved road is essential and we welcome the road.
02	Purbachal Interchange Area	16.07.2019	2.00pm to 3.00pm	<ul style="list-style-type: none"> Due to movement of additional vehicle the road condition become very poor and traffic congestion is common.
03	Bhulta More	17.07.2019	10:00 to 11:00am	<ul style="list-style-type: none"> Local people will be benefited economically due to more employment opportunities.
04	Madnpur Bus Terminal	17.07.2019	03:00 to 4:00pm	<ul style="list-style-type: none"> Water should be sprayed 2-3 times in a day to reduce the dust pollution. Since the road side trees will not be cut so the local environment will not degrade much. However, road safety should be ensured since the road will be very close to the trees. Commuting will be faster which will help

Sl. No.	Location	Date	Time	Comments/Suggestions
				improve business environment.



Figure VII.1: Consultations with Local People

2. Consultations with Stakeholder

425. The preliminary consultation with government officers has been conducted in the early stage of the design and they did not raise any problem/issues regarding this project. Further consultations and official correspondence will be conducted with relevant government authorizes such as local elected public representative, BIWTA, BWDB, DC, Gas Transmissions and Distribution, Telecommunication, Electricity Supply for proceeding construction works. After transferring the utility station further discussion in details will be done. Their concerns are summarized below –

426. Mitigative measures shall be simple and implementable.

- Adopt measures to minimize dust, smoke, and noise pollution, and to control spillages from construction machinery
- Mitigative measures shall be simple and implementable.
- Drainage system will be provided to control surface runoff
- Consider required precautionary and safety measures during relocation of gas, electricity and water pipelines.
- Ensure the proper sprinkling of water during construction stage to control dust pollution.

- To prevent impacts due to noise all the noisy construction activities will be carried out in day time.
- Identify dredged soil collection location with approval of BIWTA/BWDB, as appropriate.

C. Conclusion

427. It will be essential to continue this consultation process to ensure that the community remains supportive and that they are fully informed of progress particularly before and during the construction period. It will be essential that the community is given information on the grievance redress mechanism and that regular meetings with the community are held in the future. Once the project has been approved and a construction program has been defined, the first of a number of community meetings must be held to provide details of the construction program and to give information on the grievance redress mechanism. A website should be set up including all this information, however, many of the community may not have access to the internet, therefore face to face meetings and hard copy handouts must be provided to the whole community.

VIII. CLIMATE CHANGE ASSESSMENT

A. Overview

428. Climate change is a global issue. The world's climate is changing and will continue to change in the coming century. Climate change is one of the significant factors considered in the Environmental/Ecological Assessment. Climate change assessment is done for the current assessment process with the objective to provide assurance that climate change implications are being appropriately considered in the design of the proposed project. The specific objectives are to:

- project authority to manage or reduce the potential risk posed by the impacts of climate change to the project and contribute to climate change action;
- Provide project managers of the co-financiers with information that will assist their broader climate change action; and
- Help decision makers to address climate change implications in a risk management context.

429. The current assessment conducted climate change related investigation based on globally and nationally published climate change prediction reports focusing particularly on the variability of rainfall intensity, temperature changes, flooding and sea level rise. These variables are directly related to the functionality and durability of the proposed project.

430. To conduct the assessment literature review has been conducted available from different national climate change relevant agencies, such as Department of Disaster Management, Department of Environment and Bangladesh Meteorological Department. International and National Climate Change Communication reports, especially the 5th IPCC Assessment Report has been reviewed for relevant major sources of information for impact and vulnerability projection on global and regional temperature, sea level rise, rainfall fluctuation and their impacts on proposed infrastructures. This climate change projection information will help in designing climate resilient highways including all major bridges and other infrastructures.

B. Greenhouse Gas Emission

431. Bangladesh generated 190 million metric tons of greenhouse gas (expressed in MtCO₂e) in 2012, with the agriculture industry contributing about 40% to overall emissions (WRI-CAIT, 2015). This is followed by the energy sector, of which transportation is one of the subsectors, with 33% contribution. The Bangladesh Climate Change Strategy and Action Plan in 2009 identified improving transportation sector energy consumption as a priority since its share of emissions is growing faster than any other sector.

432. The project road is heavily congested due to the transport moving to and from the capital of Bangladesh. The transports moving through the corridor also has the contribution with the country's GHG emission. GHG emission likely to be generated from the project road has been calculated using the Transport Emissions Evaluation Model for Projects (TEEMP)³ developed by CleanAir Asia⁴, the Institute for Transportation and Development Policy and with funding from ADB.

³TEEMP is an excel-based, free-of-charge spreadsheet models to evaluate emissions impacts of transport.

⁴A 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.

433. TEEMP is an excel based tool to assess the equivalent CO₂ gross emissions without (business as usual or BAU) and with the project improvements (with project scenario or WPS). The main improvement from the project that was considered for the model are better surface roughness with less than 2.5m/km, and widening of project road from 2 lanes to 4 lanes. These were translated into increase in traffic speed and hence fuel consumption. The model has also been used for CO₂ emission assessment during construction stage. The model also allows for the inclusion of impacts related to traffic congestion with and without project through provisions for inserting data on the traffic numbers, lane width, number of lanes and volume/capacity saturation limit. The model also computes for emission and emission intensity of PM and NOx.

434. Few assumptions were made in this software:

- Fuel efficiency as reckoned in business as usual (BAU) and with project scenario (WPS) is given in Table VIII.1.it is assumed that the fuel efficiency of the vehicles would increase due to improvement of the roads.
- 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 VIII.2. Pre Euro vehicles are assumed to be completely discarded.

Table VIII.1: Fuel Efficiency in Km/l

Scenario	2017			2042		
	Petrol	Diesel	LPG	Petrol	Diesel	LPG
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 VIII.2: 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
Car			20%	80%		20%	80%
Multi-axle		10%	20%	70%	10%	20%	70%
Bus		10%	20%	70%	10%	20%	70%
2-axle		10%	20%	70%	10%	20%	70%

435. 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).

436. Traffic forecasts were taken from Detailed Project Report and is shown in Table VIII.3. The corresponding growth rates for different vehicle types are indicated in Table VIII.4.

Table VIII.3: Annual Average Daily Traffic (AADT) for Joydeppur-Madanpur Road

Section ⁵	Vehicle Type	2017	2020	2025	2030	2035	2042
1	Car	619	957	1692	2009	2433	2915
	Multi-axle	7123	8029	9245	10433	10816	11314

⁵(Section 1: Naujuri to Purbachal, km-26.5 km), Section 2: Purbachal to Bhulta; km-8.3), Section 3: Bhulta to Madanpur) (Section 3: Bhulta to Madanpur; km-13.5).

Section ⁵	Vehicle Type	2017	2020	2025	2030	2035	2042
	Bus	1956	2216	2552	2879	2985	3783
	2-axle	645	1091	2089	2496	2821	3668
2	Car	1219	1769	2930	3453	3786	4966
	Multi-axle	3473	3915	4508	5086	5275	5562
	Bus	597	661	760	856	887	981
	2-axle	990	1471	2500	2955	3259	4269
3	Car	643	1014	1827	2171	2424	3160
	Multi-axle	5387	6071	7072	7886	8177	8495
	Bus	795	896	1030	1161	1195	1336
	2-axle	1370	2218	4095	4515	5473	7125

Table VIII.4: Normal Traffic Growth Rates for Different Category of Vehicles

Period	Car	Multi-Axle	Bus	2-Axle
2017~2019	5.78	5.78	5.78	5.78
2020~2024	4.5	4.5	4.5	4.5
2025~2029	4.1	4.1	4.1	4.1
2030~2034	4	4	4	4
2035~2036	4	4	4	4
2037~2042	4	4	4	4

437. Input parameters as considered for all the project roads are as given in Table VIII.5. 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 VIII.5: Input Parameters for TEEMP

No.	Particular	BAU	WPS
1	Lane width (m)	3.5	3.65
2	Lane length (km)		
	Section 1	26.5	26.5
	Section 2	8.3	8.3
	Section 3	13.5	13.5
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

438. 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.

Table VIII.6: CO2 Emission Factors for Different Vehicle Types

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

439. It was assumed that multi-axes, bus and 2-axes constitute 40% respectively of the total local traffic. Emissions from road construction were estimated by using the emission factor for rural/urban roads, by using ADB - Carbon footprint

1(<http://www.adb.org/documents/reports/estimating-carbon-footprints-road-projects/default.asp>), which is equivalent to 48,400 kg CO₂/km of road construction.

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

441. The project road section-wise CO₂ emission intensity is provided in Table the design life of the road is 20 years. Total CO₂ emission at business-as-usual, project without induced traffic, and project with induced traffic were estimated as 22,767.40 tons, 7,355.51 tons, and 8,411.56tons, respectively.

442. Emissions from PM and NO_x were likewise shown in Table VIII.7. PM and NO_x emissions are higher during with project scenario, as a result of more vehicles using the road compared to the BAU scenario.

Table VIII.7: Output and Output Intensity of CO₂, PM and NO_x

Parameters	GHG / Pollutants	Project Scenario		
		BAU	WPS (without induced traffic)	WPS (with induced traffic)
Output (tons)	CO ₂	22,767.40	7,355.51	8,411.56
	PM	250.18	1,902.49	1,937.11
	NO _x		1,846.58	1,881.08
Output Intensity (tons/year)	CO ₂	875.67	22,490.90	25,719.96
	PM	529.23	5,817.23	5,923.08
	NO _x	527.49	5,646.27	5,751.77

443. In terms of intensity, total CO₂ emissions at business-as-usual, with-project (without induced traffic) and with project (with induced traffic) scenarios were estimated at 875.67 tons/year, 22,490.90 tons/year and 25,719.96 tons/year, respectively. These values are significantly lower than the 100,000 tons CO₂e/year threshold⁶ set in ADB SPS 2009. Thus, the project road is feasible and cost-effective option to reduce or offset greenhouse gas emissions.

C. Climate Change Impacts Considerations

444. The impacts consideration assessed the hydro-meteorological parameters that are directly and indirectly exposed to climate change phenomenon for facilitating the detail design and environmental impact assessment process. Projecting the impact of global climate change on any infrastructure/related natural resources requires representation of climate processes on a variety of spatial scales, from global down to local level. In this regard, under the current scope of works, neither any GCM or RCM climatic models nor any hydro-dynamic simulation was newly conducted; rather raw data available from different existing climate and hydro-metric observations and regional projections from different sources were used. The assessment provides some recommendation/potential solutions/mitigation for climate resilient structures based on the findings of the literature review.

1. Climate Projections: Temperature

445. The IPCC 5th assessment report (AR5) indicates that the global mean temperatures will continue to rise over the 21st century if greenhouse gas (GHG) emissions continue unabated. Global surface temperature change for the end of the 21st century is likely to exceed 2.5°C relative to 1986 to 2005 for all RCP (Representative Concentration Pathway) scenarios except

⁶Page 38, Appendix I, footnote 10 of SPS 2009

RCP2.6, and warming will continue beyond 2100 under all RCP scenarios except RCP2.6. Table VIII.8 shows the projected change in global mean surface air temperature.

Table VIII.8: Projected Surface Change in Global Mean Air Temperature (likely range)

Time Period (base year - 1986 to 2005)	Temperature (°C)			
	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
2046-2065	0.4 to 1.6	0.9 to 2.0	0.8 to 1.8	1.4 to 2.6
2081-2100	0.3 to 1.7	1.1 to 2.6	1.4 to 3.1	2.6 to 4.8

446. On the other hand, for South Asia the report projections indicate that, compared to the average in the 20th century, average annual temperatures could rise by more than 2°C over land in most of South Asia by the mid-21st century and exceed 3°C, up to more than 6°C over high latitudes, by the late 21st century under a high-emissions scenario (RCP8.5); while under a low-emissions scenario (RCP 2.6) average temperatures could rise by less than 2°C in the 21st century, except at higher latitudes, which could be up to 3°C warmer.

Table VIII.9: Projected Temperature Change for Bangladesh under CC Scenario

Time Period (base year - 1986 to 2005)	Temperature (°C)		
	Annual	Monsoon (Jun-Sep)	Winter (Dec-Feb)
2071-2100	4.34	3.43	5.37
2011-2041	1.49	1.50	1.80

447. Even though, IPCC assessment report does not provide any country level projections, under the Comprehensive Disaster Management Programme (CDMP II) of Department of Disaster Management (Ministry of Disaster Management & Relief) acclimate model PRECIS (Providing Regional Climates for Impacts Studies) is used to get climate change scenario for Bangladesh. Table VIII.9 show the projected temperature change for Bangladesh under CC scenario.

2. Climate Projections: Precipitation

448. AR5 reports that, in the long term, global precipitation will increase with increased global mean surface temperature. Global mean precipitation will increase at a rate per degree Celsius smaller than that of atmospheric water vapour. It is likely to increase by 1 to 3% / °C for scenarios other than RCP2.6, for RCP2.6 the range increase will be 0.5 to 4% / °C at the end of the 21st century.

449. In the South Asian region AR5 projections indicate that under a high-emissions scenario more rainfall will be very likely at higher latitudes by the mid-21st century and over southern areas of the late 21st century. Under a low-emissions scenario, more rainfall at higher latitudes is likely by mid-century but no likely substantial changes in rainfall patterns at low latitudes. More frequent and heavy rainfall days are projected over parts of South Asia (IPCC, 2007).

Table VIII.10: Projected Precipitation Change for Bangladesh under CC Scenario

Time Period	Precipitation (mm/day)		
	Annual	Monsoon (Jun-Sep)	Winter (Dec-Feb)
(base year - 1961 to 1990)	3.5	7.24	0.59
2071-2100	0.90	1.43	0.03
2011-2041	0.64	1.40	-0.05

450. Analysis of past trend of rainfall by (CDMP II, 2013) study reveals that all-Bangladesh annual normal rainfall has not changed much in Bangladesh. For a period of 30 years (1980-2009), the annual normal rainfall is found to be 2,306 mm, such rainfalls were 2,298 and 2,314 mm during 1960-1989 and 1970-1999, respectively. On the other hand, Bangladesh normal rainfalls in different seasons show some mixed trend. Pre-monsoon (March-May) and post-monsoonal (October-November) normal rainfalls have increased and the monsoonal (June-September) normal rainfall has decreased over the three time periods (1960-89, 1970-99 & 1980-2009). The winter (December-February) normal rainfall has increased in the last two periods compared to the first period. The change in projected precipitation for Bangladesh, as found by PRECIS run (CDMP II report) is presented in the Table VIII.10.

3. Climate Projections: Wind Speed/Cyclone

451. As predicted by AR5, globally, it is likely that the area encompassed by monsoon systems will increase over the 21st century. While monsoon precipitation is likely to intensify due to the increase in atmospheric moisture, monsoon winds are likely to weaken. However, based on process understanding and agreement in 21st century projections, it is likely that the global frequency of occurrence of tropical cyclones will either decrease or remain essentially unchanged, concurrent with a likely increase in both global mean tropical cyclone maximum wind speed and precipitation rates.

452. The future influence of climate change on tropical cyclones is likely to vary by region, but there is low confidence in region-specific projections of frequency and intensity. In fourth assessment report of IPCC (AR4, 2007), an increase of 10% to 20% in tropical cyclone intensities (wind speed) for a rise in sea-surface temperature of 2°C to 4°C relative to the current threshold temperature is likewise projected in East Asia, South-East Asia and South Asia.

453. For Bangladesh, based on the above analysis, 20% increase of wind speed (cyclone prone area) is assumed for the current assessment considering year 2100. Considering the maximum wind speed (260 km/h) of the most recent cyclone, the projected highest wind speed is calculated as 310 km/h (projection year 2100).

4. Climate Projections: Sea Level Rise

454. AR5 predicted, it is very likely that the rate of global mean sea level rise during the 21st century will exceed the rate observed during 1971–2010 for all Representative Concentration Pathway (RCP) scenarios due to increases in ocean warming and loss of mass from glaciers and ice sheets (Table VIII.11).

Table VIII.11: Global Mean Sea Level Rise (values shown as median and likely range)

Time Period (base year - 1986 to 2005)	Sea Level Rise (m)			
	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
2020	0.08 [0.06 to 0.10]	0.08 [0.06 to 0.10]	0.08 [0.06 to 0.10]	0.08 [0.06 to 0.11]
2050	0.22 [0.16 to 0.28]	0.23 [0.17 to 0.29]	0.22 [0.16 to 0.28]	0.25 [0.19 to 0.32]
2080	0.35 [0.24 to 0.48]	0.41 [0.28 to 0.54]	0.40 [0.28 to 0.53]	0.51 [0.37 to 0.67]
2100	0.44 [0.28 to 0.61]	0.53 [0.36 to 0.71]	0.55 [0.38 to 0.73]	0.74 [0.53 to 0.98]

455. It is very likely that in the 21st century and beyond, sea level change will have a strong regional pattern, with some places experiencing significant deviations of local and regional sea level change from the global mean change. However, no local level SLR data could be found for Bangladesh based on the AR5 by the current assessment. The potential impact of SLR on

the infrastructures of the proposed project described in the following section based on available literatures.

5. Flood Flow

456. Bangladesh is located at the confluence of three major river basins: the Ganges, Brahmaputra and Meghna (GBM) basins. In order to understand the future impacts on water resources in Bangladesh, it is necessary to investigate these trans-boundary rivers (only 5% of the Ganges catchment and 7% of the Brahmaputra catchment lie in Bangladesh) (Faifung, Franchis, & Jahir, 2006).

457. The previous phenomena related with flooding illustrates that, the magnitudes of water level of peak flows at Bahdurabad in the Brahmaputra in 2007, 2004, 1998, 1988 were found 0.88m, 0.68m, 0.87m and 1.12 mPWD above danger level respectively. At Hardinge Bridge of the Ganges River, the magnitudes of water level during floods in 2007, and 2004 were always below the danger level. During 1998 and 1988, magnitudes of the peak flow were found 0.94m and 0.62 mPWD above danger level respectively. In terms of the magnitudes of peak flows in the Meghna River at Bhairab Bazar point in 2007, 2004, 1998, 1988 were found 0.69m, 1.53m, 1.08m and 1.41 mPWD above danger level respectively (Islam, Haque, & Bala, May 2008).

458. The impact of climate change on a river, mainly on its flood flow may be viewed as a complex interaction between climate, hydrology, hydraulics and morphology of the river system. In order to assess such complex hydraulic and morphologic response of a river to climate change, application of mathematical modelling is essential (Kamal, 2011-12). At present, regional estimates of SLR are scarce, therefore in few instances SLR estimation was conducted through expert consultations. In the absence of a scientific SLR, local climate change scientists used an estimate of between 27 and 32cm global SLR by 2050 for the Bay of Bengal (Dasgupta, Kamal, Haque, Sharifuzzaman, & Nishat, March, 2014).

459. A recent study conducted by CEGIS an effort was made to investigate flood flow changes of the Meghna River due to climate change and sea level rise with the application of different mathematical models. The GCM precipitation projections along with the sea level rise scenarios given by IPCC have been used to construct different climate change scenarios namely A1B and A2 for the periods of 2030s, 2050s and 2080s. The study indicated that annual flow of Meghna River decreases 4% by 2030, 6% by 2050 and 6% by 2080 for A1B scenario. For A2 scenario, the changes are 14% decreases (2030), 4% decrease (2050) and 11% increase (2080) (Hossain, et al., 2015).

460. The average annual flow volume of Ganges for three time slices in two different SRES scenarios shows that annual flow volume increases 22% by 2030, 26% by 2050 and 19% by 2080 for A1B scenario. A similar situation is observed for A2 also. So, there is increasing flow which reaches the peak by 2050 and then reduces during 2080 (Ahmed, et al., 2015).

461. A study on projected flow of Brahmaputra River on the basis of future impacts on water resource due to climate change, conducted by IWFM, BUET reveals that, the change of monthly flow for monsoon seasons is predicted to increase 7-12%, 4-13% and 4-13% for 2020s, 2050s and 2080s respectively. The change of monthly flow for Pre-monsoon seasons is predicted to increase 28-56%, 23-60% and 17-92% for 2020s, 2050s and 2080s respectively (Paul, Islam, Hasan, & Rahman, 2015).

462. On a different study, Climate Change Cell of DoE with technical support from Institute of Water Modelling (IWM) conducted a study to assess the impact of Climate Change and Sea Level Rise on Monsoon Flooding. The study followed a projection of 23 cm rise of sea level above 2000 level and increase of precipitation by 13%. (Haque, Hassan, Masud, & Tarun Kanti Magumder, 2009).

6. Storm-surge Inundation

463. World Bank conducted a GIS-based research in Bangladesh to delineate vulnerable zone in coastal areas to larger storm-surges and sea-level rise in a changing climate by 2050 during 2010 (Figure VIII.1). The project developed inundation risk map due to SLR under climate change condition following IPCC AR4 (IPCC, 2007).

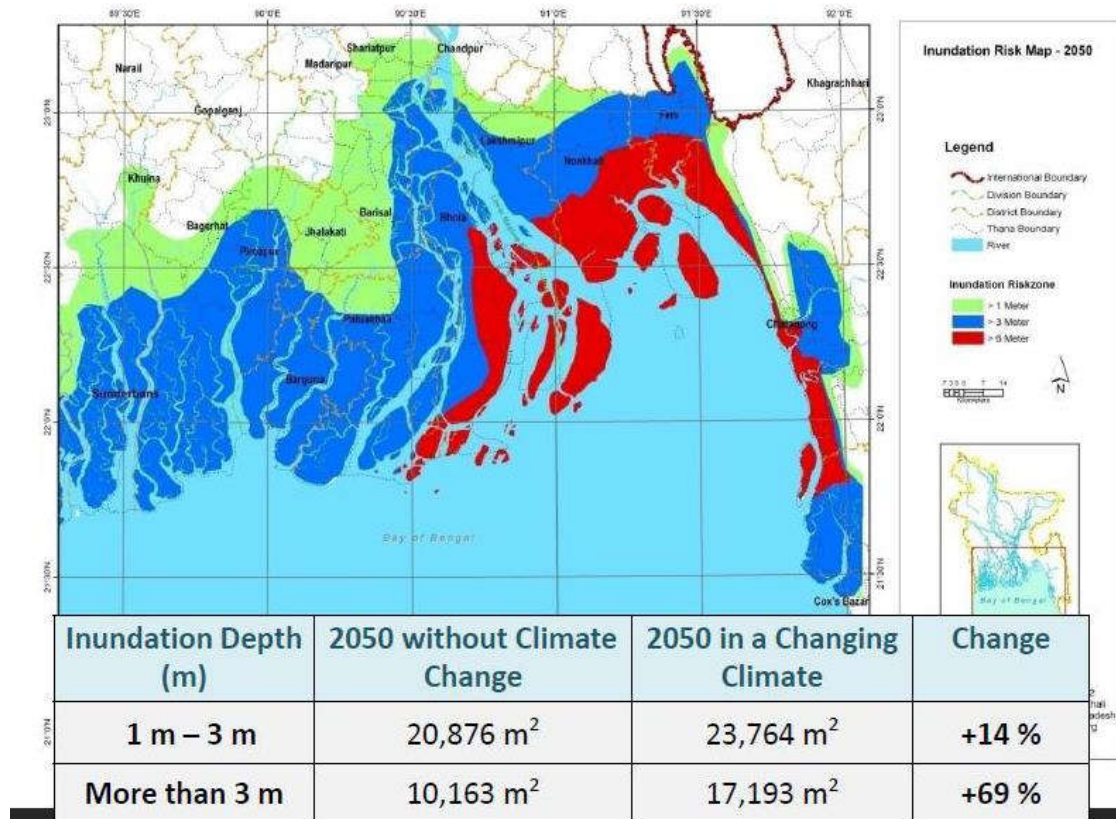


Figure VIII.1: Storm Surge Inundation Area (2050 in a changing Climate)

7. Salinity Intrusion

464. Saline water intrusion is highly seasonal in Bangladesh and during dry season deep landwards intrusion occurs through the various tidal rivers in the western part of the delta, and through the Lower Meghna estuary. Studies show that more saline water intrusion is likely to occur during dry season with the increased sea level rise. A study by WARPO (2005) shows that sea level rise would increase the extent of saline intrusion by pushing the saline waterfront landwards as projected based on IPCC 3rd Assessment Report (TAR 2001, which predicted global sea level rise of 32 cm by 2050 and 88 cm by 2100).

465. Another study by DERRA (2007), with a modified SLR projection (under high emission scenario A2) of TAR presented salinity intrusion map as follows for SLR.

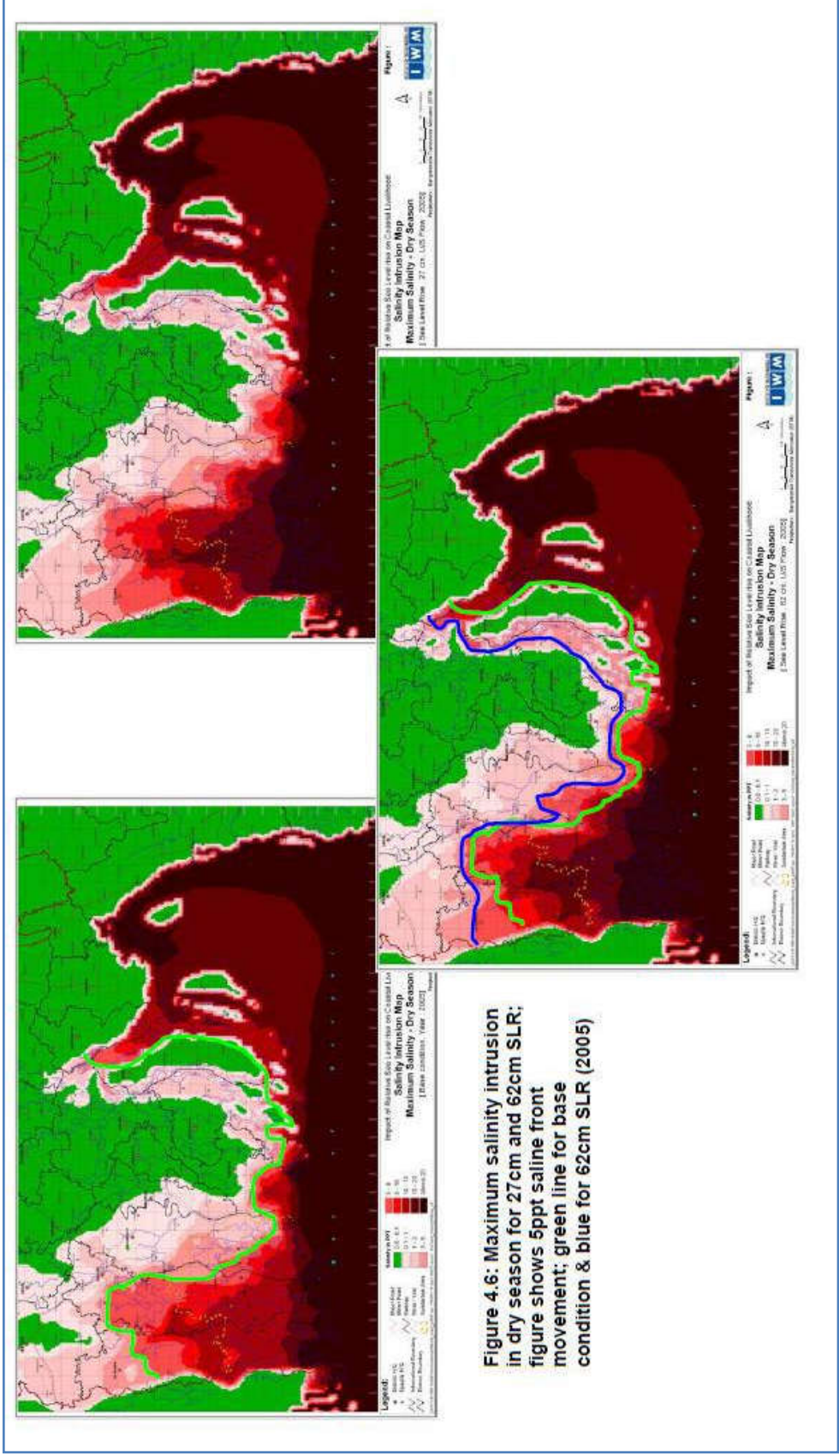


Figure VIII. 2: Salinity intrusion for different Sea Level Rise during Dry Season (DEFRA 2007)

D. Climate Adaptation

1. Introduction

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

2. Adaptation to Flooding

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

468. Weather is a complex system and so is climate change in which the prediction of absolute time and magnitude of future events cannot be envisaged with certainty. However, the IEE considers adaptation measures against flooding as described under:

a) Additional road embankment height to combat climate change induced flooding

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

470. The roads in Bangladesh are designed for 20-year recurrence period. However, as a safeguard, the hydrological study report (Chapter-8 of the FS) suggests that additional height should be applied over the design road height of 30-year return period (i.e. existing height). Thus, the design of the road embankment considers an adaptation allowance of 0.3m above flood level of sub-base of SMVT lane/ Main carriageway (whichever is lower) under a changed future climate to avoid any kind of inundation.

b) Additional freeboard for bridges to combat climate change induced flooding

471. The IEE reports that there are 03 major bridges and 59 small bridges & culverts along the Joydebpur-Madanpur road alignment. Six of the bridges is over 100m in length and is located on the several rivers. The rest of the structures are mostly across undefined channels and carry only seasonal flow. Most bridges are located over depressions and low lying ditches. Culverts are also located in depressions and at low lying agricultural land and operate merely as balancing structures, equalizing water levels on either side of the road embankment.

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

473. As an adaptation measure the design of bridges in the project area has been considered from existing levels in line with the envisaged increase in flood level under a changed future climate as per the outcome of hydrological study. The bridges in the proposed roads are designed for 1 in 50-year return period. The climate change adaptation concept for bridges in the project area takes the bridge design to protect against a 1 in 50-year flood (i.e. 2% chance of occurrence of a 50-year flood magnitude in any given year).

c) Run-off and necessary drainage capacity

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

475. In line with the climate change literature summarized in this report acknowledges that inflows from the three major rivers Ganges, Brahmaputra and Meghna into Bangladesh are on average projected to increase over the monsoon period (driven primarily by increased basin precipitation). As a result, of these increased discharges, the drainage structures throughout the roads have to drain much more water under climate change scenario.

476. The IEE report states that the present Joydebpur-Madanpur road has no longitudinal drainage system and the existing cross-drainages are inadequate in terms of discharge capacity. The road area will need to drain additional discharge due to climate change induced by higher rainfall during extreme events. As an adaptation measure, the proposed road will incorporate longitudinal drains along the highway, increase the number of cross drainages as required and replace existing pipe culverts with box culverts that provide larger discharge openings.

d) Engineering improvement in road design

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

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

3. Construction Materials Policy Adaptation

479. 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.

4. Adaptation to High Temperature

480. 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.

481. The IEE report presents an average monthly maximum and minimum temperature from the representative stations for data of last 30 years. However, many practical problems require knowledge of the behavior of extreme values as the infrastructures we depend upon for food, water, energy, shelter and transportation are sensitive to changes in climate extremes rather than averages. By the IEE report the highest recorded temperature is stated to be 37°C during the last 30 years.

482. The pavement binder bitumen is an essential component of any road pavement and is used widely throughout Bangladesh. General literature on bitumen suggests that road pavement made from viscosity grade (VG) bitumen will have better performance, because the viscosity value measured at 60°C correlates well with rutting behavior and viscosity value at 135°C gives sufficient idea about the mixing and compaction temperature and as a result pavement life is improved. IS 73:2013⁷ classifies four grades of bitumen based on viscosity at 60°C, and recommends applicability for maximum air temperature as given below:

Grade	Grade Suitable for 7-day Average Maximum Air Temperature, 0C
VG10 (80/100)	<30
VG20	30-38
VG30 (60/70)	38-45
VG40 (30/40)	>45
	NOTE—This is the 7 day average maximum air temperature for a period not less than 5 years from the start of the design period.

⁷ Bureau of Indian Standard (BIS, 2013); (Note: Literature on Bangladesh Standards for Bitumen could not be traced.)

IX. ENVIRONMENTAL MANAGEMENT PLAN

A. General

483. Environmental mitigation measures and environmental monitoring requirements will be implemented through an Environmental Management Plan (EMP). The EMP provides details of the environmental impacts, environmental mitigation measures, environment monitoring requirements, and environmental supervision responsibilities.

484. This section provides an approach for managing and monitoring environment related issues for environmental management and resource allocations to be carried out by the Roads and Highways Department (RHD) for mitigating negative impacts of the proposed Project.

B. Objectives of the Environmental Management Plan

485. Environmental management plan (EMP) is prepared for all the identified environmental impacts (as illustrated in Chapter VI) during pre-construction, construction and operation stages due to implementation of various Project activities and associated development. The EMP includes mitigation plan, monitoring plan and environmental cost.

486. The aim of the EMP is to ensure implementation of the recommended mitigation measures effectively. The mitigation measures are designed either to prevent impacts or by mitigating those to reduce the effect to an acceptable level that complies with the environmental guidelines of DoE and with the guidelines of the ADB's SPS (2009) by adopting the most suitable techno-economic options. The EMP also ensures that the positive impacts are conserved and enhanced. The main objectives of the EMP for the construction of the road project are:

- Define the responsibilities of the project proponents in accordance with the three project phases (design, construction and operation);
- 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;
- Define a monitoring mechanism and identify monitoring parameters to ensure that all proposed mitigation measures are completely and effectively implemented;
- Identify training requirements at various levels and provide a plan for the implementation of training sessions;
- Identify the resources required to implement the EMP and outline corresponding financing arrangements; and
- Providing a cost estimate for all proposed EMP actions.

C. Environmental Mitigation Plan

487. Mitigation measures for each of the impacts listed in the Table IX.1 in accordance with the chapter VI. Responsible institutions/departments for the implementation and supervision of each of the environmental issues have also been illustrated. Mitigation measures have been suggested based on the knowledge of the Environmental Specialist, suggestions of the stakeholders collected during public consultation, and opinions from other relevant specialists. Implementation of mitigation measures to protect ECA sites from any pollution due to construction activities must be conducted with due care and responsibility.

488. The mitigation measures will be considered successful when comply with the Environmental Quality Standards (EQS), policies, legal requirements set by DoE and other relevant GoB organizations. In absence of DoE's own EQS, other relevant international or other recognized organization's quality standard will have to be followed.

Table IX.1: Environmental Management Plan-Mitigative Measures

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
1.0 PRE-CONSTRUCTION PHASE						
1.1 Landscape/ Topography	<ul style="list-style-type: none"> ▪ Change in topography due to construction-related structures such as interchanges, bridges, embankments etc.; and ▪ Visual changes to topography. ▪ Improper design would lead to water, air and noise pollution during construction and operation phases. 	<ul style="list-style-type: none"> ▪ The aesthetic elements (such as plantation) should be incorporated in the design; ▪ Large filling and deep cuts would be avoided when possible with the proper alignment planning. Indigenous plants those can grow well under local climatic conditions would be planted to quickly recover the original landscape and vegetation at the cutting roadsides. Vetiver grass is recommended to use for the slope stabilization; ▪ The intersections would be properly designed so as it can be conformable with the existing land form topographically to the extent possible; ▪ Service and utility facility within project with washroom provision should provide wastewater and sewer treatment provision. ▪ Design physical noise barriers to maintain noise level within standard at sensitive receptor points (e.g. school, religious places, hospital, etc.) beside the alignment. ▪ Design speed control mechanism to regulate noise and vibration generated due to over speed of vehicles. 	<ul style="list-style-type: none"> ▪ Throughout the alignment, at intersection sites. ▪ At sensitive receptor sites 	Throughout the pre-construction period.	Project Company	PIU
1.2 Natural Calamities (Flood, Cyclone/Storm Surges)	<ul style="list-style-type: none"> ▪ The project road is not under threat to devastating flood. 	<ul style="list-style-type: none"> ▪ A detail flood study has been done and the output recommendations have been included in the engineering design of the project to assure an adequate flood 	Throughout the alignment, bridges, and culverts.	Throughout the pre-construction period.	Project Company	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
1.3 Land Acquisition and Resettlement	<ul style="list-style-type: none"> Acquisition of 37.60 acre land. Several water bodies will be directly affected; Resettlement of Project Affected Persons (PAPs). 	<p>release capacity by providing sufficient culverts and bridges along the alignment.</p> <ul style="list-style-type: none"> Land acquisition and resettlement plan has to be prepared by the social and resettlement specialists following the national legal frameworks and ADB's Safeguard Policy Statement in order to deliver proper compensation and resettlement of the affected people; Careful alignment and route selection by the designer to minimise resettlement; Acquire minimal area of land that meets the requirement of the proposed road improvement; and Allocation of proper compensation according to Resettlement Plan (RP). 	Throughout the alignment.	Throughout the pre-construction period.	PIU/Deputy Commissioner (DC)/NGO	PIU
1.4 Agriculture Production Loss	<ul style="list-style-type: none"> A total of 37.60 acre of land will directly occupied by the project and 25.60 acre of this area is agricultural land. Production of various crops from this agricultural land will be permanently lost. 	<ul style="list-style-type: none"> A compensation program of 5,597,143,705.29 BDT, creation of employment for victim family, initiatives to reduce negative impact on agricultural lands and increased crop production from limited land will keep the loss at an agreeable limit. 	Throughout the alignment.	Throughout the pre-construction period.	PIU/DC/NGO	PIU
1.5 Removal of Commercial Structures	<ul style="list-style-type: none"> 627238.21 sqft. Commercial structures are located within the ROW which will be directly affected. 	<ul style="list-style-type: none"> The Project Affected People (PAPs) must be informed through notice in time as though they can get enough time to make plan for relocation/shifting; and The PAPs will have to be properly compensated and relocated as per the RP before commencing removal of commercial infrastructure; 	Along the alignment at sites identified in the RP.	During design stage; always prior to construction starting in the area where the site is located.	PIU/DC/NGO	PIU
1.6 Removal of Physical Cultural and Other Community Structures	<ul style="list-style-type: none"> 31 cultural structures are located within ROW. 	<ul style="list-style-type: none"> The people using the infrastructure must be informed prior to removal and/or relocation; and 	Along the alignment at CPRs sites identified in the RP.	During design stage; always prior to	PIU/DC/NGO	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
1.7 Damage to Public Utilities	<ul style="list-style-type: none"> Utility lines will have to be moved disrupting services 	<ul style="list-style-type: none"> Removal and/or relocation of community structures will have to be executed after discussion with the local people/users/associated stakeholders. Provision in the design and budget for the relocation of the existing utility infrastructures, wherever required; All public utilities (e.g. water/gas pipes, power/telephone lines, mobile tower) likely to be affected by the proposed project will be relocated before the actual commencement of the construction work. Informing all hospitals, schools, places of worship, and affected communities well in advance; Utilities will only be removed and relocated with proper agency approvals and permission; If utilities are damaged during construction, it will be reported to the Consultants and utility authority and repairs will be arranged immediately at the Company's expense. Reconnection of utilities will be completed at the shortest practicable time before construction commences. 	Along the alignment.	<p>construction starting in the area where the site is located.</p> <p>Permits and locations will be established and included in construction drawing and relocation will take place prior to construction.</p>	PIU /DC/ PDB/BTCL/ Project Company	PIU
1.8 Tree Cutting and Wildlife	<ul style="list-style-type: none"> Cutting of 10782 trees; Loss of habitat (roadside, floodplain, river and coastal mangrove habitats identified in the project area) of some wildlife in relation to the wetlands, trees and vegetation; and Relocation/migration of 	<ul style="list-style-type: none"> Prior notice to the owners of the trees and ensure proper compensation to the affected people according to the Resettlement Action Plan; and During cutting of trees cautious observation is essential regarding smooth and safe relocation/migration of wildlife (if any) and it has to be ensured that no wildlife becomes hurt during tree cutting. 	Along the alignment.	<p>The Tree plantation plan will be updated and completed early during the construction period. Cutting will take place throughout the</p>	FD/PIU /DC	PIU, MoEF

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
	<p>wildlife;</p> <ul style="list-style-type: none"> ▪ Clearance of vegetation on the ROW along the alignment will cause permanent and/or temporary dislocation of some wildlife because of disturbance on their habitat. ▪ During survey, vegetation clearing, removal of infrastructure and utilities will make the wildlife panic. ▪ During site clearance there is a possibility to injure and/or death of any species. ▪ The birds and its nest on the trees will be directly affected. 	<ul style="list-style-type: none"> ▪ A total of minimum three times saplings against felled down trees will be planted during construction stage (preferably during monsoon period). ▪ Prepare a Tree Plantation Plan along with SEMP showing specific location and timeline for tree plantation. ▪ 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; ▪ During clearing of the vegetation, the security of the wildlife species must be ensured. ▪ While clearing vegetation it must be ensured that no wildlife (snakes, mongoose, fox, squirrel and other wildlife species) injure and/or die. ▪ Harming and/or killing of any types of wildlife by the workers of the project must be prohibited. ▪ In case of appearance of any endangered/threatened wildlife species respective regulatory authority must be informed as early as possible. ▪ Provide proper layout of construction camp ▪ clearly mark work area to prevent unnecessary or careless clearing, ▪ Optimum utilization of the site and existing infrastructures ▪ Construction of additional temporary infrastructures should be minimum ▪ Minimize soils movement 		<p>construction period and replanting immediately after each section of the road is completed.</p>		

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
1.9 Change of Local Hydrology/Drainage Congestion	<ul style="list-style-type: none"> Diversion across the three major bridges and 59 culverts/minor bridges construction; and Temporary change in local hydrology. 	<ul style="list-style-type: none"> Minimize cutting tree and vegetation Provide adequate stabilization protection works against the bank erosion and sedimentation as per design Ensure adequate supervision and monitoring Proper workers camp with adequate amenities Keep camps in good order Design of diversion and approach road have to be designed in a way that does not bring any short/long term hydrological change and/or drainage congestion. A Dredge Material management plan must be developed and wastes generated during dredging and piling must be disposed according to this plan. Wastes have to be disposed in controlled manner at designated site only according to the characteristics of the waste. For construction of surface drainage, avoid discharge point to sensitive environment and avoid any disruption of surface runoff All earthworks must be conducted during dry season to Carefully design and control all wastes and manage the use of petroleum products. Maximum extent possible to avoid problems from runoff. Take all precautions to prevent entering of wastewater into streams, watercourses, Setting of drainage channels, culverts, sedimentation ponds, etc. Proper compensation to the affected 	Bridges and embankments as well as at culvert construction sites.	Throughout the pre-construction period.	PIU / Project Company	PIU, BIWTA, BWDB
1.10 Water Bodies and	<ul style="list-style-type: none"> Several of water bodies will 	<ul style="list-style-type: none"> Proper compensation to the affected 	Along the alignment,	Throughout the	PIU /DC/NGO/	RHD

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
Fisheries	<p>be directly affected;</p> <ul style="list-style-type: none"> ▪ Pile driving and dredging for the construction of 3 major bridges and 59 small bridges and culverts will force to migrate the fisheries and other aquatic species. 	<p>people who will lose their culture fisheries ponds;</p> <ul style="list-style-type: none"> ▪ Flow of water in the rivers must be undisturbed as possible; ▪ Erosion and siltation have to be prevented at bridge and culvert construction site; ▪ Consider protection measures during the design when working at the Turag and Shitalakshya river since they are Ecologically Critical Area (ECA). ▪ Fallow lands can be prepared into fish ponds through excavation work. ▪ Farmers can be encouraged to practice of integrated fish farming (e.g. fish farming in the paddy field). ▪ In order to minimize the production loss of fish, production capacity in the existing fish enriched ponds in the Col can be enhanced through excavating the ponds 	River, ponds and roadside borrow pit site areas	pre-construction period.	Project Company	
1.11 Labour Standard	<p>Inadequately prepared labour standards, leading to infractions regarding child labour, minimum wage, forced labour, and unsanitary working conditions and unsafewater supplies</p>	<ul style="list-style-type: none"> ▪ RHD will strictly adhere to Bangladesh Labour Act 2006, ADB and ILO and other international standards. 	At all construction sites	At all times and for the entire construction period	Project Company	PIU
1.12 Technical Capacity to undertake all environmental work	<p>Inability of Company and RHD to implement the IEE and it EMP resulting in a breakdown of safeguards implementation.</p>	<ul style="list-style-type: none"> ▪ RHD/PIU to conduct a one day briefing and training for Company's and RHD staff on IEE and EMP implementation, surveys and data recording 	RHD/PIU Office	Pre-construction period/Beginning of construction period.	PIU, and Project Company	RHD
2.0 CONSTRUCTION PHASE						
2.1 Landscape/ Topography	<ul style="list-style-type: none"> ▪ Cutting 10782 trees and dismantling of existing 	<ul style="list-style-type: none"> ▪ Ensure minimal acquisition of agricultural land as possible and 	Embankment areas of the proposed	Throughout the construction	Project Company	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
	<p>1525 infrastructure will cause landscape change;</p> <ul style="list-style-type: none"> Permanent acquisition of land used for agricultural (25.60acre), residential (11.75acre), and other purposes to build road embankment will cause landscape change. 	<ul style="list-style-type: none"> Proper landscaping; Construction camps should be constructed at suitable place to minimize this impact. Vegetation clearing has to be at minimum level as possible. After completion of road construction, trees shall be planted along sections of road near the populous residential areas to improve landscape along the road. All the affected areas will be restored to their original levels. 	<p>alignment area as well as at all construction camp area.</p>	<p>period.</p>		
<p>2.2 Loss of Top Soil</p>	<ul style="list-style-type: none"> Typical activities during the road construction phase include ground clearing (removal of vegetative cover), grading, excavation, trenching, vehicular and pedestrian traffic, and construction and installation of facilities may lead to loss of topsoil (0.5 m from the surface) in ROW. Compaction of topsoil due to vehicular and pedestrian movement. Loss of top soil by wind and water erosion. Covering of top soil by project works. Clearing topsoil in proposed embankment area can lead to loss of nutrient. 	<ul style="list-style-type: none"> Minimize the extent of disturbance activities to minimize impacts to soil outside the ROW. The stockpile slope to be no steeper than 2 (H):1 (V) to reduce surface runoff and enhance percolation through the mass of stored soil. Minimize erosion potential and weed species invasion by establishing a healthy plant cover. Keep soil storage periods as short as possible. Locate topsoil stockpiles outside drainage lines and protect stockpiles from erosion. Construct diversion channels and silt fences around the topsoil stockpiles to prevent erosion and loss of topsoil. Use stripped topsoil to cover all disturbed areas and along the proposed tree plantation sites. Mitigate construction-related soil compaction in tree plantation areas by ripping the soil to loosen its structure prior to the spreading of topsoil. 	<p>Embankment areas of the proposed alignment area as well as at all construction camp area.</p>	<p>Throughout the construction period.</p>	<p>Project Company</p>	<p>PIU</p>

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
<p>2.3 Dredging and Dredged Materials</p>	<ul style="list-style-type: none"> ▪ Riverbank erosion and flood at downstream; ▪ Increase of water turbidity and subsequent impact on the aquatic life; ▪ Leakages and spillage from the hydraulic pipeline, impact of air quality and odor from dredge material carrying trucks; and ▪ Dispersion of sediments and release of high sediment laden runoff from the placement sites. 	<ul style="list-style-type: none"> ▪ Limit equipment and vehicular movements to within the approved construction zone. ▪ Fertile soil (or top soil) shall be distributed free to local people who need it for their own purpose. The residuals shall be reused to form the ground around the interchanges, the areas along the road within the acquired land, or recover the vegetation in some affected areas due to the road project. ▪ Obtaining permits for extraction sites and quantities from BIWTA authorities and adhering to the prescribed extraction volume limits per site. ▪ Site selection considering hydrological and river morphological consideration. ▪ Obtain permission and approval from relevant authority if dredging operation is conducted in ECA sites (Turga and Shitalakshya rivers) ▪ Water samples will be collected upstream and downstream of the dredger while in full operation and tested for nutrient, sediment loads, heavy metals as well as oil and grease concentrations. Dredging must not be carried out when the fish are likely to be breeding in the affected surface water bodies, or in the period normally from April to August between spawning and the subsequent emergence of juvenile fish. ▪ Avoid sensitive areas (fish spawning areas). No dredging will be carried out within 1 km from these sensitive areas. 	<p>Dredging sites and dredge material placement sites.</p>	<p>Inspect weekly to ensure that dredge material is properly maintained.</p>	<p>Project Company</p>	<p>PIU</p>

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
		<ul style="list-style-type: none"> ▪ Prior to start dredging and during dredging, quality of river water and river bed dredged materials of the selected rivers need to be tested by the contractor. ▪ The transporting of the dredged materials using watertight dump trucks should not exceed the truck capacity to avoid spillage onto the road and carried out during the night time period (e.g. 21.00 to 05.00). ▪ Directly place the sediments for filling the proposed embankment areas. Prior to filling commencing, the areas being filled will be subdivided into compartments by construction of temporary containment bunds of suitable material (e.g. dredged sand). Filling will be achieved by progressively pumping slurry of sand and water into the bunded areas, allowing the surplus water to drain away to artificial and natural waterways in a controlled manner through the pipeline, without affecting floodplains. 				
2.4 Soil Erosion and Siltation	<ul style="list-style-type: none"> ▪ Soil erosion due to construction activities, earthworks, cut and fill operations and from stockpiles; and ▪ Increase of the surface water turbidity and disruption of usual photosynthesis and fish spawning process. 	<ul style="list-style-type: none"> ▪ The Company is required to reuse the excavated soil as much as possible unless the soil is considered not suitable for filling. ▪ The Company shall plan his works to minimize surface excavation works during the rainy season where practicable. ▪ Precautions to be taken at any time of year when rainstorms are likely, actions to be taken when a rainstorm is imminent or forecast, and actions to be taken during or after rainstorms shall be developed by the Company. Particular attention shall be 	At all work sites, in the impact corridor, including at cut areas.	Inspection as part of the engineering cycle and reporting to RHD	Project Company	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
		<p>paid to the control of surface runoff during storm events, especially for sites located near steep slopes.</p> <ul style="list-style-type: none"> ▪ Slope protection measures through turfing and bioengineering work; ▪ In rainy season, prior to construction of roadbed, culverts will be completed with drainage system. The storm water interception and drainage system should be constructed before construction of side slopes. ▪ Riprap or rock material should be used to embed the surface of the road side slopes. Planting at the surface of the road side slopes is also recommended. Retaining structures such as gabions, cribs, or other types of green barricades and grid work should be used to batter back against the cutting slopes. ▪ At the sections involving high filling, the construction of road should be scheduled to avoid rainy season. If cannot, drainage system will be improved to ensure that storm water be drained smoothly and quickly, and the working surface will be covered. ▪ The overall slope of the works areas and construction yards shall be kept to a minimum to reduce the erosive potential of surface water flows. ▪ The earth work sites where exposed land surface is vulnerable to runoff, etc. shall be consolidated and/or covered. ▪ The material stockpile sites shall be far away from surface water bodies and areas 				

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
		<p>prone to surface run-off. Loose materials shall be bagged and covered. Open ditch shall be built around the stockpile sites to intercept wastewater. If necessary, retarding basins shall be constructed to remove sands and other solids in storm water before it reaches the downstream rivers.</p> <ul style="list-style-type: none"> ▪ Open stockpiles of construction materials (e.g. aggregates, sand and fill material) of more than 50m³ shall be covered with tarpaulin or similar fabric during rainstorms. Measures shall be taken to prevent the washing away of construction materials, soil, silt or debris into any drainage system. ▪ At the start of site establishment, perimeter cut-off drains to direct off-site water around the site shall be constructed and internal temporary drainage works and erosion and sediment control facilities shall be implemented. ▪ Cut-off drains should be built near sensitive areas to catch rainwater before it reaches the critical areas, and diverging drains should be built to avoid excessive concentration of rainwater flow. Concrete dissipation structures should be built to slow down storm water in drains, and hence reduce its downstream erosive potential. ▪ Channels, earth bunds, netting, tarpaulin and or sand bag barriers shall be used on site to manage surface water runoff and minimize erosion. 				

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
		<ul style="list-style-type: none"> ▪ All exposed earth areas shall be completed and revegetated as soon as possible after earthworks have been completed. If excavation of soil cannot be avoided during the rainy season, or at any time of year when rainstorms are likely, exposed slope surfaces shall be protected by temporary drainage measures. ▪ The overall slope of the works areas and construction yards shall be kept to a minimum to reduce the erosive potential of surface water flows. ▪ Minimize soils movement ▪ clearly mark work area to prevent unnecessary or careless clearing, ▪ Rehabilitation of site through plantation, turffing etc. ▪ Reduce the length of slope of runoff to reduce erosion velocity. Where not possible, use stone paving to control erosion ▪ All culvert and drain outlets should be carefully designed and located so that they will not erode the area downstream of the release point ▪ Proper selection and management of quarry site ▪ Rehabilitation of quarry site after completion of work ▪ Provide sediment trap ▪ All culvert and drain outlets should be carefully designed and located so that they will not erode the area downstream of the release point ▪ Proper selection and management of 				

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
2.5 Soil Contamination	<ul style="list-style-type: none"> ▪ Contamination of nearby agricultural land if dredged material is contaminated. ▪ 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. 	<p>quarry site</p> <ul style="list-style-type: none"> ▪ Rehabilitation of quarry site after completion of work ▪ Compensatory plantation ▪ Bare earth should be graded and seeded as soon as after completion as possible ▪ Provide adequate stabilization protection works against the bank erosion and sedimentation as per design <ul style="list-style-type: none"> ▪ Ensure that dredge materials do not contain heavy metals exceeding the international standards by testing prior to using it; ▪ Outflow from hydraulic fill should have max. retention time to enhance settling at the reclaimed site; ▪ Handling of bitumen, fuel and chemicals at designated site in the construction yards only; ▪ The movement of construction vehicles, machinery and equipment will be restricted to the corridor or identified route. ▪ The unusable, non-saleable, non-hazardous construction waste shall be disposed of in the properly delineated places. ▪ The compacted land is restored for agricultural use. ▪ The construction vehicles shall be fueled or repaired/serviced at the designated place with proper arrangement of waste collection and disposal. The arrangement will include, cemented floor with dyke around for fuel storage and filling as well 	At all work sites, in the impact corridor, including at cut areas.	Inspection as part of the engineering inspection cycle and reporting to RHD	Project Company	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
2.6 Air Pollution and Dust	<ul style="list-style-type: none"> The ambient levels of CO_x, NO_x, SO_x, PM_{2.5}, and PM₁₀ may increase during construction phase is mainly caused by: (1) flying dust produced from mixing lime and soil, (2) material stock grounds, (3) Emission, leakage/spillover of materials/spoils during transportation, (4) dust from temporary roads and unpaved road surfaces. Flow of particulate matter from uncovered construction materials 	<p>repairing of construction equipment.</p> <ul style="list-style-type: none"> 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 not at 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. 	At all work sites, in the impact corridor.	Inspection as part of the engineering inspection cycle and reporting to RHD	Project Company	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
	<p>carrying vehicles; and</p> <ul style="list-style-type: none"> ▪ Emissions of air pollutants/GHGs from asphalt machines/engines and firing for bitumen melting. 	<p>should meet allowable exhaust gas emission standards and should be carefully covered.</p> <ul style="list-style-type: none"> ▪ Site for stockpiling soils and sand should be located far more than 500m from the populous residential areas. ▪ All soils excavated from the land surface during the works to construct road foundation shall be transported as soon as possible to the sites for reuse or disposal. ▪ Concentration of construction machinery and vehicles near the populous residential areas should be avoided. ▪ Measures to control air pollution at concrete batching plant, asphalt melting stations, etc. <ol style="list-style-type: none"> 1. Concrete batching plants, crushing plant sites and their ancillary areas shall be frequently cleaned and watered to minimize any dust emissions. 2. Dry mix batching shall be carried out in a totally enclosed area with exhaust to suitable fabric filters. 3. A suitable air pollution control system shall be installed and operated whenever the batching plant is in operation. 4. All stockpiles of sand and aggregate within the batching plant site shall be enclosed on three sides with geotextile sheets (if they are greater than 20m3), and shall be enclosed on three sides with walls extending above the stockpile and 2000mm beyond the front of the stockpile (if they are 				

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
		<p>greater than 50m³).</p> <p>5. The asphalt melting station should be equipped with flue gas control device, operation of asphalt melting will be in enclosed mode; cement and concrete will be mixed within an enclosed structure.</p> <p>6. Cement and other such fine-grained materials delivered in bulk shall be stored in closed silos fitted with a high-level alarm indicator. The high-level alarm indicators shall be interlocked with the filling line such that in the event of the hopper approaching an overflow condition, an audible alarm will operate, and the pneumatic line to the filling tanker will close.</p> <p>7. All air vents on cement silos shall be fitted with suitable fabric filters provided with either shaking or pulse-air cleaning mechanisms.</p> <ul style="list-style-type: none"> ▪ Measures to control air pollution at construction site: <ol style="list-style-type: none"> 1. Use temporary barriers to control dust around the construction sites near the populous residential areas. 2. All vehicles shall have their engine turned off while parked on the site. 3. Construction machinery should be located as far as possible from the construction site boundary. 4. Areas within the construction site where there is a regular movement of vehicles shall have a hard surface and be kept clear 				

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
2.7 Noise and Vibration	<ul style="list-style-type: none"> ▪ Generation of noise due to project activities (e.g. movement of vehicle, construction work, maintenance etc.); ▪ Movement of the heavy construction equipment and vehicles, pile driving operations, operation of crushing, ballasting and aggregating plants, and power generation plants will cause vibration. 	<p>of loose surface material to the satisfaction of the PIU.</p> <p>5. Construction roads should be paved with gravel or asphalt to reduce generation of air-borne dust, and mitigate impacts to residential areas.</p> <p>6. All roads within the construction sites and roads leading to the sites shall be sprayed by using water bowers with spray bars, hose pipes etc. to control dust to the satisfaction of the PIU.</p> <ul style="list-style-type: none"> ▪ The Company shall abide by the provisions of the Specifications of Contract regarding environmental protection and DoE regulations (≤60 dB levels at mosque, school, populated area and other sensitive sites). ▪ The Company shall at its own expense take all appropriate measures to ensure that work carried out (including works by sub-contractors), whether on or off the site, will not cause any unnecessary or excessive noise. ▪ Construction activity near residential areas should be scheduled in daytime only, and the noisy equipment should be prohibited from night operation. During construction in daytime, the construction site should be fenced. ▪ The Company shall select, use and maintain his plant and equipment, and adopt such methods for construction that the maximum vibration levels, measures on any building or structure outside or 	Sensitive sites within 100 m of ROW in the vicinity of the sensitive receptors.	Throughout the construction period, and based on noise measurement surveys	Project Company	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
		<p>within the site limits, do not exceed the permitted levels specified in British Standard 5228-2:2009. The above are limits for vibrations.</p> <ul style="list-style-type: none"> ▪ The Company shall be responsible for repairing any damage caused as a result of vibrations generated from or by the use of his equipment, plant. ▪ Although construction shall be banned in night time some may still occur for technical and other reasons (e.g., bridge piles required continued, around clock concrete pouring). If the work is occurred in the night time and near villages and other residential areas, which would result in particularly significant impacts, the Company shall submit to the PIU a noise statement including full and comprehensive details of all powered mechanical equipment proposed for use during night time hours 21:00 to 06:00 hours and the proposed working methods and noise level reduction measures. The noise statement shall include detailed noise calculations to demonstrate the anticipated noise generation. Special measures (such as use of noise barriers) shall be proposed if excessive noise and vibration is anticipated. The noise statement shall be submitted to the PIU at least seven days before the planned start of any works. No work shall be carried out until the PIU has notified the Contractor in writing of his consent based on the noise statement submitted in relation to such 				

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
		<p>work. Such consent of the PIU shall not in any event relieve the Company of its obligations under the Contract or GOB law.</p> <ul style="list-style-type: none"> ▪ Restriction of rock drilling to the shortest period possible. ▪ All powered mechanical equipment used in the works shall be effectively sound reduced using the most modern techniques. Equipment shall be selected with due consideration for having lowest noise levels, and ensuring that this equipment is regularly maintained to keep such levels during its operation. ▪ All equipment, engines and motors shall be equipped with proper silencers or mufflers during construction. ▪ Positioning air compressors for various construction plant / caisson foundations on rubber sheets. ▪ Construction equipment should be well maintained to keep it in a best operating conditions and lowest noise levels. ▪ The Contractor shall ensure that all equipment engines and motors are equipped with proper mufflers. ▪ Restrict long heavy vehicles and speed in the areas near the populous areas. ▪ Transportation of construction equipment and materials on existing roads shall be carefully designed to minimize adverse impact on residents, as well as traffic on the existing road. The transportation vehicles should be required to slow down 				

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
2.8 Surface Water Quality	<ul style="list-style-type: none"> ▪ During the construction phase, wastewater from construction sites is mainly generated from the concrete watering, pier foundation drains, and sand washing. A medium size construction site generally generates about 20 tons/day of wastewater 	<p>and banned from honring when passing populous residential areas.</p> <ul style="list-style-type: none"> ▪ The use of temporary noise barriers, or acoustic screens or endosures shall be properly examined at the road sections close to the populous residential houses to shield residences from road traffic noise. ▪ After completion of road construction, native tree species shall be planted along sections of road near the populous residential areas to mitigate impact of traffic noise to residents living along the road. ▪ For workers who must work with excessive noisy machines such as piling, explosion, mixing, etc., ear pieces should be provided for noise control and workers protection. ▪ Use of low sound emitting machineries during construction ▪ Create noise barrier ▪ Avoid sensitive receptor as much as possible. ▪ Use new and well-maintained machines. <p>▪ The Company shall comply with the national legislation and other regulations currently applied in Bangladesh as they relate to water pollution control.</p> <ul style="list-style-type: none"> ▪ Avoid activities that may cause pollution to surface water of ECA sites (Shitalkshya and Turag Rivers). If unavoidable, take necessary permission prior to start work from the competent authority. ▪ Protection of the water environment shall 	Along the alignment and bridges/culverts locations	Throughout the construction period	Project Company	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
	<p>with high level of turbidity and pH. If this wastewater is discharged directly into the surrounding water bodies, it would pollute these water bodies.</p> <ul style="list-style-type: none"> ▪ Water pollution may cause damage to the breeding and spawning of fish and may pose threat to other aquatic species; ▪ Oil leakage from the operation of machinery during the bridge construction may also cause river water pollution. Loose materials such as cement and lime stockpiled near the river may also cause river water pollution during rainfall. In addition, domestic wastewater generated from construction camps may also cause water pollution unless it is properly controlled and treated at the site. ▪ During the construction phase, construction camps, warehouse, and material stockpile sites are planned to be set up along the proposed road. Domestic wastewater generated 	<p>be recognized as a key constraint for any construction work. The Company shall devise and arrange methods of working to minimize water quality impacts to the satisfaction of the PIU.</p> <ul style="list-style-type: none"> ▪ The Company shall at all times ensure that all existing water courses and drains within, and adjacent to, the Site are kept safe and free from any debris and any excavated materials arising from the Works. ▪ For construction of the bridge piers bundled site boundaries shall be established to prevent any wastewater discharging directly to the water body environment. ▪ The earthwork sites where exposed land surface is vulnerable to runoff, etc. shall be consolidated and/or covered; ▪ The Company shall ensure that rain runoff from the construction sites is not deposited directly into any watercourse or the coastal environment. ▪ All drainage facilities and erosion and sediment control structures shall be regularly inspected and maintained to ensure proper and efficient operation at all times and particularly following rainstorms. ▪ Wastewater shall be collected, re-used and/or disposed of off-site after oil/grease removal and settlement of suspended solids. Sediment tanks of sufficient capacity, constructed from pre-formed individual cells of approximately 6-8 m³ 				

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
	<p>from construction camps may include fecal sewage and would be a potential source of water pollution. Main pollutants in domestic wastewater are COD and BOD₅. This wastewater would pollute the surrounding water bodies if it is discharged directly into these water bodies without treatment.</p>	<p>capacities shall be used at all sites for settling waste-waters prior to disposal.</p> <ul style="list-style-type: none"> ▪ Construction wastes shall be collected and re-used wherever possible. Otherwise should be disposed in the small deposit area invulnerable to surface run-off, along with soil erosion prevention measures. ▪ The material stockpile sites shall be located far away from water bodies and areas prone to surface run-off. If some must be placed near bridge construction sites, the stockpiles should be surrounded by interception ditches or retaining structures to prevent the erosion and materials into the water bodies. The loose materials should be bagged and covered. ▪ The fuel storage and equipment maintenance yard should have weather/rain protection and should be on concrete pads to prevent dripping and leaking oils from entering the water bodies via surface runoff. All spoil soil disposal sites should only be allowed in the dedicated areas where will be erosion control measures and landscaping plan following the disposal operations. ▪ For construction of bridges, there should be strict waste control plan to restrict discharge or dumping of any directly discharge of wastewater, slurry, waste, fuels and waste oil into the water. All these materials should be collected and disposed at the banks. The slurry and sediment should be pumped to the banks for disposal and should not be allowed to 				

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
2.9 Groundwater Quality	<ul style="list-style-type: none"> ▪ Spillage of oil and chemicals on the soil surface may percolate into the local groundwater aquifer and pollute the groundwater; and ▪ Extraction of excessive groundwater from the locality in the project area for construction work may decrease the level of groundwater table. 	<p>discharge to the rivers directly.</p> <ul style="list-style-type: none"> ▪ Drainage from vehicle maintenance areas, plant servicing areas and vehicle wash bays shall be passed via a petrol interceptor prior to discharge. ▪ The Company shall ensure that no tools or machinery are washed in any water source or areas that drain into an existing watercourse or to the coastal environment. ▪ The Company shall weekly check all equipment for prevention of oil and or lubrication leaks and ensure that all equipment oil and lubrication replacements are performed only in bounded maintenance and repair areas. ▪ Prepare a separate Site-Specific Management Plan before starting the work at Turag and Shitalakshya river since they are ecologically critical area. 	Throughout the alignment, especially where the pile placed to depths ≥ 30 m, and where any new wells were dug.	If new wells are dug and toilet facilities built near wells	Project Company	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
2.10 Drainage Congestion	<ul style="list-style-type: none"> ▪ Construction of bridges and culverts over the waterways may cause drainage congestion; and ▪ Erosion from embankment may also cause drainage congestion through siltation/sedimentation. 	<p>yards and construction camps to regularly monitor the water quality and water levels.</p> <ul style="list-style-type: none"> ▪ Protect groundwater supplies to adjacent lands. ▪ Prepare a program to prevent/avoid standing waters, which PIU will verify in advance and confirm during implementation. ▪ 3 major bridges and 59 culverts/minor bridges have to be constructed with sufficient vertical clearance; Diversion over the waterways during construction of bridges and culverts shall be made in such a way that does not cause any localized drainage congestion; ▪ Proper slope protection (normal conventional reinforced concrete retaining walls and mechanically stabilized earth) on the embankment shall be ensured; ▪ Regular cleaning of channels to avoid choking; ▪ Provide alternative drainage for rainwater if the construction works/earth-fillings cut the established drainage line. ▪ Rehabilitate road drainage structures immediately if damaged by contractors' road transports. ▪ Build new drainage lines as appropriate and required for wastewater from construction yards connecting to the available nearby recipient water bodies. ▪ Construct wide drains instead of deep drains to avoid sand deposition in the 	Throughout alignment earthworks inspection at all work camps and major construction sites such as bridges and embankments as well as at culvert construction sites.	Throughout the construction period	Project Company	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
2.11 Vegetation	<ul style="list-style-type: none"> ▪ During the construction phase, particularly at the sites around the bridge, there will be considerable flow of workers and trucks that will lead to the reduction of vegetation cover. ▪ Presence of trucks hauling loose materials which generates air-borne dust will pose a detrimental effect on the growth of plants near the proposed road. The dust accumulating on the leave surface of plants will prevent the photosynthetic function. ▪ The lime and cement will produce hardpan soil if they are dumped to the soil. Although these impacts are short term, a 	<p>drains that require frequent cleaning.</p> <ul style="list-style-type: none"> ▪ Provide appropriate silt collector and silt screen at the inlet and manholes and periodically clean the drainage system to avoid drainage congestion. ▪ Protect natural slopes of drainage channels to ensure adequate stormwater drains. ▪ Regularly inspect and maintain all drainage channels to assess and alleviate any drainage congestion problem. ▪ Make selective and careful pruning of trees where possible to reduce need of tree removal. ▪ Control noxious weeds by disposing of at designated dump site or burn on site. ▪ Clear only the vegetation that needs to be cleared in accordance with the plans. <p>These measures are applicable to both the construction areas as well as to any associated activities such as sites for stockpiles, disposal of fill and construction of diversion roads, etc.</p> <ul style="list-style-type: none"> ▪ Don't burn off cleared vegetation – where feasible, chip or mulch and reuse it for the rehabilitation of affected areas, temporary access tracks or landscaping. Mulch provides a seed source, can limit embankment erosion, retains soil moisture and nutrients, and encourages re-growth and protection from weeds. ▪ Return topsoil and mulched vegetation (in areas of native vegetation) to approximately the same area of the roadside it came from. 	Along the alignment, trees cutting, camp areas and River site areas	Throughout the construction period	Project Company	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
<p>2.12 Terrestrial Fauna</p>	<p>certain period of time is required to restore the vegetation cover after the works are completed.</p> <ul style="list-style-type: none"> ▪ The vibration of equipment, noise, waste water and exhausts gas are often considered to be disturbances to animals. These could drive animals away from their current habitats. ▪ During the construction phase, trees around the construction sites may be cut down and cause damage to the habitat of wild animals. ▪ Illegal hunting may also occur and pose the threat to wild animals. ▪ During construction phase, air pollution, wastewater, 	<ul style="list-style-type: none"> ▪ Avoid work within the drip-line of trees to prevent damage to the tree roots and compacting the soil. ▪ Minimize the length of time the ground is exposed or excavation left open by clearing and re-vegetate the area at the earliest practically possible. ▪ Ensure excavation works occur progressively and re-vegetation done at the earliest. ▪ Provide adequate knowledge to the workers regarding nature protection and the need of avoid felling trees during construction. ▪ Supply appropriate fuel in the work camps to prevent fuel wood collection. ▪ Setting up and implementation code of conducts to workers, including no catching or hunting fish and wildlife, and no consumption of wildlife products. ▪ Provision of environmental training with information on the importance of biological diversity, and its relationships with sustainable development. ▪ Limit the construction works within the designated sites allocated to the contractors. ▪ Minimize the tree removal during the bird breeding season (February-July). If works must be continued during the bird breeding season, a nest survey will be conducted by a qualified biologist prior to commence of works to identify and located active nests. ▪ Minimize the release of oil, oil wastes or 	<p>Along the alignment, trees cutting, camp areas and River site areas</p>	<p>Throughout the construction period</p>	<p>Project Company</p>	<p>PIU</p>

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
2.13 Aquatic Species	<p>and solid waste generated by the construction works may also deteriorate the animals' habitat, and may force them to evacuate to another habitat.</p> <ul style="list-style-type: none"> Construction of temporary construction sites and access roads may lead to damage and deterioration of local ecosystems. Water pollution may change the dominance and the composition of the plankton. Water pollution will reduce species numbers and relative abundances of populations. Construction materials stored near the watercourses, uncovered excavated soil, stone dumps, and construction wastes may be easily washed out and flow into the water sources by rainfall, thus pollute the watercourses, change the water's pH value and deteriorate the aquatic animals' habitats. This can lead to plankton and benthos deaths and aquatic biomass reduction in the construction areas. 	<p>any other substances harmful to migratory birds to any waters or any areas frequented by migratory birds.</p> <ul style="list-style-type: none"> Provide adequate knowledge to the workers regarding protection of flora and fauna, and relevant government regulations and punishments for illegal poaching. Provision of environmental training with information on the importance of biological diversity, and its relationship with sustainable development. Ensure the riverine transports, vessels and ships are well maintained and do not have oil leakage to contaminate river water. Do not dump wastes, be it hazardous or non-hazardous into the nearby water bodies or in the river. Use pingers upstream and downstream to chase away aquatic species; Monitor area for these creatures to ensure they are well away from the piling site – scare them away if they are too close to the site using pingers. 	Water bodies, wetlands and River site areas along the alignment	Throughout the construction period	Project Company	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
2.14 Fisheries	<ul style="list-style-type: none"> The construction of bridges may lead to the loss of fish habitat due to increased turbidity, decreased dissolved oxygen in the water, and reduction of food sources including temporary decline of plankton and benthos organisms. Increase in suspended solids in the rivers would drive fishes away from the bridge construction sites during the construction phase. Ponds are used for exotic fish culture which has little conservation significance. 	<ul style="list-style-type: none"> Oil and chemical storage should be placed safe distance from the rivers. There shall not be any storage of waste or polluting substances near ECA sites (Turag and Shitalakshya rivers). Do not dump wastes, be it hazardous or non-hazardous into the nearby water bodies or in the river. Inspect any area of a water body containing fish that is temporarily isolated for the presence of fish, and all fish shall be captured and released unharmed in adjacent fish habitat. Ensure the earth filling is done in dry season to avoid killing of the floodplain and many burrow pit fishes. Avoid construction activities during breeding/spawning season 	Water bodies, wetlands and River site areas along the alignment	Throughout the construction period	Project Company	PIU
2.15 Loss of Agricultural Production	<ul style="list-style-type: none"> Earth filling may alter the soil development and soil structure, damage soil texture, lead to loss of organic matter and inorganic nutrients in soil, soil fertility and water-holding capacity, deteriorate soil quality, cause soil erosion and loss of agricultural production. Loss of floodplain areas with consequent loss of crops. Sand removal with wind blow and rain water runoff from road construction 	<ul style="list-style-type: none"> Ensure the approval from National Land Use Committee presided by honourable Prime Minister to avoid any conflict with National Land Use Policy, 2001. Demonstrate measures for changing cropping pattern to compensate the loss of crop production including development of demonstrating plots. Provide training program for the farmers and technical support to them. They should get employment opportunity on a priority. Fertile land where two or more crops grow at present or the land which has such potentiality, that land could be avoided. Non-agriculture khash land should be considered on a priority if non- 	Throughout the alignment	Throughout the construction period	Project Company	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
	<p>place to nearby agricultural field will result in increased sand percentage which will ultimately change the soil composition i.e. its texture.</p> <ul style="list-style-type: none"> ▪ Most of the burrow pits will be filled; winter cropping will face some difficulties as water retention area will be shrunk. ▪ Various types of heavy vehicles and machineries will go also on the besides agricultural land; thus, soil compaction and direct loss of standing crop of one season will be completely or partially destroyed. ▪ Soils of adjacent area of road may be changed in texture and fertility with mixing up with external sand and soils, sometimes oil spills, mobile, pitch, dust, ash etc. ▪ Increased movement of construction laborers will have adverse impacts on adjacent crop fields. ▪ Some marginal and landless farmers may become unemployed due to loss of agricultural land and water logging. 	<p>agriculture khash land becomes available.</p> <ul style="list-style-type: none"> ▪ Top soils of adjacent land could be preserved as these are most fertile and suitable for crop production. ▪ Install drainage system to drain out excessive water during rainy season. Irrigation and drainage system should be installed and reconstructed for a sustainable agricultural production. ▪ Shallow and deep tube well could be used for irrigation to cultivate Boro rice and Rabi crops. Winter cropping area may be increased by installing of deep tube wells. ▪ Agricultural production could be compensated by increasing cropping intensity through introduce of short durational crops, hybrid seeds, HYVs, improved technologies etc. ▪ All fallow land could be cultivated properly. Marginal land like wide ‘ails’, bank of ponds, roof of semi pucca building may use for cultivation of different vegetables. ▪ The farmers could be made financially better off by crop diversifying (Maize, potato, sweet potato, mustard, groundnut, green gram, lentil etc.), vegetable and fruit crop which is much more labour intensive than rice production directly involves women and can employ many more marginal farmers and landless as labourers. ▪ Enhanced inter cropping may result in more crop production. ▪ Movement of heavy vehicles and 				

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
2.16 Pollution from Wastes	<ul style="list-style-type: none"> ▪ Fencing will obstruct cattle movement across the road and thus may cause adverse impacts on agricultural activity like ploughing and cow grazing. ▪ Photosynthesis of nearby crops in the corridor may become slower due to regular deposition of dust and smoke on leaves surfaces created in by vehicles movement. ▪ Dismantling of any structure will generate solid waste; and ▪ Kitchen and sewage wastes from labour camp will cause growth of flies and water born germs. 	<p>machineries should be confined within the right of way; if necessary, a minimum strip of land can only be used.</p> <ul style="list-style-type: none"> ▪ Precaution should be maintained to keep soil erosion and flight of dust at a minimum level, wetting of soil may be helpful. ▪ Ensure maximum possible cleanliness of construction activity. ▪ There might have a provision of cattle pass at a regular interval of 5km, each width should be enough for cattle movement and agricultural machinery movement. ▪ Update the waste management plan (Appendix 10) for various specific waste (reusable waste, flammable waste, construction debris, food waste etc.) prior to commencing of construction and submit to PIU for approval. ▪ Make available MSDS for chemicals and dangerous goods on-site. ▪ Place a high emphasis on good housekeeping practices. ▪ Conduct separate waste collection and promote recycling and reuse. ▪ Appropriate disposal of non-recyclable waste according to rules ▪ Hazardous waste should be treated under the related regulation Maintain landscape, aesthetic appeal ▪ Designs for the works must be compatible with the surrounding environment ▪ Prepare the Debris Disposal Plan, ▪ Remove all construction and demolition 	All construction camp and contractor operations areas, such as batch plants and maintenance yards	Complete monthly	Project Company	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
<p>2.17 Asphalt Hot Mix Plant, Rock Crushing, and Bitumen Supply</p>	<ul style="list-style-type: none"> ▪ Rock crushing activities will generate noise and dust, and asphalt hot-mix plant and pavement works will generate gas and odour while compaction of the pavement will also generate noise and dust. ▪ It is also possible that soil may be contaminated by oils and chemicals at asphalt/bitumen plant sites, workshop areas, and equipment washing yards. ▪ The contamination may limit the future use of the land for agricultural purposes. 	<p>wastes on a daily basis,</p> <ul style="list-style-type: none"> ▪ The site must be kept clean to minimize the visual impact of the site, ▪ Manage solid waste according to 3R policy, Reduce Reuse, and Recycling, ▪ Ensure disposal to designated areas. ▪ Contractors should ensure proper disposal of waste. ▪ Provide a garbage disposal service such that no garbage and food waste is dumped in the contractor's yard or work camp at any time. There should be no litter or food scraps dumped anywhere but in appropriate bins that are collected and cleaned at least weekly. ▪ Cement batching and aggregate mixing plant will be located as far as possible (at least 500 m from settlements and habitation near the project corridor, or as required by environmental regulations; ▪ All conditions of DoE permits and local guidelines will be observed; ▪ Dust suppression equipment will be installed at cement and aggregate mix plants; ▪ Areas of construction, as well as the haul road, will be kept damp by watering. The construction area where local roads are used for hauling, they shall be kept in serviceable condition, and any damage will be repaired promptly without interference to local travel routes; ▪ All hot-mix plants, crushers, and batching plants will be located in agreement with the local district or municipality, and 	<p>All Asphalt hot mix plant, rock crushing plants</p>	<p>Complete monthly</p>	<p>Project Company</p>	<p>PIU</p>

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
2.18 Construction Waste Disposal (Waste water, Oil, Hazardous Waste etc.)	<ul style="list-style-type: none"> ▪ Oil, grease etc. from construction machinery; ▪ Hazardous and solid waste from waste construction material and food; ▪ Waste water from washing and sprinkling; and ▪ Sanitary waste from staff toilets. 	installed in a sealed area only after receiving approval from the relevant local authority and DoE. <ul style="list-style-type: none"> ▪ Organize disposal of all wastes generated during construction in an environmentally acceptable manner. This will include consideration of the nature and location of disposal site, so as to cause less environmental impact. ▪ Transport waste of dangerous goods, which cannot be recycled, to a designated disposal site approved byDoE. Vehicles transporting solid waste shall be covered with traps or nets to prevent spilling waste along the route ▪ Train and instruct all personnel in waste disposal practices and procedures as a component of the environmental induction process. ▪ Provide absorbent and containment material (e.g., absorbent matting) where hazardous material is used and stored and personnel trained in the correct use. ▪ Provide protective clothing, safety boots, helmets, masks, gloves, goggles, to the construction personnel, appropriate to materials in use. ▪ Make sure all containers, drums, and tanks that are used for storage are in good condition and are labelled with expiry date. Any container, drum, or tank that is dented, cracked, or rusted might eventually leak. Check for leakage regularly to identify potential problems before they occur. 	All construction camp and company operations areas	Complete monthly	Project Company	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
<p>2.19 Construction Yards</p>	<ul style="list-style-type: none"> ▪ The siting of construction camps may cause 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. ▪ The construction process will take several years, with the result that the camps will take on a semi-permanent appearance; ▪ Impacts on the local communities and social structures; 	<ul style="list-style-type: none"> ▪ Minimize the production of waste materials by 3R (Reduce, Recycle and Reuse) approach. ▪ Segregate and reuse or recycle all the wastes, wherever practical. ▪ Prohibit burning of solid waste. ▪ Provide reuse containers at each worksite. ▪ Request suppliers to minimize packaging where practicable. ▪ Avoid the use of material with greater potential for contamination by substituting them with more environmentally friendly materials. ▪ Maintain all construction sites in a cleaner, tidy and safe condition and provide and maintain appropriate facilities as temporary storage of all wastes before transportation and final disposal. ▪ The construction camps shall not be located within or nearby the sensitive cultural structures 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 proposed project and implementation of mitigation measures. The crushing plants, asphalt hot mix and batching plants will not be located in environmentally sensitive cultural sites, productive land or existing settlements. ▪ The construction camps shall not be 	<p>All construction camp and company operations areas, such as batch plants and maintenance yards</p>	<p>Complete monthly and submit to PIU</p>	<p>Project Company</p>	<p>PIU</p>

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
	<ul style="list-style-type: none"> ▪ Pollution risk of soil and surface water due to sanitation of the construction camp; 	<p>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.</p> <ul style="list-style-type: none"> ▪ The sites for construction camps and associated facilities shall be reinstated by the Company just after completion of construction works. ▪ Debris, construction wastes, vegetation or other materials shall not be burned on the site. 				
2.20 Occupational Health and Safety (OHS)	<ul style="list-style-type: none"> ▪ Construction workers are more likely to be affected by occupational health hazard through accident and handling hazardous materials at construction site; and ▪ Construction workers are also likely to be affected by water borne diseases and food poisoning at construction camp. 	<ul style="list-style-type: none"> ▪ An OHS plan should be prepared and followed during construction work; ▪ Workers have to be provided PPE (high visible vest, hard hat, safety harness, gum boot, life jacket, goggles, ear plugs etc.) and it has to be ensured that they use PPE properly; ▪ First Aid Box should be readily available at construction site and labour camp; and ▪ Separate accommodation and toilet for female workers. ▪ Proper workers camp with adequate amenities ▪ Keep camps in good order ▪ Cleanup litters and other wastes regularly ▪ Provide secure containers for disposal at designated area ▪ Proper safety on site 	All construction camps	Conduct at work camps every month	Project Company	PIU
2.21 Community Health and Safety	<ul style="list-style-type: none"> ▪ Improper health and safety policy maintained at the site may lead to outbreak of different diseases to the 	<ul style="list-style-type: none"> ▪ Proper health and safety plan should be prepared by the Contractors prior to start construction and take action accordingly during construction to avoid road 	All areas	At all times during construction	Project Company	PIU/Local Authority

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
2.22 Health and Vector Borne Diseases	<p>surrounding communities/ public through the sickness</p> <p>Personal and occupational health issues, stemming from unsanitary toilet facilities, lack of potable water and sanitary washing areas can lead to common disease outbreaks in work camps.</p> <p>Construction work creates areas for water to form stagnant puddles; Also, water can collect in old equipment waste tyre</p>	<p>accidents and health hazards of the surrounding project community.</p> <ul style="list-style-type: none"> ▪ Provide emergency program in the locality for events such as accidents, spillage of hazardous materials on road etc. ▪ Adequate provision of drainage and maintenance ▪ Avoid road paving activities during monsoon. ▪ Locations of hot-mix plants, batching plants and crushers shall be located at least 100 m away from the nearest dwelling preferably in the downwind direction. ▪ Traffic management systems in road and at level crossings, level crossings up-gradation, provision of round the clock manned barriers, and installation of warning signs at all unauthorized crossings indicating the danger involved. ▪ Ensure Flag Man during transport, loading and unloading. 	All work sites and particularly at Construction camps	At least twice per week	Project Company	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
2.23 Traffic Management Plan	<p>dump stored outside, ideal breeding areas for malaria and dengue mosquitoes.</p> <ul style="list-style-type: none"> Traffic jam was occurred without traffic management plan. Construction vehicles sometimes creates road accidents without proper traffic management plan. 	<p>old oil drums–empty to prevent water ponding.</p> <p>The project is mainly the reconstruction of existing road which has heavy traffic volume at present, bearing the important economic exchanges in Dhaka, so traffic maintain is the highlight of the project. According to the conditions of other reconstructed or widened roads under construction in Bangladesh, segmental or semi-segmental construction shall be adopted. The road cannot be blocked completely, and a detailed traffic maintain scheme should be developed before construction.</p>	All areas	Daily	Project Company	PIU
2.24 Traffic Congestion	<ul style="list-style-type: none"> Traffic jams causing inconvenience to the people; The construction vehicles will add more traffic and as a result, traffic congestions and road accidents will be increased. 	<ul style="list-style-type: none"> Prepare and submit a traffic management plan to the PIU for his approval at least 30 days before commencing work on any project component involved in traffic diversion and management. Include in the traffic management plan to ensure uninterrupted traffic movement during construction: detailed drawings of traffic arrangements showing all detours, temporary road, temporary bridges temporary diversions, necessary barricades, warning signs / lights, road signs etc. Traffic management shall be undertaken in coordination with the local traffic police department; BRTA traffic rules and regulations should be strictly followed. Divert traffic to follow alternative routes to avoid traffic jams. Provision to be made for passing traffic 	All areas	At all times during construction	Project Company	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
2.25 Road Accidents	<ul style="list-style-type: none"> The influx of heavy vehicles used for construction work on the road may cause sudden road incident and/or accident. 	<p>during construction.</p> <ul style="list-style-type: none"> In Traffic Management Plan, the road safety measures such as speed breakers, warning signs/lights, road safety signs, zebra crossing, flagman etc. should be included to ensure uninterrupted traffic movement especially at nearby the educational (Schools, colleges, Madrasah etc.), cultural structures (mosques, graveyards, prayer ground etc.) and health complex which are located at the existing road sides as well as at road crossing points during construction stage; Provide signs at strategic locations of the roads complying with the schedules of signs contained in the Bangladesh Traffic Regulations; Restrict truck deliveries, where practicable, to day time working hours; Restrict the transport of oversize loads. Operate road traffics/transport vehicles, if possible, to non-peak periods to minimize traffic disruptions; Enforce on-site speed limit; Install and maintain a display board at each important road intersection on the roads to be used during construction. 	All construction areas	At all times during construction	Project Company	PIU
2.26 Income/Job Opportunities	<ul style="list-style-type: none"> Some job opportunities for executing the construction activities; and Income opportunity through generating small business. 	<ul style="list-style-type: none"> Priority should be given to the local poor and affected people during recruitment; and Gender equity and equal wage have to be ensured. 	All construction areas	At all times during construction	Project Company	PIU
2.27 Tree Plantation	<ul style="list-style-type: none"> 10782 trees to be removed from project construction 	<ul style="list-style-type: none"> Undertake a Tree Plantation Program such that for each tree cut three are planted 	All along the alignment, and	As construction in an area ceases but	RHD/Company/ NGO	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
	<p>corridor.</p> <ul style="list-style-type: none"> Inappropriate selection of tree species and plantation location may not ensure the inherent objective of the tree plantation plan. Lack of proper care (e.g. watering, securing with fence) by the respective authority will also hinder the process of proper growth of the planted trees. 	<p>(32346) and all dead trees to be replanted.</p> <ul style="list-style-type: none"> If possible, shifted homesteads may be compensated through providing seedlings. Especial care should be taken for biodiversity rich areas during construction. 	<p>according to a tree replanting plan</p>	<p>not only at end of construction</p>		
2.28 The Construction Period Environmental Completion	<ul style="list-style-type: none"> Project Company fails to prepare a summary report defining the mitigation and monitoring actions completed and what needs to be continued during the Operating period. The result is a failed or weakened environmental safeguards programme. 	<ul style="list-style-type: none"> Prepare a completion report and deliver to the PIU. 	<p>N/A</p>	<p>Complete within the last one month of the Project</p>	<p>Project Company</p>	<p>PIU</p>
3.0 OPERATION PHASE						
3.1 Construction Period Decommissioning	<p>Inspection of sites to be decommissioned by contractor, are:</p> <ul style="list-style-type: none"> work camps; fuels storage areas waste dump sites; construct access roads <p>But not undertaken, leading to chronic environmental problems due to a lack of proper clean-up.</p>	<ul style="list-style-type: none"> Undertaken a Complete construction area inspection. 	<p>The entire length of the road</p>	<p>Within the first quarter of operations.</p>	<p>Project Company</p>	<p>PIU</p>

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
3.2 Landscape/ Topography	<ul style="list-style-type: none"> Structures attached with the road, such as interchanges, underpasses/overpasses, bridges, etc. would cause slight negative effect on landscape. 	<ul style="list-style-type: none"> It can be mitigated by tree plantation along the proposed Corridor. It would also serve as physical barrier between the road and the existing settlements as well as future developments. On the other hand, aesthetic beauty plays an important role. The construction of new structures such as toll plaza, flyovers, bridges and culverts as well as new carriageway with road side plantation will improve the aesthetics view of the project area. 	Along the entire corridor	At all times	Project Company	PIU
3.3 Air Quality	<ul style="list-style-type: none"> Dust (PM) generated from the road surface dispersed to the air by vehicles running on the roads, and Toxic gases (NOx, SOx, CO, VOC, etc.) generated from vehicle's engines when burning fuel. 	<ul style="list-style-type: none"> The road and bridge surface should be maintained periodically to limit dust generated from the aged asphalt layer. Black smoke producing old engine driven vehicles' movement shall be prohibited. 	Along the entire corridor	At all times	Project Company	PIU
3.4 Noise and Vibration	<ul style="list-style-type: none"> Noise pollution due to the movement of increased number of vehicles; and Wildlife particularly the birds will be affected mostly because of noise. 	<ul style="list-style-type: none"> Construct physical noise barriers to maintain noise level within standard at sensitive receptor points (e.g. school, religious places, hospital, etc.) beside the alignment. Use of hydraulic horn has to be prohibited and use of horn in front of sensitive areas shall be controlled; Tree Plantation will not only help to protect the village from the noise impact but also clean the air, improve landscape and eco-system. This option shall be applied at all road sections near the populous areas. Trees shall be planted along the road section near the populated areas, and in the space between the ROW 	To be determined during detailed design period for baseline establishment and as well as during construction period	At all times	Project Company	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
3.5 Water pollution and (surface groundwater)	<ul style="list-style-type: none"> Erosion on the slope of the road will add silts into the nearby surface water streams. Uncontrolled release of contaminated storm-water/road runoff from road surfaces will pollute the surface water. Hydrocarbons, heavy corrosive products and suspended solids are the surface water pollutants associated with road runoff. Accidental spillage of hydrocarbon products from the vehicles moving on the road may cause nearby surface water pollution through surface runoff. Because of the project, many commercial and business structures will be constructed alongside the road which will cause increased groundwater extraction. 	<p>and the slope. In order to effectively mitigate the impact of noise, trees shall be planted in strip with its length covering the populated area plus 100m more at both sides of the populated area.</p> <ul style="list-style-type: none"> Slopes protection measures and periodic maintenance of the road's slopes have to be ensured; Construction of sanitary public toilet and Arsenic free drinking water structures (e.g. deep tube well); Cross slopes and longitudinal drainage will be constructed to ensure faster removal of storm-water/road runoff; 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; 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 water courses. 	To be determined during detailed design period for baseline establishment and as well as during construction period	At all times	Project Company	PIU
3.6 Cultural/ Sensitive Structure	<ul style="list-style-type: none"> Loss of cultural/sensitive structures will cause 	<ul style="list-style-type: none"> Proper rehabilitation of the cultural/sensitive structures will ease out 	Along the entire corridor	At all times	Project Company	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
	<p>stress/tense on the PAPs; and</p> <ul style="list-style-type: none"> Cultural/sensitive structures adjacent up to 250 m away from the ROW boundary will not be affected due to the noise and dust pollution. 	<p>the stresses of the PAPs.</p>				
3.7 Road Accidents/ Road safety	<ul style="list-style-type: none"> The increased vehicular movement and speed may result in road safety issues like traffic accidents. The accidents may also be due to tiredness. The vehicles may not follow speed limit having widened and free road which may cause road accidents. 	<ul style="list-style-type: none"> By enforcing speed limits and imposing penalties on the traffic violators will ensure the road safety. Traffic signs will be provided to facilitate road users about speed limits, rest areas, eating establishments etc. Warning messages will also be displayed at appropriate locations to aware drivers about likely accidents due to over speeding. All the lanes, median, sharp bends will be reflectorized to facilitate travelers in the night time. Proper lighting arrangement on the proposed highway will be done at required places. The BRTA rules should be followed strictly in every relevant case. 	Along the entire corridor	At all times	Project Company	PIU
3.8 Split of Communities	<ul style="list-style-type: none"> Some of residential areas and agricultural land of the villages along the road would be divided into fragmented areas by the proposed highway. Local residents' daily activities, production activities, etc. would be 	<ul style="list-style-type: none"> Underpass and overpass for local residents and local vehicles are designed. The locations of underpasses/overpasses have been carefully determined based on existing and future condition of local areas, and result of consultation with local communities. The cross structures combining with the SMVT Lane would help to mitigate impact 	Along the entire corridor	At all times	Project Company	PIU

Environmental Issues	Environmental Impacts	Mitigation Measures	Location	Timing/ Duration	Who will Implement	Who will Supervise
3.9 Income/ Job Opportunities	<p>significantly affected.</p> <ul style="list-style-type: none"> ▪ In several cases, the highway would not only split the communities, but also cause hindrance to people in accessing to the schools, hospitals, markets, administrative agencies, mosques etc. ▪ Development of new infrastructure of residential, commercial, social and community is expected to be established alongside the upgraded highway. 	<p>of the highway to local resident's movement.</p> <ul style="list-style-type: none"> ▪ Illegal infrastructure development and encroachment alongside the road have to be checked and controlled. 	Along the entire corridor	At all times	Project Company	PIU

D. Environmental Monitoring Plan

489. The monitoring plan is one of the important tools of the implementing the mitigation plan for the proposed road project. The Monitoring plan provides guidance regarding environmental issues/parameters, location, frequency and means of monitoring.

490. The aim of environmental monitoring during the pre-construction, construction and operation phases of the project road is to compare the monitored data against the baseline condition collected during the study period (particularly during the detailed design stage) to assess the effectiveness of the mitigation measures and the protection of environmental components (e.g. air, water, soil, noise etc.) based on the national environmental standards (e.g. ECR 1997). Since the project is likely to have impact on various components of the environment, a comprehensive monitoring plan covering soil erosion, drainage congestion, tree plantation, air quality, water quality, noise, wildlife movement, workers' and community health and safety and so on need to be developed.

491. An Environmental Monitoring Plan (EMoP) has been prepared (Table IX.2) along with this IEE for the execution as a means to mitigate or minimize the adverse impacts associated with construction and operational activities of the project on the natural and social environments.

1. Objectives

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

- i. Monitor the actual impact of the works on physical, biological and socioeconomic receptors within the project corridor for indicating the adequacy of the IEE;
- ii. Monitor impacts of construction works on water quality and fauna of ECA sites (Turag and Shitalakshya Rivers), and take necessary corrective measures in case monitoring results exceeds limits of certain parameters;
- iii. Ensure compliance with legal and community obligations including safety on construction sites;
- iv. Monitor the rehabilitation of borrow areas and the restoration of construction campsites as described in the EMP;
- v. Ensure the safe disposal of excess construction materials.
- vi. Appraise the adequacy of the IEE with respect to the project's predicted long-term impacts on the corridor's physical, biological and socio-economic environment;
- vii. Evaluate the effectiveness of the mitigation measures proposed in the EMP and recommend improvements, if and when necessary;
- viii. Compile periodic accident data to support analyses that will help minimize future risks; and
- ix. Monitor the survival rate of avenue plantations.
- x. Noise barrier must be considered for sensitive receptors.

Table IX.2: Environmental Management Plan-Monitoring Actions

Environmental Issues	Environmental Impacts	Monitoring Method			Responsible Organization	
		Monitoring Parameters	Location	Duration and Frequency	Implement	Supervise
1.0 PRE-CONSTRUCTION PHASE						
1.1 Landscape/ Topography	<ul style="list-style-type: none"> ▪ Change in topography due to construction-related structures such as interchanges, bridges, embankments etc.; and ▪ Visual changes to topography. 	Consultation with adjacent households along the road	Throughout the alignment, bridges and culverts, embankment height	Throughout the pre-construction period.	Project Company	PIU
1.2 Natural Calamities (Flood, Cyclone/Storm Surges)	<ul style="list-style-type: none"> ▪ The project road is not under threat to devastating flood. 	Consider climate condition and natural calamities occurred in the last century.	Bridges and culverts, embankment height	Throughout the pre-construction period.	Project Company	PIU
1.3 Land Acquisition and Resettlement	<ul style="list-style-type: none"> ▪ Acquisition of 37.60 acre land. ▪ Resettlement of Affected Persons (PAPs). 	Ensure that PAPs get compensation as per RP; and Resettlement of PAPs as per the procedure of RP.	Along the project's alignment	As per RP	PIU/Deputy Commissioner (DC)/NGO	RHD
1.4 Agriculture Production Loss	<ul style="list-style-type: none"> ▪ A total of 37.60acre of land will directly occupied by the project and 25.60acre of this area is agricultural land. Production of various crops from this agricultural land which will be permanently lost. 	Ensure that PAPs get compensation as per RP; and resettlement of PAPs as per the procedure of RP.	Along the project's alignment	As per RP	PIU/DC/NGO	RHD
1.5 Removal of Commercial Structures	<ul style="list-style-type: none"> ▪ 787 commercial structures are located within the ROW which will be directly affected. 	Safe removal/or relocation; and Handling and transport of debris.	Along the project's alignment	As per RP	PIU/DC/NGO	RHD
1.6 Removal of Physical Cultural and Other Community Structures	<ul style="list-style-type: none"> ▪ 31 cultural structures are located within ROW. 	The physical cultural and community structures to be relocated in stages, after consultation with local communities. Local communities will be	Along the project's alignment	As per RP	PIU/DC/NGO	RHD

Environmental Issues	Environmental Impacts	Monitoring Method			Responsible Organization	
		Monitoring Parameters	Location	Duration and Frequency	Implement	Supervise
1.7 Damage to Public Utilities	<ul style="list-style-type: none"> Utility lines will have to be moved disrupting services 	<p>compensated for dismantling and relocating these sites.</p> <p>Ensure that the respective authority of utility service providers and consumers are informed in time; and inspect that utilities are being relocated at the designated site maintaining proper safety measures</p>	Along the project's alignment	As per RP and/or utility relocation plan prepared by RHD	PIU /DC/ PDB/BTCL/ Project Company	RHD
1.8 Tree Cutting and Wildlife	<ul style="list-style-type: none"> Cutting of 10782 trees; Loss of habitat (roadside, floodplain, river and coastal mangrove habitats identified in the project area) of some wildlife in relation to the wetlands, trees and vegetation; Relocation/migration of wildlife; Clearance of vegetation on the ROW along the alignment will cause permanent and/or temporary dislocation of some wildlife because of disturbance on their habitat. During survey, vegetation clearing, removal of infrastructure and utilities will make the wildlife panic. During site clearance there is a possibility to injure and/or death of any species. The birds and its nest on the trees 	<p>Notice of removal of trees will be provided. RHD or local NGOs will ensure compensation and planting of at least three trees for every one cut. A basic tree replacement plan has been prepared and is included as Annex 12. For every tree cut, three will be replanted.</p> <p>Checking whether proper compensation as mentioned in RP is received by PAPs; Checking whether wildlife is not harmed and/or get enough time to migrate safely before tree felling.</p>	Within ROW along the alignment	During tree felling and site clearing operations	FD/ PIU /DC	RHD, MoEF,

Environmental Issues	Environmental Impacts	Monitoring Method			Responsible Organization	
		Monitoring Parameters	Location	Duration and Frequency	Implement	Supervise
1.9 Change of Local Hydrology/Drainage Congestion	<ul style="list-style-type: none"> will be directly affected. Diversion across the 3 major bridges and 59 culverts/minor bridges construction; and Temporary change in local hydrology. 	Inspect waste and field management at camps and record actions taken when non-compliance recorded	Along the project's alignment	Construction and operation stage/ Monthly inspection/ Long term	PIU / Project Company	RHD, BIWTA, BWDB
1.10 Water Bodies and Fisheries	<ul style="list-style-type: none"> Several water bodies will be directly affected; Pile driving and dredging for the construction of 3 major bridges and 59small bridges and culverts will force to migrate the fisheries and other aquatic species. 	Confirming the population and change in types of fish species	Along the project's alignment, including Turag and Shitalakshya Rivers	Throughout the pre-construction period	PIU /DC/NGO	RHD
1.11 Labour Standard	Inadequately prepared labour standards, leading to infractions regarding child labour, minimum wage, forced labour, and unsanitary working conditions and unsafe water supplies	Confirm that these standards are specifically incorporated into the contract documents either as clauses or by appending this EMP to the contract.	Construction site and labour camp	Once as contract documentation is being prepared	Project Company	PIU
1.12 Technical Capacity to undertake all environmental work	Inability of Company and RHD to implement the IEE and it EMP resulting in a breakdown of safeguards implementation.	Minutes of workshop, attendance list and presentation review	N/A	During the pre-construction period	Project Company	PIU
2.0 CONSTRUCTION PHASE						
2.1 Landscape/ Topography	<ul style="list-style-type: none"> Cutting 10882 trees and dismantling of existing infrastructure will cause landscape change; Permanent acquisition of land used for agricultural (25.60acre), residential (11.75 acre), and other purposes to build road embankment will cause landscape change. 	Consultation with adjacent households and RHD authority to get opinion on work being completed.	Along the project's alignment	Construction stage/Monthly inspection	Project Company	PIU

Environmental Issues	Environmental Impacts	Monitoring Method			Responsible Organization	
		Monitoring Parameters	Location	Duration and Frequency	Implement	Supervise
2.2 Loss of Top Soil	<ul style="list-style-type: none"> ▪ Typical activities during the road construction phase include ground clearing (removal of vegetative cover), grading, excavation, trenching, vehicular and pedestrian traffic, and construction and installation of facilities may lead to loss of topsoil (0.5 m from the surface) in CROW. ▪ Compaction of topsoil due to vehicular and pedestrian movement. ▪ Loss of top soil by wind and water erosion. ▪ Covering of top soil by project works. ▪ Clearing topsoil in proposed embankment area can lead to loss of nutrient. 	Top soil management	Along the project's alignment	Construction stage/Monthly inspection	Project Company	PIU
2.3 Dredging and Dredged Materials	<ul style="list-style-type: none"> ▪ Riverbank erosion and flood at downstream; ▪ Increase of water turbidity and subsequent impact on the aquatic life; ▪ Leakages and spillage from the hydraulic pipeline, impact of air quality and odor from dredge material carrying trucks; and ▪ Dispersion of sediments and release of high sediment laden runoff from the placement sites. 	Cd, Cu, Zn, Hg, Pb, As, PCB, POPs, Hydrocarbons	Proposed dredging sites 5 locations (approx.)	Once	Project Company	PIU
2.4 Soil Erosion and Siltation	<ul style="list-style-type: none"> ▪ Soil erosion due to construction activities, earthworks, cut and fill 	Slope protection measures; and strengthen	Along the project's alignment	Regular/and or during	Project Company	PIU

Environmental Issues	Environmental Impacts	Monitoring Method			Responsible Organization	
		Monitoring Parameters	Location	Duration and Frequency	Implement	Supervise
2.5 Soil Contamination	<p>operations and from stockpiles; and</p> <ul style="list-style-type: none"> Increase of the surface water turbidity and disruption of usual photosynthesis and fish spawning process. Contamination of nearby agricultural land if dredged material is contaminated. 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. 	<p>slope stability of the embankment with special consideration at bridge and culvert construction sites.</p> <p>Careful and proper handling of oil and other hazardous liquids by trained personnel; and Handling/disposal of oil and liquid wastes at designated site; and</p> <p>Total Organic Matter, Total Phosphate, Nitrate, Ammonia, Total Sulphate, Al, As, Cd, Ca, Co, Total Cr</p>	<p>Along the whole alignment; Construction yards, bridge and dumping sites</p> <p>2 locations (construction yard & near the alignment)</p>	<p>onstruction period</p> <p>Regular/and or during construction period;</p> <p>Semi-annually</p>	<p>Project Company</p> <p>PIU</p>	
2.6 Air Pollution and Dust	<ul style="list-style-type: none"> The ambient levels of COx, NOx, SOx, PM_{2.5}, and PM₁₀ may increase during construction phase is mainly caused by: (1) flying dust produced from mixing lime and soil, (2) material stock grounds, (3) Emission, leakage/spillover of materials/spills during transportation, (4) dust from temporary roads and unpaved road surfaces. Flow of particulate matter from uncovered construction materials carrying vehicles; and Emissions of air pollutants/GHGs from asphalt plant, 	<p>PM_{2.5}, PM₁₀, CO, SO₂, NOx, O₃, temperature, humidity, wind speed and wind direction</p>	<p>Residential/Populated/Cultural areas near to construction site along the alignment. In particular, the following locations must be given priority for AQM-School, college, hospital; Major bus station areas; and Major road intersection points.</p> <p>3 locations</p>	<p>Quarterly</p>	<p>Project Company</p> <p>PIU</p>	

Environmental Issues	Environmental Impacts	Monitoring Method			Responsible Organization	
		Monitoring Parameters	Location	Duration and Frequency	Implement	Supervise
2.7 Noise and Vibration	<p>machines/engines and firing for bitumen melting.</p> <ul style="list-style-type: none"> Generation of noise due to project activities (e.g. movement of vehicle, construction work, maintenance etc.); Movement of the heavy construction equipment and vehicles, pile driving operations, operation of crushing, ballasting and aggregating plants, and power generation plants will cause vibration. 	Measurement of noise level in dBA and vibration in velocity, acceleration, displacement	Bridge site, sensitive spots (school, college, mosque, hospital) and construction yard 5 locations	Quarterly	Project Company	PIU
2.8 Surface Water Quality	<ul style="list-style-type: none"> During the construction phase, wastewater from construction sites is mainly generated from the concrete watering, pier foundation drains, and sand washing. A medium size construction site generally generates about 20 tons/day of wastewater with high level of turbidity and pH. If this wastewater is discharged directly into the surrounding water bodies, it would pollute these water bodies. Water pollution may cause damage to the breeding and spawning of fish and may pose threat to other aquatic species; Oil leakage from the operation of machinery during the bridge construction may also cause river 	pH, temperature, EC, DO, Turbidity, TOC, Total P, TSS; BODs, COD, Cd, Cu, Fe, Pb, Oil and Grease	At three (03) major surface water bodies, including at one location from Turag and Shitalakshya River each. 3 locations	Quarterly	Project Company	PIU

Environmental Issues	Environmental Impacts	Monitoring Method		Responsible Organization		
		Monitoring Parameters	Location	Duration and Frequency	Implement	Supervise
2.9 Groundwater Quality	<p>water pollution. Loose materials such as cement and lime stockpiled near the river may also cause river water pollution during rainfall. In addition, domestic wastewater generated from construction camps may also cause water pollution unless it is properly controlled and treated at the site.</p> <ul style="list-style-type: none"> During the construction phase, construction camps, warehouse, and material stockpile sites are planned to be set up along the proposed road. Domestic wastewater generated from construction camps may include fecal sewage and would be a potential source of water pollution. Main pollutants in domestic wastewater are COD and BOD₅. This wastewater would pollute the surrounding water bodies if it is discharged directly into these water bodies without treatment. Spillage of oil and chemicals on the soil surface may percolate into the local groundwater aquifer and pollute the groundwater; and Extraction of excessive groundwater from the locality in the project area for construction 	pH, TDS, Cl, As, Mn, Fe, SO ₄ , TC, FC	Sites where the pile drilling to 30 m depth is conducted and/or where any new wells are dug or a well becomes a camp potable water supply, testing to be undertaken. 2 locations	Quarterly	Project Company	PIU

Environmental Issues	Environmental Impacts	Monitoring Method		Responsible Organization		
		Monitoring Parameters	Location	Duration and Frequency	Implement	Supervise
2.10 Drainage Congestion	<p>work may decrease the level of groundwater table.</p> <ul style="list-style-type: none"> Construction of bridges and culverts over the waterways may cause drainage congestion; and Erosion from embankment may also cause drainage congestion through siltation/sedimentation. 	<p>Construct drainage structures as per the design; and</p> <p>Control erosion and siltation.</p>	At cross drainage sites	Regular/and during construction period	Project Company	PIU
2.11 Vegetation	<ul style="list-style-type: none"> During the construction phase, particularly at the sites around the bridge, there will be considerable flow of workers and trucks that will lead to the reduction of vegetation cover. Presence of trucks hauling loose materials which generates airborne dust will pose a detrimental effect on the growth of plants near the proposed road. The dust accumulating on the leave surface of plants will prevent the photosynthetic function. The lime and cement will produce hardpan soil if they are dumped to the soil. Although these impacts are short term, a certain period of time is required to restore the vegetation cover after the works are completed. 	<p>Ensure clearance of vegetation in accordance with the plans and check the re-vegetation done at the earliest</p>	Along the project's alignment	Regular/and during construction period	Project Company	PIU
2.12 Terrestrial Fauna	<ul style="list-style-type: none"> The vibration of equipment, noise, waste water and exhausts gas are often considered to be disturbances to animals. These 	<p>As part of the monthly site inspection, examine embankments, subgrade storage areas, to confirm</p>	Along the project's alignment	Twice a year in dry and rainy seasons	Project Company	PIU

Environmental Issues	Environmental Impacts	Monitoring Method		Responsible Organization		
		Monitoring Parameters	Location	Duration and Frequency	Implement	Supervise
2.13 Aquatic Species	<p>could drive animals away from their current habitats.</p> <ul style="list-style-type: none"> ▪ During the construction phase, trees around the construction sites may be cut down and cause damage to the habitat of wild animals. ▪ Illegal hunting may also occur and pose the threat to wild animals. ▪ During construction phase, air pollution, wastewater, and solid waste generated by the construction works may also deteriorate the animals' habitat, and may force them to evacuate to another habitat. ▪ Construction of temporary construction sites and access roads may lead to damage and deterioration of local ecosystems. ▪ Water pollution may change the dominance and the composition of the plankton. Water pollution will reduce species numbers and relative abundances of populations. ▪ Construction materials stored near the watercourses, uncovered excavated soil, stone dumps, and construction wastes may be easily washed out and flow into the water sources by rainfall, thus pollute the watercourses, change the water's pH value and 	<p>these facilities are not contributing to environmental degradation</p> <p>Evaluation of existence of species; Benthos & Plankton</p>	<p>Major bridge locations</p> <p>2 locations</p>	<p>Twice a year in dry and rainy seasons</p>	<p>Project Company</p>	<p>PIU</p>

Environmental Issues	Environmental Impacts	Monitoring Method			Responsible Organization	
		Monitoring Parameters	Location	Duration and Frequency	Implement	Supervise
2.14 Fisheries	<p>deteriorate the aquatic animals' habitats. This can lead to plankton and benthos deaths and aquatic biomass reduction in the construction areas.</p> <ul style="list-style-type: none"> The construction of bridges may lead to the loss of fish habitat due to increased turbidity, decreased dissolved oxygen in the water, and reduction of food sources including temporary decline of plankton and benthos organisms. Increase in suspended solids in the rivers would drive fishes away from the bridge construction sites during the construction phase. Ponds are used for exotic fish culture which has little conservation significance. 	<p>Confirming the population and change in types of fish species</p>	<p>Along the project's alignment, including Turag and Shitalakshya Rivers</p>	<p>Twice a year in dry and rainy seasons</p>	<p>Project Company</p>	<p>PIU</p>
2.15 Loss of Agricultural Production	<ul style="list-style-type: none"> Earth filling may alter the soil development and soil structure, damage soil texture, lead to loss of organic matter and inorganic nutrients in soil, soil fertility and water-holding capacity, deteriorate soil quality, cause soil erosion and loss of agricultural production. Loss of floodplain areas with consequent loss of crops. Sand removal with wind blow and rain water runoff from road construction place to nearby agricultural field will result in 	<p>Measurement for changing cropping pattern to compensate the loss of crop production</p>	<p>Along the project's alignment</p>	<p>Twice a year in dry and rainy seasons</p>	<p>Project Company</p>	<p>PIU</p>

Environmental Issues	Environmental Impacts	Monitoring Method		Responsible Organization		
		Monitoring Parameters	Location	Duration and Frequency	Implement	Supervise
	<p>increased sand percentage which will ultimately change the soil composition i.e. its texture.</p> <ul style="list-style-type: none"> ▪ Most of the burrow pits will be filled; winter cropping will face some difficulties as water retention area will be shrunk. ▪ Various types of heavy vehicles and machineries will go also on the besides agricultural land; thus, soil compaction and direct loss of standing crop of one season will be completely or partially destroyed. ▪ Soils of adjacent area of road may be changed in texture and fertility with mixing up with external sand and soils, sometimes oil spills, mobile, pitch, dust, ash etc. ▪ Increased movement of construction laborers will have adverse impacts on adjacent crop fields. ▪ Some marginal and landless farmers may become unemployed due to loss of agricultural land and water logging. ▪ Fencing will obstruct cattle movement across the road and thus may cause adverse impacts on agricultural activity like ploughing and cow grazing. ▪ Photosynthesis of nearby crops in 					

Environmental Issues	Environmental Impacts	Monitoring Method			Responsible Organization	
		Monitoring Parameters	Location	Duration and Frequency	Implement	Supervise
2.16 Pollution from Wastes	<p>the corridor may become slower due to regular deposition of dust and smoke on leaves surfaces created in by vehicles movement.</p> <ul style="list-style-type: none"> ▪ Dismantling of any structure will generate solid waste; and ▪ Kitchen and sewage wastes from labour camp will cause growth of flies and water born germs. 	Waste and effluents to be collected and disposed safely to the designated sites;	Construction yard, bridge and dumping sites	Weekly	Project Company	PIU
2.17 Asphalt Hot Mix Plant, Rock Crushing, and Bitumen Supply	<ul style="list-style-type: none"> ▪ Rock crushing activities will generate noise and dust, and asphalt hot-mix plant and pavement works will generate gas and odour while compaction of the pavement will also generate noise and dust. ▪ It is also possible that soil may be contaminated by oils and chemicals at asphalt/bitumen plant sites, workshop areas, and equipment washing yards. ▪ The contamination may limit the future use of the land for agricultural purposes. 	Wastes and garbage from bridge construction sites to be disposed properly at the designated sites.	Construction yard, bridge and dumping sites	Weekly	Project Company	PIU
2.18 Construction Waste Disposal (Waste water, Oil, Hazardous Waste etc.)	<ul style="list-style-type: none"> ▪ Oil, grease etc. from construction machinery; ▪ Hazardous and solid waste from waste construction material and food; ▪ Waste water from washing and sprinkling; and ▪ Sanitary waste from staff toilets. 	Checking storage, transportation, handling, and disposal of hazardous waste;	Construction yard, bridge and dumping sites	Weekly	Project Company	PIU
2.19 Construction Yards	<ul style="list-style-type: none"> ▪ The siting of construction camps may cause loss of plantation and 	Undertake housekeeping good practices	Construction yard	Weekly	Project Company	PIU

Environmental Issues	Environmental Impacts	Monitoring Method			Responsible Organization	
		Monitoring Parameters	Location	Duration and Frequency	Implement	Supervise
	<p>vegetation, permanent physical and visual impact on the area, siltation and pollution risks if construction materials are extracted from the river bed.</p> <ul style="list-style-type: none"> ▪ The construction process will take several years, with the result that the camps will take on a semi-permanent appearance; ▪ Impacts on the local communities and social structures; ▪ Pollution risk of soil and surface water due to sanitation of the construction camp; 	<p>inspection weekly and report results and record what actions taken to mitigate</p>				
2.20 Occupational Health and Safety (OHS)	<ul style="list-style-type: none"> ▪ Construction workers are more likely to be affected by occupational health hazard through accident and handling hazardous materials at construction site; and ▪ Construction workers are also likely to be affected by water borne diseases and food poisoning at construction camp. 	<p>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; 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</p>	<p>Construction site and labour camp</p>	<p>Regularly</p>	<p>Project Company</p>	<p>PIU</p>

Environmental Issues	Environmental Impacts	Monitoring Method			Responsible Organization	
		Monitoring Parameters	Location	Duration and Frequency	Implement	Supervise
2.21. Community Health and Safety	<ul style="list-style-type: none"> Improper health and safety policy maintained at the site may lead to outbreak of different diseases to the surrounding communities/public through the sickness 	stored and handled safely. Control movement of project traffics especially at dense populated areas such as school, bazars etc. to avoid any accident.	School, college, mosque, bazar etc.	Regularly	Project Company	PIU
2.22 Health and Vector Borne Diseases	<ul style="list-style-type: none"> Personal and occupational health issues, stemming from unsanitary toilet facilities, lack of potable water and sanitary washing areas can lead to common disease outbreaks in work camps. Construction work creates areas for water to form stagnant puddles; Also, water can collect in old equipment waste tyre dump stored outside, ideal breeding areas for malaria and dengue mosquitoes. 	Undertake checks at all sites and instruct contractors to take immediate action if non-compliance identified	Construction site and labour camp	Regularly	Project Company	PIU
2.23 Traffic Congestion	<ul style="list-style-type: none"> Traffic jams causing inconvenience to the people; The construction vehicles will add more traffic and as a result, traffic congestions and road accidents will be increased. 	Traffic volume, composition and speed	Along the project's alignment	Continuous records	Project Company	PIU
2.24 Road Accidents	<ul style="list-style-type: none"> The influx of heavy vehicles used for construction work on the road may cause sudden road incident and/or a accident. 	Evaluation of effect of traffic schedules; Fitness of vehicles should be strictly maintained.	Project Company's office	Continuous records	Project Company	PIU
2.25 Income/Job Opportunities	<ul style="list-style-type: none"> Some job opportunities for executing the construction activities; and Income opportunity through generating small business. 	Control illegal infrastructure development and encroachment alongside	Along the project's alignment	Regularly	Company/ NGO	PIU/RHD

Environmental Issues	Environmental Impacts	Monitoring Method		Responsible Organization		
		Monitoring Parameters	Location	Duration and Frequency	Implement	Supervise
2.26 Tree Plantation	<ul style="list-style-type: none"> ▪ Several trees to be removed from project construction corridor. ▪ Inappropriate selection of tree species and plantation location may not ensure the inherent objective of the tree plantation plan. ▪ Lack of proper care (e.g. watering, securing with fence) by the respective authority will also hinder the process of proper growth of the planted trees. 	Ensure that tree plantation plan is followed properly during planting seedlings of 32,346 trees.	Along the project's alignment	Periodic at the end of the construction of each road section.	Company/ NGO	PIU/RHD
2.27 The Construction Period Environmental Completion Reporting	<ul style="list-style-type: none"> ▪ Project Company fails to prepare a summary report defining the mitigation and monitoring actions completed and what needs to be continued during the Operating period. The result is a failed or weakened environmental safeguards programme. 	Prepare a completion report and deliver to the PIU.	N/A	Once at the end of construction period	Project Company	PIU
3.0 OPERATION PHASE						
3.1 Construction Period Decommissioning	<ul style="list-style-type: none"> Inspection of sites to be decommissioned by contractor, are: <ul style="list-style-type: none"> ▪ work camps; fuels storage areas ▪ waste dump sites; construct access roads But not undertaken, leading to chronic environmental problems due to a lack of proper clean-up. 	Inspect to be sure that work camps, fuel storage areas, waste dumps, toilet facilities and construction access roads have been properly decommissioned and no contamination is likely.	All farcialities	Within month of operation	Project Company	RHD
3.2 Landscape/ Topography	<ul style="list-style-type: none"> ▪ Structures attached with the road, such as interchanges, underpasses/overpasses, bridges, etc. would cause slight negative effect on landscape. 	Consultation with adjacent households and RHD to get opinion on work being completed.	Along the alignment	Regular	Project Company	RHD

Environmental Issues	Environmental Impacts	Monitoring Method			Responsible Organization	
		Monitoring Parameters	Location	Duration and Frequency	Implement	Supervise
3.3 Air Quality	<ul style="list-style-type: none"> Dust (PM) generated from the road surface dispersed to the air by vehicles running on the roads, and Toxic gases (NOx, SOx, CO, VOC, etc.) generated from vehicle's engines when burning fuel. 	PM2.5, PM10, CO, SO2, NOx, O3, temperature, humidity, wind speed and wind direction	Most busy traffic points 2 Locations	Twice per year for operating Years 1, 3 and 5.	Project Company	RHD
3.4 Noise and Vibration	<ul style="list-style-type: none"> Noise pollution due to the movement of increased number of vehicles; and Wildlife particularly the birds will be affected mostly because of noise. 	Measurement of noise dB(A) and vibration in velocity, acceleration, displacement	Bus Stoppages/cultural sites along the alignment 2 Locations	Twice per year for operating Years 1, 3 and 5.	Project Company	RHD
3.5 Water pollution and (surface groundwater)	<ul style="list-style-type: none"> Erosion on the slope of the road will add silts into the nearby surface water streams. Uncontrolled release of contaminated storm-water/road runoff from road surfaces will pollute the surface water. Hydrocarbons, heavy corrosive products and suspended solids are the surface water pollutants associated with road runoff. Accidental spillage of hydrocarbon products from the vehicles moving on the road may cause nearby surface water pollution through surface runoff. Because of the project, many commercial and business structures will be constructed alongside the road which will cause increased groundwater 	SW: pH, DO, Turbidity, TOC, Total P, TSS; TSS, BOD5, COD, Cd, Total Cr, Cu, Fe, Pb, Oil and Grease; GW: pH, TDS, Cl, As, Mn, Fe, SO4, TC, FC	At 3 major surface water bodies; 3 Locations Public tube-well at Company Office area; 1 Location	Twice per year for operating Years 1, 3 and 5.	Project Company	RHD

Environmental Issues	Environmental Impacts	Monitoring Method			Responsible Organization	
		Monitoring Parameters	Location	Duration and Frequency	Implement	Supervise
3.6 Cultural/ Sensitive Structure	<p>extraction.</p> <ul style="list-style-type: none"> Loss of 31 cultural/sensitive structures will cause stress/tense on the PAPs; and Cultural/sensitive structures adjacent up to 250 m away from the ROW boundary will not be affected due to the noise and dust pollution. 	Cultural/sensitive structures adjacent up to 250 m away from the ROW boundary will not be affected due to the noise and dust pollution	Along the road side in front of the cultural structures	Regular	Project Company	RHD
3.7 Road Accidents/ Road safety	<ul style="list-style-type: none"> The increased vehicular movement and speed may result in road safety issues like traffic accidents. The accidents may also be due to tiredness. The vehicles may not follow speed limit having widened and free road which may cause road accidents. 	Traffic signs, kilometre posts, speed breakers (where required) along the road and traffic signal at road crossing have to be provided.	At designated places (intersection points, cultural structures, School, hospital)	Regular	Project Company	RHD
3.8 Split of Communities	<ul style="list-style-type: none"> Some of residential areas and agricultural land of the villages along the road would be divided into fragmented areas by the proposed highway. Local residents' daily activities, production activities, etc. would be significantly affected. In several cases, the highway would not only split the communities, but also cause hindrance to people in accessing to the schools, hospitals, markets, administrative agencies, mosques etc. 	Clearance at important road such as district road and main road of village/towns	At designated places (intersection points, cultural structures, School, hospital)	Regular	Project Company	RHD

Environmental Issues	Environmental Impacts	Monitoring Method		Responsible Organization		
		Monitoring Parameters	Location	Duration and Frequency	Implement	Supervise
3.9 Income/ Job Opportunities	<ul style="list-style-type: none"> Development of new infrastructure of residential, commercial, social and community is expected to be established alongside the upgraded highway. 	Control illegal infrastructure development and encroachment alongside	At market areas	Regular	Project Company	RHD

E. Institutional Requirements

493. There are certain institutional requirements to ensure that the environmental aspects of the Project will be realized.

494. The Project has already obtained the Environmental Clearance Certificate from the Department of Environment (DoE) under the Ministry of Environment and Forest, according to Environmental Conservation Rules 1997 of Bangladesh. Beyond this requirement, Roads and Highways, the proponent of the Project, with the assistance of its Project Company, will also be responsible for ensuring that all environmental procedures and proposals are incorporated in the Detailed Engineering Design process and construction process, including the incorporation of appropriate provisions in the Project's Contract Documents.

495. The institutional requirement includes the following

- **Contract Preparation:** The environmental provisions recommended for inclusion in the Contracts for the Dhaka Bypass Road will be provided in the EMP. This is essential provisions to be incorporated and enforceable if the goals of the Project are to be fully achieved.
- **Environmental Management as an Integral Part of Construction Supervision:** Once Contract has been accepted and awarded, it will be necessary to monitor compliance with the environmental provisions of the Contract as an integral part of overall construction supervision. Supervision by the PIU will include the following requirements:
 - ✓ Ensure that asphalt plants, pilling equipment, construction camps and other facilities are properly sited and installed in accordance with the Contract.
 - ✓ Determine the timing and exact locations of both baseline and routine air quality and noise level monitoring and all other monitoring is in accordance with the Contract provisions.
 - ✓ Undertake critically important routine visual monitoring of construction, waste disposal and overall environmental management practices by the Contractors. Effective environmental management during construction will require frequent site visits and observation skills. Adequate staffing of in conjunction with the services provided by its PIU will be required.

F. Institutional Arrangements

496. Environmental management of the project requires a multidisciplinary approach with consolidated and coordinated efforts from a number of agencies. Various institutions will be involved during implementation of the Project. While contractor is responsible for implementation of EMP during construction works, Project Implementation Unit (PIU) of RHD is primarily responsible for supervision of monitoring of the implementation of the EMP with the assistants of Independent Engineers and also reporting the progress to RHD who is also the Executing Agency (EA). The RHD will be involved in the implementation and management of the works for which they are responsible by establishing a PIU. The Key organizations and people involved in environmental management of the project are as presented in Figure IX-1.

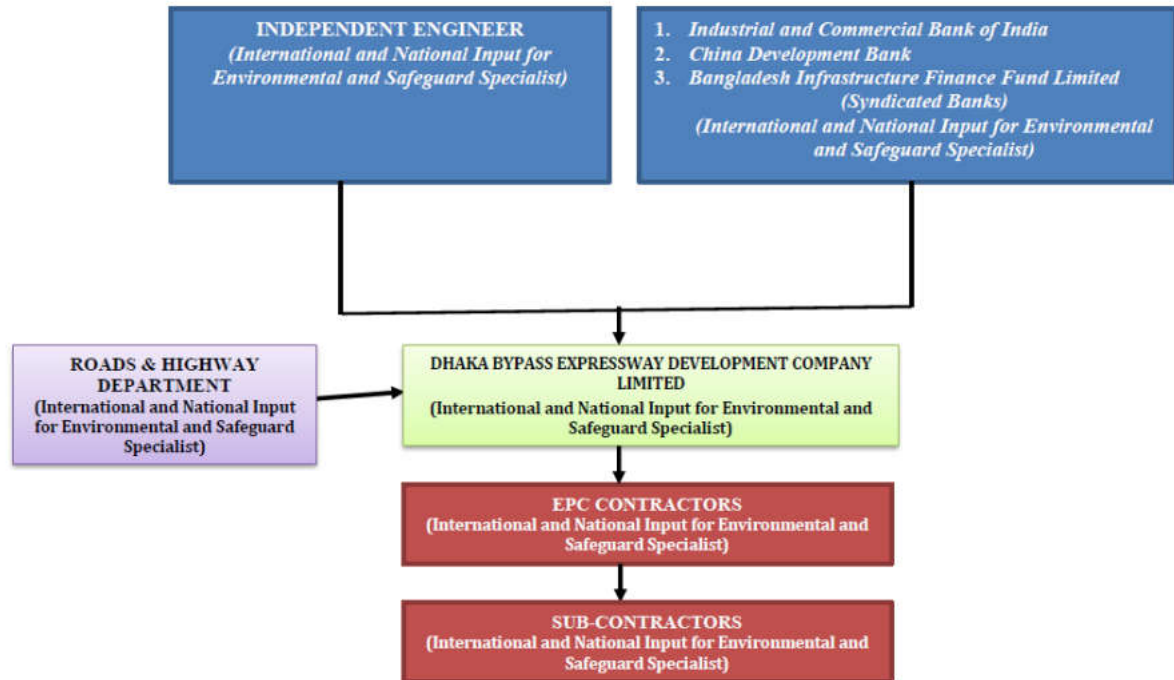


Figure IX.1: Proposed Institutional Framework for EMP Implementation

G. Institutional Responsibilities

497. A number of institutions will be involved during construction and operation phase of the Project in order to achieve environmental compliance goal set by EMP. A proposed institutional framework for EMP implementation has been showed in Figure IX-1. These institutions will carry out following distinct but interrelated responsibilities:

1. Ministry of Road Transport and Bridges (MoRTB)

498. MoRTB as the highest authority of the Project will have the overall responsibility of ensuring that the environmental safeguard requirements of the project are fulfilled through the Road and Highways Department. The main responsibilities of the MoRTB are to:

- Ensure that the project, regardless of financing source, complies with the provisions of the EMP and ADB Safeguard Policy Statement 2009 (SPS);
- Ensure that project implementation complies with government environmental policies and regulations;
- Ensure that project environmental management is implemented and reported to the Steering Committee and the financing agency as required.

2. Inter-ministerial Steering Committee

499. A Steering Committee with representatives from related Ministries and Government agencies covering will be established at the time of implementation of this project. This committee will facilitate the coordination of various agencies under the ministries in the environmental management and monitoring process.

3. Roads and Highways Department

500. The Roads and Highways Department (RHD), as the main project implementing agency, is responsible for the effective execution of the environmental safeguards. Although not directly involved in the day to day monitoring activities, RHD will have oversight on the monitoring activities carried out by the PIU and will report to MoRTB.

4. The Social and Environmental Circle

501. The Social and Environmental Circle of the RHD is headed by a Superintending Engineer (Resettlement and Environment). There is an Environmental Division under this circle staffed by one Executive Engineer, one Sub divisional Engineer, two Assistant Engineers and three Sub Assistant Engineers. The Environmental Division under the Social and Environmental circle will provide guidance to PIU staff for developing mechanisms for effective project supervision throughout the project construction and even in operation phase. They will also assist PIU and the Company in conducting subsequent monitoring and reporting and in undertaking corrective options and establishment and implementation of an environmental management system.

5. Project Implementation Unit

502. The Project Implementation Unit will be established under the RHD will include an environmental unit (EU). The EU will consist of one Executive engineer, one sub-divisional engineer and two assistant engineers to monitor environmental compliance. The EU will be responsible for overseeing of the monitoring activities conducted by the Project Company on its behalf. It will also be responsible for overseeing the activities of contractor through PIU. The main activities of the EU with regard to environmental safeguards are:

- Planning and implementation of EMP
- Ensuring that environmental protection and mitigation measures in the EMP are incorporated in the Construction Environmental Management Plan (CEMP);
- Supervision and monitoring of the progress of activities of the consultants and contractors for implementation of different components of EMP
- Provide guidance to PIU, and Company in conducting subsequent monitoring and reporting and in undertaking corrective options
- Responsible for modifications of the EMP when there were adaptation/changes during implementation.
- Ensure submission of periodical environmental management and monitoring reports to steering committee and co-financers through RHD;
- Submit semi-annual monitoring reports on EMP implementation for co-financers review through RHD;
- Ensure establishment and implementation of an environmental management system;
- Implementation of environmental monitoring measures (such as environmental quality monitoring, tree plantation, landscaping, wild life monitoring) during O/M stage of the Project.
- Promote improved social and environment performance through the effective use of management systems;
- External communications with other government, semi-government and non-government organizations, universities, research institutes in the country on the matters of mutual interest related to environmental management and filming of activities to be carried out under the project development.

6. Syndicate Banks

503. ICBC, CDB and BIFFL will be acting as the syndicate banks of this project. The BIFFL will play the role of Financial Intermediary of ADB and will be primarily responsible to monitor

the implementation status of ADB safeguard policy. Along with the BIFFL, all the banks will have both national and international expert to monitor the works.

7. Independent Engineers (IE)/Consultants

504. The Independent Engineers or Consulting Team functioning under the RHD will be directly responsible for contract administration and day-to-day project supervision including environmental management. The Engineers will consist of a Health, Safety and Environment unit with an environmental expert. The engineers will advise the RHD and the PIUs on EMP implementation, and monitor the work of the Company/contractors in the field. The Engineers will also help the PIUs prepare quarterly progress reports to be submitted to the RHD, who will submit semi-annual reports to co-financier for review. The Engineers will, inter alia, be responsible for the following:

- Engage environment specialist to ensure proper implementation of EMP provisions;
- Undertake regular monitoring of the Company/Contractor's environmental performance, as scheduled in the EMP;
- Conduct periodical environmental audits;
- Prior to construction, review and approve SEMP/method statements prepared by the Project Company;
- Supervise site environmental management system of the contractors, and provide corrective instructions;
- Monitor the implementation of the SEMP and review the environmental management and monitoring reports prepared by the Company;
- Review and report on SEMP implementation by the Company.

505. Overall, IE is responsible for ensuring proper and timely implementation of all their tasks specified in the EMP.

8. Project Company

506. The Project Company will be primarily responsible for preparing and implementing the CEMP. The Project Company will be recommended to have one Environmental Specialist and one Occupational, Health and Safety (OHS) Specialist, who will be working in close coordination with the environmental staff of PIU. The main functions of the Company with regard to environmental management and monitoring are to:

- Prior to start of construction, prepare the SEMP and other method statements and management plans according to requirements of EMP and get them approved by PIU.
- Recruit qualified environmental and safety officers (ESO) to ensure compliance with environmental statutory and contractual obligations and proper implementation of SEMP;
- Provide sufficient funding and human resources for proper implementation of SEMP;
- Prepare monthly reports on environmental management and monitoring for review and verification by the PIU;
- Prepare and implement an Environmental Management system according to requirement specified in IEE/ ISO 14001.

9. EPC Contractor & Sub-contractor

507. The Project Company may engage several Engineering, Procurement and Construction (EPC) contractor and Sub-contractors during the project implementation stage. These Contractors will also have national and international Environmental and Social Safeguard Specialists to comply with the GoB and ADB safeguard policy. The Project Company will ensure the preparation of several SEMP by these Contractors on behalf of them and will regularly monitor their works as per the EMP guidelines.

H. Environmental Monitoring Cost Estimation

508. Most of the mitigation measures require the contractors/project authority to adopt good site practice, which should be part of their normal procedures already, so there are unlikely to be major costs associated with compliance.

509. Mitigation that is the responsibility of RHD and contractor's will be provided as part of their management of the project. The cost estimation for Environmental Mitigation Measures and Monitoring is given in the following Table IX.3. The total mitigation and monitoring cost for the project is calculated as **BDT 79,206,760** including the remuneration of Company's Environment, Health and Safety Officer. The total duration of the engagement of these experts will be decided as per the requirement of the project after getting approval from the PIU.

Table IX.3: Cost Estimation for Environmental Mitigation Measures and Monitoring

EMP Task No.	Mitigation and Monitoring Items	Unit	Cost/Unit	Total Unit	Total Cost
1.0	Pre-construction Period				
1.1	Landscape/Topography	Included in engineering cost			0
1.2	Natural Calamities (Flood, Cyclone /Storm Surges)	Costed in resettlement plan			0
1.3	Land Acquisition and Resettlement	Costed in resettlement plan			0
1.4	Agriculture Production Loss	Costed in resettlement plan			0
1.5	Removal of Commercial Structures	Costed in resettlement plan			0
1.6	Removal of Physical Cultural and Other Community	Costed in resettlement plan			0
1.7	Damage to Public Utilities	Costed in resettlement plan & engineering cost			0
1.8	Tree Cutting and Wildlife	Included in engineering cost			0
1.9	Change of Local Hydrology/Drainage Congestion	Included in engineering cost			0
1.10	Water Bodies and Fisheries	Included in engineering cost			0
1.11	Labour Standard	Included in engineering cost			0
1.12	Technical Capacity to undertake all environmental work (Workshop)	No.	30000	1	30000
2.0	Construction Period (38 months)				
2.1	Landscape/Topography	Monitoring by EHSO			0
2.2	Loss of Top Soil	Monitoring by EHSO			0
2.3	Dredging and Dredged Materials	No.	40000	5	200000
2.4	Soil Erosion and Siltation	Monitoring by EHSO			0
2.5	Soil Contamination	No.	25000	14	350000
2.6	Air Pollution and Dust	No.	25000	30	750000
2.7	Noise and Vibration	No.	5000	100	500000
2.8	Surface Water Quality	No.	20000	30	600000
2.9	Groundwater Quality	No.	10000	20	200000
2.10	Drainage Congestion	Monitoring by EHSO			0
2.11	Vegetation	Monitoring by EHSO			0
2.12	Terrestrial Fauna	Monitoring by EHSO			0
2.13	Aquatic Species	No.	20000	14	280000
2.14	Fisheries	Monitoring by EHSO			0
2.15	Loss of Agricultural Production	Monitoring by EHSO			0
2.16	Pollution from Wastes	Lump-sum			500000
2.17	Asphalt Hot Mix Plant, Rock Crushing, and Bitumen Supply	Monitoring by EHSO			0
2.18	Construction Waste Disposal (Waste water, Oil, Hazardous Waste etc.)	Lump-sum			500000
2.19	Construction Yards	Monitoring by EHSO			0
2.20	Occupational Health and Safety (OHS)	Month	5000	38	190000
2.21	Community Health and Safety	Month	2000	38	76000
2.22	Health and Vector Borne Diseases	Month	2000	38	76000
2.23	Traffic Congestion	Month	5000	38	190000
2.24	Road Accidents	Monitoring by EHSO			0
2.25	Income/Job Opportunities	Monitoring by EHSO			0
2.26	Tree Plantation	No.	32346	200	6469200
2.27	The Construction Period Environmental Completion Reporting	Prepared by EHSO			0
	Other Expenses during Construction Period				
	Water Spray for dust suppression	Month	60000	38	2280000
	Installation of Noise Barrier	Lump-sum			60000000
	Transportation (for Environmental Monitoring)	Month	10000	38	380000
	Reporting and Report Production	No.	2000	40	80000
	Remuneration of EHSO	Month	50000	38	1900000
3.0	Operating Period (Yrs. 1, 3, and 5)				
3.1	Construction Period Decommissioning	Included in engineering cost			0
3.2	Landscape/Topography	Included in engineering cost			
3.3	Air Quality	No.	25000	12	300000
3.4	Noise and Vibration	No.	5000	12	60000
3.5	Water pollution (surface and groundwater)	No.	20000	18	360000
		No.	10000	6	60000
3.6	Cultural/Sensitive Structure	Monitoring by Company			0
3.7	Road Accidents/Road safety	Monitoring by Company			0
3.8	Split of Communities	Monitoring by Company			0
3.9	Income/Job Opportunities	Monitoring by Company			0
MITIGATION AND MONITORING					
	Pre Construction Period				30000
	Construction (38 Months)				75521200
	Operating Period (Yrs. 1, 3 and 5)				360000
	Total				75911200
	Contingency Costs @ 5% of total				3795560
	Grand Total:				79706760

X. GRIEVANCE REDRESS MECHANISM

A. Requirements of the ADB

510. As a partner in the delivery of this project, the ADB's environmental safeguard requirements were carefully considered during the preparation of this IEE. The description of a grievance redress mechanism (GRM) is not required under the GoB environmental legislation but is mandatory for any ADB-funded project. To that end a step-by-step process is defined in this chapter.

511. Grievance redress refers to the set of actions available to anyone negatively impacted by the project and not properly dealt with, ignored or overlooked the implementation of Mitigative and monitoring measures defined in the IEE. The overriding principle of any GRM is that it must be non-threatening, easily accessible, quick and impartial; delivering decisions to the complainant in an unbiased a-political manner. GRM's have been developed for many past donor-funded projects and have been accepted by the GoB and been reasonably successful in doing what they are supposed to do. The GRM described in this chapter (Figure X-1) builds on that success.

B. Grievance Redress Mechanism

512. The Grievance redress mechanism described here refers to the mechanism related to the IEE/EIA preparation, approval and implementation, and for construction activities. Grievance Redress for all resettlement and other social matters are covered separately in the Resettlement and Social reports. Nevertheless, the mechanisms described in this section will be compatible with and complementary to the Resettlement and Social mechanisms.

513. It is essential that the communities as whole and individual members of the community are given every opportunity to express their views, concerns and worries in connection with the expected and projected environmental impacts and construction impacts for each of the proposed projects. The support of the community is a key indicator of the success of a project and it will therefore be essential that the communities are given the opportunity to express their views during the initial planning and design, during the construction phase and during operation of the projects.

514. It is essential that an effective and transparent mechanism is designed and established at the earliest opportunity for all members of the community to be able to lodge complaints and grievances.

C. Details of Mechanism

1. Formation and Operation of the GRC

515. Rather than suggesting a route normally taken when a citizen has a concern, namely the local administrative official route, grievance redress committees (GRCs) will be formed in each Union Parishad (UP) the project passes through. Each project will likely trigger both environmental (as defined in this IEE) and social impacts (as defined in the project's Resettlement Plan) and therefore the GRC will need be able to address both areas. Prior to the start of construction RHD will meet with UP heads to request the establishment of such committees, with the understanding that they will have to meet when complaints are received. As a minimum the composition of the GRC will be as follows:

- RHD Regional Director or Representative - GRC Chair and convener
- Union Parishad Chairman or Senior Representative- GRC Committee member

- Female member of concerned ward(s) of the UP- GRC Committee member
- Implementing NGO Representative - GRC Committee member (Social)
- UP DoE representative - GRC Committee member (Environment)
- Female Representative of Affected People (AP) - GRC Committee member (Social)
- Representative from area where grievance was filed- GRC Committee member.

516. When dealing with environmental matters, the GRC should have five permanent members, with the DoE representative replaced by the INGO and Female Representative of the AP when social or resettlement matters are on the agenda. In order to convene a GRC meeting a quorum of three persons will be required.

517. To function in a fair and transparent manner, GRC conditions of operation will form the framework for the decision-making process for the GRCs established for this Project. The following seven GRC operating conditions, largely adapted from the Padma Bridge EIA report (pg. 9-13 and 9-14), are:

- i. GRC meetings must be announced and held locally;
- ii. The complainant must be given the opportunity to appear before the GRC, prior to or during the GRC decision meeting;
- iii. The time between submission of the grievance by a citizen and a decision/ resolution should five days, and any decision/resolution must be placed with the office where grievance was made. If the decision will take longer than five days, the complainant must be notified with an explanation;
- iv. Maximum time for resolution should be one month;
- v. GRC decisions should be based on majority vote, and should adhere to the objectives defined in the IEE's Environmental Management Plan;
- vi. The GRC will not deal with any matters pending in the court of law; and
- vii. Any resolutions/decisions must, as a first priority, deal with eliminating the source of the environmental effects resulting in the complaint and secondly finding ways to mitigate the effect to the satisfaction of the complainant.

518. Further, the GRC would only be convened if direct communication between the Company, the complainant and the PIU cannot solve the issue quickly. Once the complaint reaches the GRC, the GRC has two weeks to render a decision, based on discussion with all parties involved. The GRC will be used as the third step when filing a complaint.

2. Steps to a Solution

519. **Step 1:** The complainant will be advised to first attempt to settle the complaint through direct communication with the either in person or by a phone, and a call to the local RHD office. If the discussion with the Complainant/Community is successful, the contractor will be responsible for undertaking corrective measures as defined in the grievance decision and recording the decision and filing that with RHD, via the PIU.

520. **Step 2:** Should the complaint not be addressed within a week, the next level would be to notify the Upazila office and RHD of the unresolved issue. The Upazila official will then communicate either to the contractor or RHD and a solution will be discussed with the complainant within one working week. If more time is required, The Upazila or RHD should communicate directly with the complainant describing the reasons of the delay.

521. **Step 3:** If Step 2 fails to resolve the issue within two weeks of the receipt of the complaint the GRC should be formed and a formal hearing undertaken. At this point a decision must be rendered within 2 weeks or the complainants concerns will be deemed correct and immediate mitigative actions will be required and fully executed within 5 days of the end of the 2-week period.

522. **Step 4:** If Step 3 fails to resolve the issue, the complainant may proceed to legal arbitration.

523. All GRC decisions will be recorded by the GRC, and sent to the local and head office of RHD.

3. Publicizing the Grievance Redress Steps and the Committee

524. Prior to the start of the construction, RHD or its representative will publicize the establishments of the grievance redress steps and the process, and advertise all via contact information and the grievance redress steps posted at every UP office involved, as well as at busy public places in the Project corridor. The poster(s) will be in the local language(s) and posted within 30 days of the start of construction. The RHD representative will check at least monthly to ensure that the posters are prominently displayed and provide clear contact instructions and numbers. This procedure and monitoring will be reported in the semi-annual monitoring report submitted to the ADB.

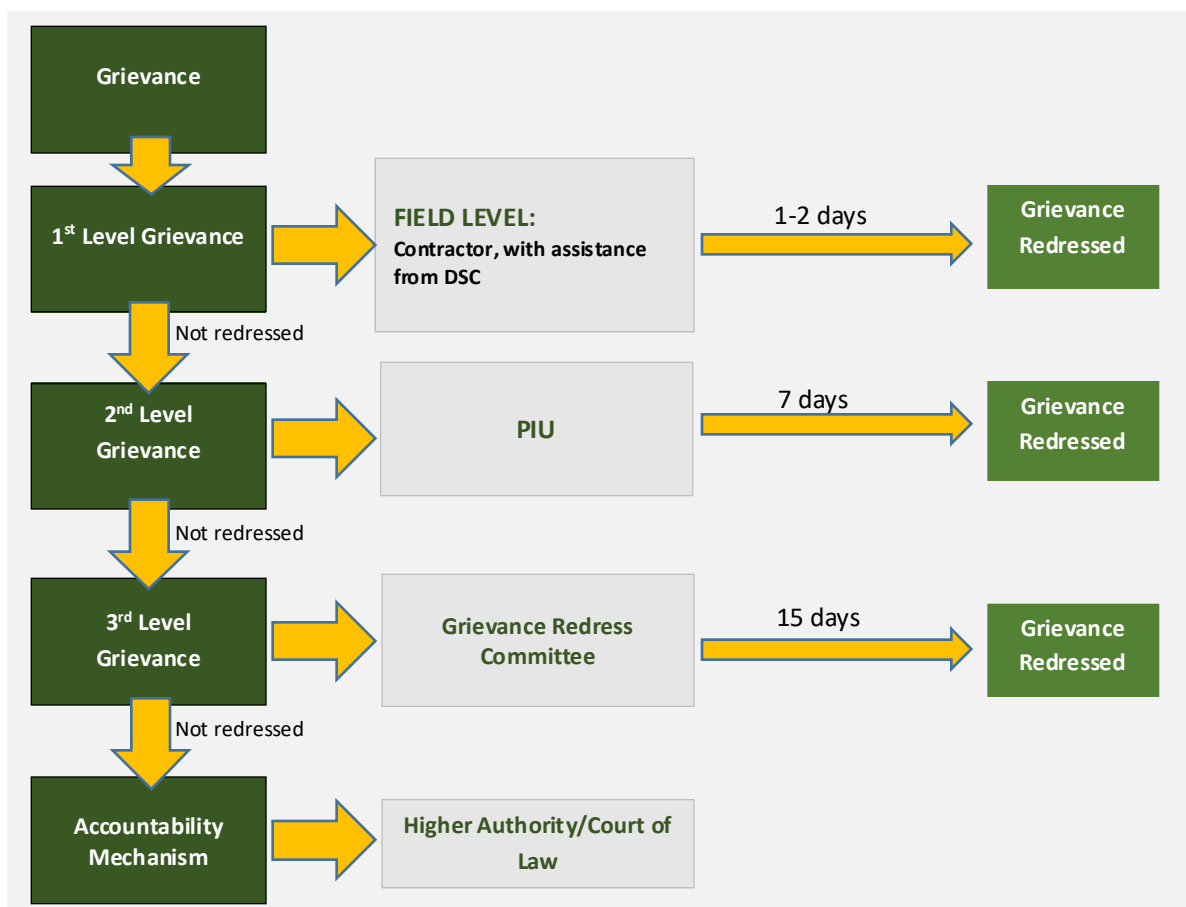


Figure X.1: Grievance Redress Mechanism of the Project

525. Any grievance filed with the GRC, must be reported in the Annual report to the PIU who will then submit a consolidated report to ADB, via RHD.

4. Construction Workers Grievance

526. At construction sites, work camps and on-the-job, labourers and other unskilled hired employees of the contractor have little recourse when either their living conditions are badly degraded, they are not paid according to agreement, or basics, such as potable water, are not supplied. Under this contract, as part of the written agreement with each hire, the contract or

letter of assignment with the work will include the name and contact information of RHD and/or the PIU's employee for the worker to contact. The letter/agreement will contain a second statement indicating that the contractor will not penalize the worker for reporting a complaint and if that occurs, the contract will be levied a fine equal to the employees contract duration from the time of the incident to the end of the contract period. That amount will be paid to the complainant.

527. The contractor will provide a compliant box, sealed by the PIU and collected by the PIU, thus allowing the construction worker to file complaints by going directly to the PIU.

XI.CONCLUSIONS AND RECOMMENDATIONS

528. The project will have a number of environmental impacts during the construction and operation periods. Assuming effective implementation of the mitigation measures and monitoring requirements as outlined in the Environmental Management Plan, the Project is not expected to have significant adverse environmental impacts. It should also be pointed out that the environmental benefits are likely to be important; an all-weather transport route will link between Joydebpur and Madanpur. The potential for congestion will be reduced which will reduce vehicle emissions due to increased and more regular speeds and air quality adjacent to the road should improve.

529. The EMP has identified necessary mitigative actions needing to be addressed during the pre-construction, construction, and during the operating period of the road. To track the mitigation work, an air, noise, and surface water quality monitoring programme will be started during the construction period. There is little chance that impacts will extend much beyond the 50 m or 100 m wide corridor of impact centred over the road, given that all work will be strictly confined to the road's existing right of way.

530. The assessment concludes that this IEE is complete and addresses all relevant likely impacts and proposes a full set of time-bounded mitigative and monitoring actions, including the assignment of responsibilities. The application of the detailed EMP will ensure that the nature and socio-cultural environmental are not unduly affected by the work or the operation of the second line. Additionally, an environmental approval has been granted by DoE, and that no further studies be required except the renewal of the approval.

531. The EMP, its mitigation and monitoring programs, contained herewith shall be included within the contract documents for project works. As per contract documents, based on Environment Management Plan, the contractor shall be responsible for preparation of a Site-Specific Environmental Management Plan (SEMP) with a addition section on ECA Management Plan and specific Tree Plantation Plan prior to 30 days of commencement of construction work. SEMP will adopt all site-specific elements that are not currently known, such as the borrow pit locations, worker shed area, waste dumping location, plantation area, dredging locations, etc. This ensures that the Company is aware of the environmental requirements of the project and its associated environmental costs.

532. Contractor will submit the SEMP to PIU for approval. Additionally, the prepared SEMP will be submitted to ADB after reviewing by the PIU for ADB's record and future inspection. To ensure compliance with the SEMP the Company should employ a national environmental specialist to monitor and report project activities throughout the project construction phase.

533. 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.

534. In case any noncompliance is reported due to poor or inadequate implementation of the any measure of SEMP, the contractor shall be penalized through suspending payment disbursement unless and until the issue reported noncompliance is made compliant. Independent Engineer will assure implementation of penalty mechanism in consultation with relevant environmental personnel of PIU, IE and contractor. Repeated non-compliance of SEMP implementation may lead to higher level of penalty for contractor, such as financial compensation as determined by the Independent Engineers and PIU of the project.

REFERENCES

- Banglapedia, 2015. National Encyclopedia of Bangladesh[http://en.banglapedia.org/index.php?title=Main_Page]
- International Union for Conservation of Nature (IUCN), 2002. *Bio-ecological zones of Bangladesh*. Dhaka: IUCN Bangladesh.
- IUCN Bangladesh. ed. 2002f. *Bio-ecological Zones of Bangladesh*. Dhaka: IUCN The World Conservation Union.
- Riemann, K.U. 1993. *Geology of Bangladesh*; Gubrunder-Bornfraeger, Berlin, Germany.
- Soil Resource Development Institute (SRDI), 1997. *Physiography of Bangladesh*. Dhaka: SRDI, Ministry of Agriculture.
- Soil Resource Development Institute (SRDI), 1998. *Agro-ecological regions of Bangladesh*. Dhaka: SRDI, Ministry of Agriculture.
- United Nations Population Fund (UNFPA), 2010. *State of World Population 2010- From Conflict and Crisis to Renewal: generations of change* [Online]. Available at: http://www.unfpa.org/webdav/site/global/shared/swp/2010/swop_2010_eng.pdf
- Wikipedia. (2015). Geology of Bangladesh. Wikipedia. Retrieved from wikipedia.org/wiki/Geology_of_Bangladesh
- Zahiruddin, S.A., 1993. *Bangladesh National Building Code*. Dhaka: Housing and Building Research Institute, Ministry of Housing and Public Works, Government of the People's Republic of Bangladesh.

APPENDICES

Appendix 1: Rapid Environmental Assessment (REA) Checklist

Rapid Environmental Assessment (REA) Checklist

Instructions:

(i) The project team completes this checklist to support the environmental classification of a project. It is to be attached to the environmental categorization form and submitted to the Environment and Safeguards Division (RSES), for endorsement by Director, RSES and for approval by the Chief Compliance Officer.

(ii) This checklist focuses on environmental issues and concerns. To ensure that social dimensions are adequately considered, refer also to ADB's (a) checklists on involuntary resettlement and Indigenous Peoples; (b) poverty reduction handbook; (c) staff guide to consultation and participation; and (d) gender checklists.

(iii) Answer the questions assuming the "without mitigation" case. The purpose is to identify potential impacts. Use the "remarks" section to discuss any anticipated mitigation measures.

Country/Project Title:

BANGLADESH: JOYDEBPUR-DEBOGRAM-BHULTA-MADANPUR (DHAKA BY-PASS) ROAD (N-105) INTO 4 LANES THROUGH PUBLIC PRIVATE PARTNERSHIP(PPP)

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, church, 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		✓	None
▪ 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
<ul style="list-style-type: none"> Encroachment on historical/cultural areas; disfiguration of landscape by road embankments, cuts, fills, and quarries? 	✓		<p>No encroachment on historical but some cultural areas are envisaged.</p> <p>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.</p>
<ul style="list-style-type: none"> Encroachment on precious ecology (e.g. sensitive or protected areas)? 		✓	None
<ul style="list-style-type: none"> Alteration of surface water hydrology of waterways crossed by roads, resulting in increased sediment in streams affected by increased soil erosion at construction site? 	✓		<p>There 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.</p> <p>All measures shall be taken during construction stage so that watercourses are not affected and temporary soil and rock stockpiles will be designed so that runoff will not induce sedimentation of waterways.</p>
<ul style="list-style-type: none"> Deterioration of surface water quality due to silt runoff and sanitary wastes from worker-based camps and chemicals used in construction? 	✓		<p>Suitable siltation prevention measures such as silt fencing is included in the EMP.</p> <p>Adequate measures for sanitary and construction related waste such as chemicals shall be taken to prevent contaminating local water resources.</p>
<ul style="list-style-type: none"> Increased local air pollution due to rock crushing, cutting and filling works, and chemicals from asphalt processing? 	✓		<p>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.</p>
<ul style="list-style-type: none"> Risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during project construction and operation during project construction and operation? 	✓		<p>Construction activities could cause accidents and health risks to workers. Occupational health and safety measures will be mandatory for the contractor.</p>

Screening Questions	Yes	No	Remarks
<ul style="list-style-type: none"> 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.
<ul style="list-style-type: none"> Dislocation or involuntary resettlement of people? 		✓	There will be minimal resettlement impacts. Further details are provided in the Resettlement Plan.
<ul style="list-style-type: none"> Dislocation and compulsory resettlement of people living in right-of-way? 		✓	
<ul style="list-style-type: none"> Disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups? 		✓	Due to road improvement some households of indigenous people will be impacted but they will be compensated as per the resettlement plan.
<ul style="list-style-type: none"> Other social concerns relating to inconveniences in living conditions in the project areas that may trigger cases of upper respiratory problems and stress? 		✓	No major impacts anticipated. However, efforts will be made to minimize air pollution through appropriate measures such as wet spraying, covering of trucks, location of hot mix plants and other stationary equipment's away from settlement areas and others.
<ul style="list-style-type: none"> Hazardous driving conditions where construction interferes with pre-existing roads? 	✓		Proper safety measures such as barricades, flagman, sign boards etc. will be placed to prevent accidents.
<ul style="list-style-type: none"> Poor sanitation and solid waste disposal in construction camps and work sites, and possible transmission of communicable diseases (such as STI's and HIV/AIDS) from workers to local populations? 	✓		Appropriate waste management shall be adopted in construction camps. Worker health checks and awareness raising will be implemented to educate workers on communicable diseases.
<ul style="list-style-type: none"> Creation of temporary breeding habitats for diseases such as those transmitted by mosquitoes and rodents? 	✓		Breeding habitats maybe created in labour camps, garbage disposal sites borrow pits and material storage yards. Appropriate sanitation requirements in labour camps and avoidance of stagnant water included in the EMP.
<ul style="list-style-type: none"> Accident risks associated with increased vehicular traffic, leading to accidental spills of toxic materials? 	✓		Temporarily during construction Stage. Adequate measures will be provided to prevent them such as speed reduction, provision of crash barrier and proper traffic signage system at sensitive places will ensure smooth traffic flow which will reduce accidental risk

Screening Questions	Yes	No	Remarks
<ul style="list-style-type: none"> Increased noise and air pollution resulting from traffic volume? 	✓		Due to improvement in road riding conditions the net effect on noise and air pollution will be negligible. However, the number of traffic will increase and the pollution will also increase consistently.
<ul style="list-style-type: none"> Increased risk of water pollution from oil, grease and fuel spills, and other materials from vehicles using the road? 		✓	EMP recommendations are designed to mitigate water pollution due to construction related activities.
<ul style="list-style-type: none"> Social conflicts if workers from other regions or countries are hired? 		✓	EMP suggests to hire most workers from the local area and to ensure gender equality.
<ul style="list-style-type: none"> Large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)? 		✓	Most workers will be hired locally, hence this is not anticipated.
<ul style="list-style-type: none"> Risks to community health and safety due to the transport, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during construction and operation? 	✓		Transport, storage, use and disposal of fuel and chemicals will be required. Appropriate safety, storage and disposal measures recommended in the EMP.
<ul style="list-style-type: none"> Community safety risks due to both accidental and natural causes, especially where the structural elements or components of the project are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning. 	✓		Safety and injury related risks will arise from the presence of equipment's and construction activities. Clear demarcation of restricted areas and prevention of open access to construction areas is included in the EMP.

Climate Change and Disaster Risk Questions	Yes	No	REMARKS
The following questions are not for environmental categorization. They are included in this checklist to help identify potential climate and disaster risks.			
<ul style="list-style-type: none"> Is the Project area subject to hazards such as earthquakes, floods, landslides, tropical cyclone winds, storm surges, tsunami or volcanic eruptions and climate changes 	✓		As in most parts of Bangladesh, parts of the project road face problems of flooding. A separate hydrological analysis has been conducted during the feasibility stage. Required design measures for adapting to future flooding events have been recommended to this IEE as well.
<ul style="list-style-type: none"> Could changes in temperature, precipitation, or extreme events patterns over the Project lifespan affect technical or financial sustainability (e.g., increased erosion or landslides could increase maintenance costs, permafrost melting or increased soil moisture content could affect sub-grade). 		✓	With the incorporation of hydrological analysis it is expected that the road will be able to withstand with future changes of various climatic parameters.
<ul style="list-style-type: none"> Are there any demographic or socio-economic aspects of the Project area that are already vulnerable (e.g., high incidence of marginalized populations, rural-urban migrants, illegal settlements, ethnic minorities, women or children)? 		✓	There is no potential impact identified in the project area yet.

▪ 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)?		✓	
--	--	---	--

Note: Hazards are potentially damaging physical events.

Appendix 2: Renewal of ECC of Dhaka Bypass Road

Government of the People's Republic of Bangladesh
Department of Environment
Dhaka Regional Office
Paribesh Bhaban
E-16 Agargaon, Dhaka-1207
www.doe.gov.bd

Memo No: 22.02.0000.131.72.034.17/Renewal-03

Date: 27/05/2019.

Subject : Renewal of the Environmental Clearance Certificate of the Dhaka Bypass Road (Joydevpur-Debogram-Bhulta-Madanpur) 4-Lane Highway Project

Ref: (1) Your application dated 07/05/2019.
(2) Memo No- DOE/Clearance/5407/2015/133, Date :10/03/2016.

With reference to your application of 07/05/2019 on the subject mentioned above, the Department of Environment (DOE) is pleased to renew the Environmental Clearance Certificate (ECC) of the Dhaka Bypass Road (Joydevpur-Debogram-Bhulta-Madanpur) 4-Lane Highway Project. The renewal of ECC is valid until 09/03/2020.

2. The terms and condition set out in the original ECC (DOE/Clearance/5407/2015/133, Date: 10/03/2016) shall remain valid. Any violation of those conditions shall render this clearance void.


(Masud Iqbal Md. Shameem)
Director
Phone : 8181794.

Additional Chief Engineer
Public Private Partnership Cell
Roads and Highways Department (RHD)
132/4, New Baliy Road, Dhaka-1000.

Copy Forwarded to:

1. Assistant Director to the Director General, Department of Environment, Head Office, Dhaka.

E:\Dhaka Region Office\Renewal Clearance\Clearance & other Renewal_E-3.doc

Appendix 3: Test Result of Air Quality Measurement



Multidisciplinary Development Consultants

Name of the Project	Environmental Impact Assessment (EIA) of Dhaka-Bypass Road (Joydebpur-Debogram-Bhulta-Madanpur) 4-Lane Highway Project
Description of Sample	Ambient Air Quality
Sample Collector	Collected by DSCL Personnel
Sampling Date	16 July 2019 – 17 July 2019

Test Result of Ambient Air Quality Analysis

Parameter	Unit	Project Site		Bangladesh Standard	Duration (hours)	Weather Condition	Method of Analysis
		DBR_AAQ_01 23.92909°N; 90.45358°E	DBR_AAQ_02 23.78833°N; 90.36849°E				
SPM	µg/m ₃	155	75	200	24	Cloudy	Gravimetric
PM _{2.5}	µg/m ₃	50.1	39.5	65	24		Gravimetric
PM ₁₀	µg/m ₃	65.3	105	150	24		Gravimetric
SO ₂	µg/m ₃	1.41	3.05	365	24		West-Geake
NO _x	µg/m ₃	8.82	12.7	100	Annual		Jacob and Hochheiser
O ₃	µg/m ₃	10.6	1.01	157	8		Spectrophotometric Method
CO*	ppm	1.30	1	9	8		CO Meter

Note:

** The Bangladesh National Ambient Air Quality Standards have been taken from the Environmental Conservation Rules, 1997 which was amended on 19th July 2005 vide S.R.O. No. 220-Law/2005.

NY3: Not Yet Standardized

Test Result of Ambient Air Quality Analysis (Weather Data)

Sample ID	Location	GPS Location	Time		Humidity (%)	Temperature (°C)	Wind speed and direction (Km/h)
			Start	End			
DBR_AAQ_01	Mirer Bazar, Pubail, Gazipur	23.92909°N; 90.45358°E	9:00	17:00	88%	29°C	24 km/h from North to East
DBR_AAQ_02	Bhulta Mor, Narayanganj	23.78833°N; 90.36849°E	9:00	17:00	62%	34°C	10 km/h from North to East

Development Solutions Consultant Ltd.

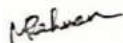
House# 734 (5-B), Road# 10, Avenue# 04
DOHS Mirpur, Dhaka-1216, Bangladesh. Tel: +8801822857548
Email: dsc@dsclbd.com Web: www.dsclbd.com




Multidisciplinary Development Consultants

Description of the Surrounding Environment

Location	Sample Site Description
Mirer Bazar, Pubali, Gazipur (DBR_AAQ_01)	<ul style="list-style-type: none">➤ Commercial area➤ Lower amount of dust particles were present➤ People movement was high➤ Traffic volume was moderate➤ The weather was cloudy
Bhulta Mor, Narayanganj (DBR_AAQ_02)	<ul style="list-style-type: none">➤ Commercial area➤ Lower amount of dust particles were present➤ People movement was low➤ Traffic volume was moderate➤ The weather was sunny


Test Performed By:
Md. Mashiur Rahman
Jr. Environmental Specialist




Checked By:
Tonmoy Pandit
Deputy Manager

Development Solutions Consultant Ltd.
House# 734 (5-B), Road# 10, Avenue# 04
DOHS Mirpur, Dhaka-1216, Bangladesh. Tel: +8801822857548
Email: dsc@dsclbd.com Web: www.dsclbd.com

Appendix 4: Test Result of Noise Level Measurement



DSCL

Multidisciplinary Development Consultants

Name of the Project	Environmental Impact Assessment (EIA) of Dhaka-Bypass Road (Joydebpur-Debogram-Bhulta-Madanpur) 4-Lane Highway Project
Description of Sample	Noise Level Measurement
Sample Collector	Collected by DSCL Personnel
Sampling Date	16 July 2019 – 17 July 2019

Noise Level Analysis

Location	GPS Location	Land Use Category	Time		Noise Level dBA (LA _{eq})		Bangladesh Standard (dBA)	
			Day	Night	Day	Night	Day	Night
Bhogra Bypass, Mogorkhala, Gazipur	23.97753°N; 90.38335°E	Commercial	10:36	20:05	71.33	45.79	70	60
Mirer Bazar, Pubail, Gazipur	23.92902°N; 90.45354°E		15:24	20:58	72.56	49.44		
Purbachal Interchange, Dhaka	23.834866°N; 90.538945°E		17:39	21:45	72.33	61.45		
Bhulta Mor, Narayanganj	23.78840°N; 90.56852°E		10:54	22:50	73.45	58.89		
Chandpur, Madanpur	23.69226°N; 90.54775°E		13:16	23:58	73.39	64.78		
<p><i>Notes:</i></p> <ul style="list-style-type: none"> Land use category is based on the classification provided in the Noise Pollution Control Rules (2006) Shaded cells indicate noise levels in excess of Noise Pollution Control Rules ambient noise limits for a given land use area The sound level standard for commercial area at day and night time is 70 dBA & 60 dBA respectively.. <p>Noise Level is the average noise recorded over the duration of the monitoring period</p>								

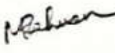
Development Solutions Consultant Ltd.

House# 734 (5-B), Road# 10, Avenue# 04
 DOHS Mirpur, Dhaka-1216, Bangladesh. Tel: +8801822857548
 Email: dsc@dscibd.com Web: www.dscibd.com




Multidisciplinary Development Consultants

Location	Sample Site Description
Bhogra Bypass, Mogorkhala, Gazipur (DBR_NM_01)	<ul style="list-style-type: none"> ➤ Commercial area ➤ Traffic volume was high ➤ People movement was high
Mirer Bazar, Pubail, Gazipur (DBR_NM_02)	<ul style="list-style-type: none"> ➤ Commercial area ➤ Traffic volume was high ➤ People movement was medium
Purbachal Interchange, Dhaka (DBR_NM_03)	<ul style="list-style-type: none"> ➤ People movement was high ➤ Traffic volume was high ➤ Several peoples were gossiping loudly
Bhulta Mor (DBR_NM_04)	<ul style="list-style-type: none"> ➤ Traffic volume was moderate ➤ People movement was low ➤ A tea stall was located just beside the alignment
Chandpur, Madanpur (DBR_NM_05)	<ul style="list-style-type: none"> ➤ Traffic volume was high ➤ People movement was high ➤ A man was talking very loudly to his friend beside the road


 Test Performed By:
Md. Mashiur Rahman
 Jr. Environmental Specialist




 Checked By:
Tonmoy Pandit
 Deputy Manager

Development Solutions Consultant Ltd.

House# 734 (5-B), Road# 10, Avenue# 04
 DOHS Mirpur, Dhaka-1216, Bangladesh. Tel: +8801822857548
 Email: dscl@dsclbd.com Web: www.dsclbd.com

Appendix 5: Test Result of Vibration Level Measurement



DSCL

Multidisciplinary Development Consultants

Name of the Project	Environmental Impact Assessment (EIA) of Dhaka-Bypass Road (Joydebpur-Debogam-Bhulta-Madanpur) 4-Lane Highway Project
Description of Sample	Vibration Level Monitoring
Sample Collector	Collected by DSCL Personnel
Sampling Date	16 July 2019 – 17 July 2019

Test Result of Vibration Level Monitoring

Sample ID	Location	Velocity (mm/s)			Acceleration (m/s ²)			Displacement (mm)			
		Max.	Standard Deviation	Mean Value	Max.	Standard Deviation	Mean Value	Max.	Standard Deviation	Mean Value	
DBR_VB_01	Bhogra Bypass, Mogorkhala, Gazipur	26.77	10.299	9.235	8.3	0.1	2.862	0.039	0	0.005	0.007
DBR_VB_02	Mirer Bazar, Pubail, Gazipur	42.57	18.794	16.170	7.6	0.1	3.089	0.011	0	0.002	0.002
DBR_VB_03	Purbachal Interchange, Dhaka	0.71	0.259	0.270	12.9	0	3.134	0.012	0	0.005	0.002
DBR_VB_04	Bhulta Mor	3.51	1.236	1.130	19.7	1.9	7.285	0.030	0	0.007	0.007
DBR_VB_05	Chandpur, Madanpur	28.83	9.999	8.205	0.1	0.1	0	0.011	0.004	0.003	0.009



(Signature)

Test Performed By:
Md. Mashur Rahman
 Jr. Environmental Specialist

Checked By:
Toumoy P andit
 Deputy Manager

Development Solutions Consultant Ltd.

House# 734 (5-B), Road# 10, Avenue# 04
 DOHS Mirpur, Dhaka-1216, Bangladesh. Tel: +8801822857548
 Email: dscsl@dsclbd.com Web: www.dsclbd.com

Appendix 6: Test Result of Groundwater Quality



DSCL

Multidisciplinary Development Consultants

Name of the Project	Environmental Impact Assessment (EIA) of Dhaka-Bypass Road (Joydebpur-Debogram-Bhulta-Madanpur) 4-Lane Highway Project
Description of Sample	Groundwater Quality
Sample Collector	Collected by DSCL Personnel
Sampling Date	16 July 2019

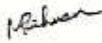
Test Result of Groundwater Quality Analysis

Parameters	Unit	Concentration Present		Standards for Potable water*	Analysis Method
		Mirer Bazar, Pubali, Gazipur	Bhulta Mor Near Bypass, Narayanganj		
		DBR_GW_01 23.92902°N; 90.45329°E	DBR_GW_02 23.78904°N; 90.56419°E		
pH*	-	7.53	7.54	6.5-8.5	Multimeter
Total Dissolved Solids (TDS)*	mg/L	279	333	1000	Multimeter
ORP*	mg/L	44.0	36.2	NYS	Multimeter
Electric Conductivity (EC)*	µs/cm	422	506	NYS	Multimeter
Temperature*	°C	28.9	29.8	20-30	Multimeter
Dissolve Oxygen	mg/L	1.2	1.1	5 or Less	DO Meter

Note:

** The Bangladesh National Potable Water Standards have been taken from the Environmental Conservation Rules, 1997 which was amended on 19th July 2005 vide S.R.O. No. 220-Law/2005.

NYS: Not Yet Standardized




Test Performed By:
Md. Mashiur Rahman
 Jr. Environmental Specialist




Checked By:
Tonmoy Pandit
 Deputy Manager

Development Solutions Consultant Ltd.

House# 734 (5-B), Road# 10, Avenue# 04
 DOHS Mirpur, Dhaka-1216, Bangladesh. Tel: +8801822857548
 Email: dscl@dsclbd.com Web: www.dsclbd.com

	<p>Government of the People's Republic of Bangladesh Office of the Chief Chemist Department of Public Health Engineering Central Lab, 38-39, Mohakhali C/A, Dhaka-1212 Phone: 88-02-9881927, Fax: 88-02-9882003, Email: wqmsc_central_lab@yahoo.com</p>	
---	---	---

Lab Memo: 082/ CC, DPHE, CL, Dhaka.

Date: 24-07-2019

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2019070185	Sample Receiving date: 18-07-2019
Ref. Memo No: DSCL/2019/Nill & Dated: 18-07-2019	Sample Source: Ground Water
Sent by: Tonmoy Pandit ,Deputy Manager , DSCL, Mirpur DOHS, Dhaka-1216.	Dist:Gazipur, Upa:
Care Taker: DSCL (DBR_GW-01)	Union:, Vill.:Mirer Bazar
Sample Collection date:	Date of Testing: 18/07/2019-24/07/2019

LABORATORY TEST RESULTS:



Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Arsenic (As)	0.05	0.001	mg/L	AAS	0.001
2	Chloride	150-600	15	mg/L	Titrimetic	-
3	Iron (Fe)	0.3-1	0.49	mg/L	AAS	0.05
4	Lead (Pb)	0.05	0.003	mg/L	AAS	0.001
5	Manganese (Mn)	0.1	0.05	mg/L	AAS	0.03

Comments: Sample was collected & Supplied by client.

N.B: AAS - Atomic Absorption Spectrophotometer, LOQ - Limit of Quantitation.

<p><u>Test Performed by:</u></p> <p>1.) Name: Mahabuba Sabina Motin Designation: Sample Analyzer</p> <p>2.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer</p>	<p><u>Signature</u></p> <p><i>Mahabuba Sabina Motin</i> 24-07-19</p> <p><i>Md. Saiful Alam Khosru</i> 24.07.19</p>	<p><u>Countersigned/Approved by:</u></p> <p>1.) Name: Mita Sarker Designation: Senior Chemist</p> <p>2.) Name: Md. Biplab Hossain Designation: Chief Chemist</p>	<p><u>Signature</u></p> <p><i>Mita Sarker</i> 24/07/19</p> <p><i>Md. Biplab Hossain</i> 24/07/19</p>
---	--	--	--

Md. Biplab Hossain
 Chief Chemist
 Department of Public Health Engineering
 Central Laboratory Mohakhali, Dhaka.

	<p>Government of the People's Republic of Bangladesh Office of the Chief Chemist Department of Public Health Engineering Central Lab, 38-39, Mohakhali C/A, Dhaka-1212 Phone: 88-02-9881927, Fax: 88-02-9882003, Email: wqmsc_central_lab@yahoo.com</p>	
---	---	---

Lab Memo: 082/ CC, DPHE, CL, Dhaka.

Date: 24-07-2019

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2019070188	Sample Receiving date: 18-07-2019
Ref. Memo No: DSCL/2019/Nill & Dated: 18-07-2019	Sample Source: Groundwater
Sent by: Tonmoy Pandit, Deputy Manager, DSCL, Mirpur DOHS, Dhaka-1216	Dist: Narayanganj; Upa:
Care Taker: DSCL (DBR_GW_02)	Union; Vill.: Bhulta Mor
Sample Collection date:	Date of Testing : 18/07/2019-24/07/2019

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Arsenic (As)	0.05	0.002	mg/L	AAS	0.001
2	Chloride	150-60	12	mg/L	Titrimetric	-
3	Iron (Fe)	0.3-1	0.38	mg/L	AAS	0.05
4	Lead (Pb)	0.05	0.001	mg/L	AAS	0.001
5	Manganese (Mn)	0.1	0.03	mg/L	AAS	0.03

Comments: Sample was collected & Supplied by client.
 N.B: AAS - Atomic Absorption Spectrophotometer, LOQ - Limit of Quantitation.

<p><u>Test Performed by:</u></p> <p>1.) Name: Mahabuba Sabina Motin Designation: Sample Analyzer</p> <p>2.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer</p>	<p><u>Countersigned/Approved by:</u></p> <p>1.) Name: Mita Sarker Designation: Senior Chemist</p> <p>2.) Name: Md. Biplab Hossain Designation: Chief Chemist</p>
---	--


Md. Biplab Hossain
 Chief Chemist
 Department of Public Health Engineering
 Central Laboratory Mohakhali, Dhaka.

Appendix 7: Test Result of Surface Water Quality



DSCL

Multidisciplinary Development Consultants

Name of the Project	Environmental Impact Assessment (EIA) of Dhaka-Bypass Road (Joydebpur-Debogram-Bhulta-Madanpur) 4-Lane Highway Project
Description of Sample	Surface Water Quality
Sample Collector	Collected by DSCL Personnel
Sampling Date	16 July 2019

Test Result of Groundwater Quality Analysis

Parameters	Unit	Concentration Present		Standards for Inland Surface water*	Analysis Method
		Turag River, Ulukhola Bridge	Shitalakshya River, Kanchan Bridge		
		DBR_SW_01 23.90060°N; 90.48111°E	DBR_SW_02 23.83619°N; 90.54707°E		
pH*	-	9.27	8.02	6.5-8.5	Multimeter
Total Dissolved Solids (TDS)*	mg/L	2203	97.2	1000	Multimeter
ORP*	mg/L	23.7	49.5	NYS	Multimeter
Electric Conductivity (EC)*	µs/cm	307	145.5	NYS	Multimeter
Temperature*	°C	28.5	30	20-30	Multimeter
Dissolve Oxygen*	mg/L	1.8	4.9	6 or more	DO Meter

Note:

** Inland Surface Water Standards have been taken from the Environmental Conservation Rules, 1997 which was amended on 19th July 2005 vide S.R.O. No. 220-Law/2005.

NYS: Not Yet Standardized



Test Performed By:
Md. Mashiur Rahman
 Jr. Environmental Specialist



Checked By:
Tonmoy Pandit
 Deputy Manager

Development Solutions Consultant Ltd.

House# 734 (5-B), Road# 10, Avenue# 04
 DOHS Mirpur, Dhaka-1216, Bangladesh. Tel: +8801822758548
 Email: dscl@dsclbd.com Web: www.dsclbd.com

	<p>Government of the People's Republic of Bangladesh Office of the Chief Chemist Department of Public Health Engineering Central Lab, 38-39, Mohakhali C/A, Dhaka-1212 Phone: 88-02-9881927, Fax: 88-02-9882003, Email: wqmsc_central_lab@yahoo.com</p>	
---	---	---

Lab Memo: 082/ CC, DPHE, CL, Dhaka.

Date: 24-07-2019

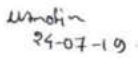
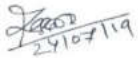

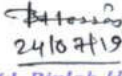
Physical /Chemical/ Bacteriological Analysis of Water Sample



Sample ID: CEN2019070186	Sample Receiving date: 18-07-2019
Ref. Memo No: DSCL/2019/Nil & Dated: 18-07-2019	Sample Source: Surface Water
Sent by: Tonmoy Pandit, Deputy Manager, DSCL, Mirpur DOHS, Dhaka-1216.	Dist: Gazipur, Upa:
Care Taker: DSCL (DBR_SW-01)	Union:, Vill.: Tongi river, Ulukhola
Sample Collection date:	Date of Testing: 18/07/2019-24/07/2019

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Biochemical Oxygen Demand (BOD)	0.2	19	mg/L	5 days incubation	0.1
2	Chemical Oxygen Demand (COD)	4.0	68	mg/L	CRM	-
3	Total Suspended Solid (TSS)	10	24	mg/L	Gravimetric Method	-
4	Turbidity	10	143	NTU	Turbidity Meter	-

Comments: Sample was collected & Supplied by client.
 N.B: CRM-Closed Reflex Methods, LOQ - Limit of Quantitation.

Test Performed by:		Countersigned/Approved by:	
	Signature		Signature
1.) Name: Mahabuba Sabina Motin Designation: Sample Analyzer	 24-07-19	1.) Name: Mita Sarker Designation: Senior Chemist	 24/07/19
2.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer	 24.07.19	2.) Name: Md. Biplab Hossain Designation: Chief Chemist	 24/07/19 Md. Biplab Hossain Chief Chemist Department of Public Health Engineering Central Laboratory Mohakhali, Dhaka.

	<p>Government of the People's Republic of Bangladesh Office of the Chief Chemist Department of Public Health Engineering Central Lab, 38-39, Mohakhali C/A, Dhaka-1212 Phone: 88-02-9881927, Fax: 88-02-9882003, Email: wqmsc_central_lab@yahoo.com</p>	
---	---	---

Lab Memo: 082/ CC, DPHE, CL, Dhaka.

Date: 24-07-2019

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2019070189	Sample Receiving date: 18-07-2019
Ref. Memo No: DSCL/2019/Nill & Dated: 18-07-2019	Sample Source: Surface Water
Sent by: Tonmoy Pandit, Deputy Manager, DSCL, Mirpur DOHS, Dhaka-1216	Dist: Narayanganj; Upa:
Care Taker: DSCL (DBR_SW_02)	Union; Vill.: Shittolakhya River
Sample Collection date:	Date of Testing : 18/07/2019-24/07/2019

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Biological Oxygen Demand (BOD)	0.2	17	mg/L	5 days incubation	0.1
2	Chemical Oxygen Demand (COD)	4.0	56	mg/L	CRM	-
3	Total Suspended Solids (TSS)	10	20	mg/L	Gravimetric Method	-
4	Turbidity	10	78	NTU	Turbidity Meter	-

Comments: Sample was collected & Supplied by client.
 N.B:CRM-Closed Reflex Methods, LOQ - Limit of Quantitation

<p>Test Performed by:</p> <p>1.) Name: Mahabuba Sabina Motin Designation: Sample Analyzer</p> <p>2.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer</p>	<p style="text-align: center;"><u>Signature</u></p> <p style="text-align: center;"><i>Motin</i> 24-07-19</p> <p style="text-align: center;"><i>Saiful Alam</i> 24.07.19</p>	<p>Countersigned/Approved by:</p> <p>1.) Name: Mita Sarker Designation: Senior Chemist</p> <p>2.) Name: Md. Biplab Hossain Designation: Chief Chemist</p>	<p style="text-align: center;"><u>Signature</u></p> <p style="text-align: center;"><i>Mita Sarker</i> 24/07/19</p> <p style="text-align: center;"><i>Biplab Hossain</i> 24/07/19</p> <p style="text-align: center;">Md. Biplab Hossain Chief Chemist Department of Public Health Engineering Central Laboratory Mohakhali, Dhaka.</p>
---	---	--	---

মৃত্তিকা, পানি ও পরিবেশ বিভাগ
ঢাকা বিশ্ববিদ্যালয়
ঢাকা ১০০০



Department of Soil, Water and Environment
University of Dhaka
Dhaka 1000
Bangladesh



Date: 24.07.2019

Report of Analysis

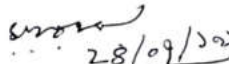
Sample Supplied by
Tonmoy Pandit
Deputy Manager
Development Solutions Consultant Limited
H-734 (5-B), Road-10, Avenue-04, Mirpur DOHS
Dhaka-1216, Bangladesh

Sample Title: Surface Water Test for Oil & Grease

Re: Environmental Impact Assessment for Dhaka-Bypass Road (Joydebpur-Debogram-Bhulta-Madanpur) 4-Lane Highway Project

Analytical Results:

SL. No.	Water Source	Sample ID	Test Parameters	Test Methods (APHA)
			Oil & Grease (mg/L)	
1	Surface Water	DBR_SW_01	Less than 5.0	5520.B
2	Surface Water	DBR_SW_01	Less than 5.0	5520.B


(Dr. Md. Khalilur Rahman)
Professor and Chairman

Dr. Md. Khalilur Rahman
Professor & Chairman
Dept. of Soil, Water & Environment
University of Dhaka
Dhaka-1000, Bangladesh

Telephone: 9661920-73/7470, Fax:(880-2) 8615583, e-mail: swed @du.ac.bd

Appendix 8: Test Result of Soil Quality Analysis

মৃত্তিকা, পানি ও পরিবেশ বিভাগ
ঢাকা বিশ্ববিদ্যালয়
ঢাকা ১০০০
বাংলাদেশ



Department of Soil, Water and Environment
University of Dhaka
Dhaka 1000
Bangladesh



Date: 24. 07. 2019

Report of Analysis

Sample supplied by
Mr. Tonmoy Pandit
Deputy Manager
Development Solutions Consultant Ltd.
House # 734 (5-B), Road # 10, Avenue # 04
DOHS Mirpur, Dhaka 1216, Bangladesh

Sample Title: Soil Quality Test

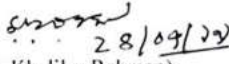
Re. Environmental Impact Assessment for Dhaka-Bypass Road (Joydebpur-
Debogram-Bhulta-Madanpur) 4-Lane Highway Project

Analytical Results:

Sample Source	Sample ID	Test Parameters	Units	Results
Surface Soil	DBR_SL_01	Total Organic matter	(%)	1.07
		Phosphate (PO ₄ ³⁻)	(mg/kg)	9.53
		Nitrate (NO ₃)	(mg/kg)	12.10
		Sulphate (SO ₄ ²⁻)	(mg/kg)	128.46
		Zinc (Zn)	(mg/kg)	68.24
		Iron (Fe)	(%)	1.55
		pH	-	7.58

Methods Used:

1. Total Organic Matter : Wet Oxidation Method
2. Phosphate : Olsen Method
3. Nitrate : Kjeldahl distillation Method
4. Sulphate : Turbidity Method
5. Fe and Zn : Aquaregia digestion and AAS Method
6. pH (Soil : Water ratio 1:2.5) : pH meter


(Dr. Md. Khalilur Rahman)
Professor and Chairman

Dr. Md. Khalilur Rahman
Professor & Chairman
Dept. of Soil, Water & Environment
University of Dhaka
Dhaka-1000, Bangladesh

Telephone : 9661920-73/7470, Fax: (880-2) 8615583, e-mail : swed@du.ac.bd

মৃত্তিকা, পানি ও পরিবেশ বিভাগ
ঢাকা বিশ্ববিদ্যালয়
ঢাকা ১০০০



Department of Soil, Water and Environment
University of Dhaka
Dhaka 1000
Bangladesh



Date: 24.07.2019

Report of Analysis

Sample Supplied by
Tonmoy Pandit
Deputy Manager
Development Solutions Consultant Limited
House-734 (5-B), Road-10, Avenue-04
DOHS Mirpur, Dhaka-1216, Bangladesh

Sample Title: Soil Quality Test

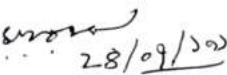
Re: Environmental Impact Assessment for Dhaka-Bypass Road (Joydebpur-Bhulta-Debogrom-Madanpur) 4-Lane Highway Project

Analysis Results:

Sample Source	Sample ID	Test Parameters	Units	Results
Surface Soil	DBR_SL_02	Total Organic Matter	(%)	0.98
		Phosphate (PO ₄)	(mg/kg)	8.86
		Nitrate (NO ₃)	(mg/kg)	10.32
		Sulphate (SO ₄)	(mg/kg)	98.32
		Zinc (Zn)	(mg/kg)	56.24
		Iron (Fe)	(%)	1.67
		pH	-	7.02

Test Methods:

1. Total Organic Matter : Wet Oxidation Method
2. Phosphate : Olsen Method
3. Nitrate : Kjeldahl distillation Method
4. Sulphate : Turbidity Method
5. Fe and Zn : Aqua-regia digestion and AAS Methods
6. pH (1:2.5) : pH Meter


(Dr. Md. Khalilur Rahman)
Professor and Chairman

Dr. Md. Khalilur Rahman
Professor & Chairman
Dept. of Soil, Water & Environment
University of Dhaka
Dhaka-1000, Bangladesh

Telephone: 9661920-73/7470, Fax:(880-2) 8615583, e-mail: swed @du.ac.bd

Appendix 9: Consultations Details and List of Participants for FGD

FGD No- 1

Site: Bhogra Bypass, Mogorkhala, Gazipur

GPS Coordination: 23.97753°N; 90.38335°E

Date: 16 July 2019.

Time: 10:00 AM TO 11:00 PM.

Outcome of the FGD

A focus group discussion was held during 10:00 am to 11:00 pm on 17 July 2019 at Bhogra Bypass, Mogorkhala, Gazipur adjacent to the proposed project site. All the participants were local people from several professions. Total 08 (Eight) people participated in the meeting. In the discussion meeting; environmental and social issues were examined. The main focus was to dig out information on how indiscriminate use of natural resources causes social and environmental degradation or benefit by implementing the proposed project with using several natural resources. The issue on potential impact of construction works has also been raised.

Most of participants appreciated because of the benefit from the proposed project. They also discussed about noise, water and soil pollution issue that are evolving because of existing the future possibilities. They expect improved technology and good management practice to minimize the problem. Additionally, some of the participants informed that it would be better for local community if project proponent recruit up to 50% employment from local people.

Some Specific Question and Comments from the Stakeholder are given below-

Questions to the Groups	Participants opinion, comments and suggestions
Are you aware about the activities of the DBR Project? If yes, how do you?	Robiul Hasan (Business): Without a doubt, the endeavour backer has conferred this information to us. The Govt. of Bangladesh will improve the existing road in order to improve the transportation offices among the overall public especially the adjacent people.
How The project will impact on surrounding environment? Please mention both positive and negative sides	Rabbi (Business): Improvement of this proposed undertaking, the incorporating condition may influence yet concise. Air contamination and soil contamination will affect on incorporating condition. Agrarian land will decrease because of the utilization of this endeavour. The endeavour protector should take genuine thought to reduce these impacts. The waste materials should be kept up fittingly and it should not be kept at the open spot. This errand will improve the progression of our work monetarily.
Do you have any recommendation before the implementation of this project?	Jamil (Business): We are really happy to understand that a road improvement adventure for decreasing traffic obstructs and basic access is to be realized here. Adjacent Labours should be sorted out during advancement work. The overall public of that system proposed to squander workplaces bedside the road. A reclamation plan for the affected person's masses. To the extent a conceivable announcement on the different sides of the proposed road.



Environmental Impact Assessment (EIA) of Dhaka-Bypass Road (Joydebpur-Debogram-Bhulta-Madanpur) 4-Lane Highway Project

List of Participants for Focus Group Discussion

Address Bhogra Bypass, Mogorkhala, Gazipur

GPS Location 23.97753°N, 90.38335°E

Date 16 July 2019

Time 10:00 AM - 11

SL No.	Participant's Name	Age	Occupation	Telephone No.	Signature
1	Cham Mia	61	Retired		
2	Robiul Hasan	41	Business		
3	Rafiqun Bakar	56	Retired		
4	Tipu Sultan	18	Student		
5	Noqibul	24	Worker		
6	Rabbi	36	Business		
7	Jamil	34	Business		
8	Khalid	51	Retired		

Facilitated By MA. Shakil Ahmed

Signature

FGD No- 2

Site: Purbachal Interchange, Purbachal, Dhaka

GPS Coordination: 23.92902 °N; 90.45354 °E

Date: 16 July 2019.

Time: 02:00 PM to 03:00 PM.

Outcome of the Consultation

A focus group discussion was held during 02:00 PM to 03:00 PM on 17 July 2019 at Purbachal Interchange, Purbachal, and Dhaka beside the project site. The focus group discussion was conducted with local people of the project site. Total 06 (Six) people participated in the meeting. In consultation meeting; environmental and social issues were examined. The main focus was to dig out information on how indiscriminate use of natural resources causes social and environmental degradation or benefit by implementing the proposed project with using several natural resources. The issue on potential impact of construction works has also been raised.

During the consultation the participants appreciated the new project explaining their desires and expectations. The project will increase and improve the quality of their life. No major impact will take place due to the implementation of this project. Most of the people argued that they are willing to endure the negative impact to some extent for the sake of this project which they believe will improve their livelihood.

Some Specific Question and Comments from the Stakeholder are given below-

Questions to the Groups	Participants opinion, comments and suggestions
Do you face any traffic congestion problem due to existing national highway road?	kashem (Mechanic): Yes. Traffic congestion is a noteworthy issue. The majority of the streets are thin and broken. The quantity of vehicles has expanded contrasted with the past. The recurrence of stacked vehicles expanded out and about. Streets are likewise officially broken and need fixing.
Are you in favour of this project? Why?	Razzaq (Mechanic): Yes, we appreciate the initiative. This will influence the other people to take initiative of such kind project. In the long run it will help to develop the economic and social condition of this area.
Do you have any recommendation before the implementation of this project?	lutfar (Business): We are glad to realize that a street improvement venture for lessening traffic clog and simple access is to be executed around there. Local Labours ought to be organized during development work. The general population of that network proposed seepage offices bedside the street. A recovery plan for the influenced individual's populace. As far as a possible billboard on the two sides of the proposed street. The best possible pay ought to be given to the influenced individuals. I likewise prescribe executing the undertaking in the neglected land in the larger part as it will make less harm to the local individuals.

FGD No- 3**Site: Bhulta Mor, Bhulta, Narayanganj****GPS Coordination: 23.78840 °N, 90.56852 °E****Date: 17 July 2019.****Time: 11:00 AM TO 12:00 PM.****Outcome of the FGD**

A focus group discussion was held during 11:00 am to 12:00 pm on 17 July 2019 at Bhulta Mor, Bhulta, Narayanganj adjacent to the proposed project site. All the participants were local people from several professions. Total 08 (Eight) people participated in the meeting. In the discussion meeting; environmental and social issues were examined. The main focus was to dig out information on how indiscriminate use of natural resources causes social and environmental degradation or benefit by implementing the proposed project with using several natural resources. The issue on potential impact of construction works has also been raised.

Most of participants appreciated because of the benefit from the proposed project. They also discussed about noise, water and soil pollution issue that are evolving because of existing the future possibilities. They expect improved technology and good management practice to minimize the problem. Additionally, some of the participants informed that it would be better for local community if project proponent recruit up to 50% employment from local people.

Some Specific Question and Comments from the Stakeholder are given below-

Questions to the Groups	Participants opinion, comments and suggestions
Are you aware about the activities of the DBR Project? If yes, how do you?	<p>Motin Mia (Business): No, but this is definitely a good initiative to control the huge traffic problem. Especially this bypass road will help to improve the transportation network from Chittagong to Dhaka. This will certainly release extensive pressure over existing highway.</p>
How The project will impact on surrounding environment? Please mention both positive and negative sides	<p>Akkas Ali Ratan (Labour): Development of this proposed task, the encompassing condition may affect yet transitory. Air contamination and commotion contamination will impact on the encompassing condition. Horticultural land will diminish due to the execution of this task. The undertaking concern should take appropriate thoughtfulness regarding decrease these effects. The waste materials ought to be kept up appropriately and it ought not to be kept in at an open spot. This task will upgrade the advancement of our employment financially.</p>
Do you have any recommendation before the implementation of this project?	<p>Ali (Mechanic): We are exceptionally glad to realize that a street improvement venture for diminishing traffic clog and simple access is to be actualized around there. Nearby Labours ought to be organized during development work. The general population of that network proposed waste offices bedside the street. A recovery plan for the influenced individual's populace. Foot over the scaffold for the streets. As far as a possible billboard on the two sides of the proposed street.</p>



Environmental Impact Assessment (EIA) of Dhaka-Bypass Road (Joydebpur-Debogram-Bhulta-Madanpur) 4-Lane Highway Project

List of Participants for Focus Group Discussion

Address Bhulta Mor, Bhulta Morayanganj

GPS Location 23.78840°N, 90.56852°E

Date 17 July 2019

Time 11:00 AM - 12:00 PM

Sl. No.	Participant's Name	Age	Occupation	Telephone No.	Signature
1	Motin Mia	25	Business		
2	AKKAS Ali Rotan	28	worker		
3	Ali	26	worker		
4	Fazal	25	Business		
5	Mamik	28	worker		
6	Raja	24	worker		
7	Faruq	21	worker		
8	Enayet Mollah	32	worker		

Facilitated By Md. Shakil Ahmed

Signature

FGD No- 4

Site: Chandpur, Madanpur, Narayanganj

GPS Coordination: 23.13392°N; 89.16805°E

Date: 17 July 2019.

Time: 04:00 PM TO 05:00 PM.

Outcome of the Consultation

A focus group discussion was held during 04.00 pm to 05:00 pm on 26 May 2019 at Chandpur, Madanpur, Narayanganj beside the project site. The focus group discussion was conducted with local people of the project site. Total 12 (Twelve) people participated in the meeting. In consultation meeting; environmental and social issues were examined. The main focus was to dig out information on how indiscriminate use of natural resources causes social and environmental degradation or benefit by implementing the proposed project with using several natural resources. The issue on potential impact of construction works has also been raised.

During the consultation the participants appreciated the new project explaining their desires and expectations. The project will increase and improve the quality of their life. No major impact will take place due to the implementation of this project. Most of the people argued that they are willing to endure the negative impact to some extent for the sake of this project which they believe will improve their livelihood.

Some Specific Question and Comments from the Stakeholder are given below-

Questions to the Groups	Participants opinion, comments and suggestions
Do you have face any traffic congestion problem due to existing national highway road?	<p>Sobuj Mia (Business): Traffic problem is a noteworthy issue. The vast majority of the streets are tight and broken.. The quantity of vehicles has expanded contrasted with the past. The recurrence of stacked vehicles expanded out and about. Streets are likewise effectively broken and need fixing.</p>
Are you in favour of this project? Why?	<p>Abdur Rahman(Driver) Truly, we value the activity. This will impact different individuals to step up to the plate of such sort of venture. Over the long haul, it will build up the financial and social status of this territory.</p>
Do you have any recommendation before the implementation of this project?	<p>Kashem Munshi (Business): We are exceptionally glad to realize that a street improvement venture for decreasing traffic clog and simple access is to be executed around there. Neighbourhood Labours ought to be organized during development work. The general population of that network proposed waste offices bedside the street. A recovery plan for the influenced individual's populace. As far as a possible billboard on the two sides of the proposed street. The correct pay ought to be given to the influenced individuals. I likewise suggest executing the task in the neglected land in the greater part as it will make less harm the nearby individuals.</p>



Environmental Impact Assessment (EIA) of Dhaka-Bypass Road (Joydebpur-Debogram-Bhulta-Madanpur) 4-Lane Highway Project

List of Participants for Focus Group Discussion

Address Chandpur, Mahanipura, Narayanganj

GPS Location 23.13392°N ; 89.16805°E

Date 17 July 2019

Time 04:00 PM to 5:00 PM

SL No.	Participant's Name	Age	Occupation	Telephone No.	Signature
1	Sobuj Mia	32	Business		Sobuj
2	Abdur Rahman	28	Driver		Abdur
3	Kashem Munshi	29	Business		কাজেম মুন্সী
4	Nadim	25	Student		Nadim
5	Zilani	24	Student		Zilani
6	Jamal	25	Labour		জামাল
7	Dobir	22	Labour		দুবির
8	Hunnu Karim	61	Retired		হুন্না কারিম
9	Kaisar	27	Worker		কায়সার
10	Bakkar	24	Worker		বাক্কার
11	Hasan	30	Driver		হাসান
12	Jaded	36	Business		Jaded

Facilitated By Md. Shakil Ahmed

Signature (Signature)

Appendix 10: Waste Management Plan

1. GENERAL

Considerable quantities of wastes (general & construction) will be generated due to the 3 years construction of the project road. Two types of wastes will be generated during construction:

- a. General Waste:
 - Organic waste (wastes from kitchen, foods, fruits, vegetation etc.); and
 - Inorganic waste (such as papers, plastic and glass bottles & containers, polythene etc.); and
- b. Construction Waste:
 - Construction wastes are: construction materials such as sand, piece of rocks, bricks, rods, geotextiles, remaining concrete & bentonite waste.

2. OBJECTIVES

The main objective of the WMP is to organize disposal of all wastes generated during construction in an environmentally acceptable manner specially consider the following:

- Health hazards of the project personnel as well as community people should not be occurred;
- Manage the wastes in such a way that environment (specially air, soil, water etc.,) will not be polluted;
- Odor means bad smell should not be generated;
- Always friendly environment at the construction sites and construction camps;
- Any waste should not be disposed into the river and any water bodies to avoid water pollution;
- Any waste should not be burnt; and
- Any waste should not be placed in earth holes/chambers.

3. POTENTIAL ENVIRONMENTAL IMPACTS

Major potential environmental impacts due to the lack of waste management are:

- All types of environmental pollutions such as air, soils, water (surface & ground) pollutions;
- Generation of odor;
- Increase of flies, mosquitoes, insects etc.,
- Health hazards; and
- Environmental nuisance at the project sites

4. STRATEGIES TO ADOPT

The following strategies need to be adopted for appropriate soil waste collection system to be functioned properly:

- a. Setting waste collection bins (not permanent structure, movable high-quality movable plastic bins; See Figure 1) in suitable points of the construction camp and work sites.
- b. Introduce solid waste bins for organic and non-organic waste.
- c. Coordinate with the municipal waste collection system so that the waste can be collected at midnight when the road transports are minimum.
- d. Wash liquids needs to be drained out through the functioning drains. The liquid waste needs to be treated with bleaching power every evening before draining so that the waste water cannot create nuisance and local pollution.



Figure 1: High quality plastic bins for solid waste collection

5. METHOD OF DISPOSAL OF WASTES

The Project Company will segregate organic and inorganic wastes in separate bin at sources and dumped at the designated waste disposal site. The Company will construct concrete waste disposal site under shed to avoid, air, bad smell, soil and ground water pollutions. Based on the quantity of general waste (organic & inorganic waste), the following two chambers (rooms) of the concrete disposal site will be constructed by Company.

When one chamber is filled up by organic waste, the waste will be covered by earth (soils) properly & keeps to make it air tight and allow waste to be compost. After filling 1st chamber by organic waste, 2nd chamber will be used for organic waste disposal and decomposition. Compost may be used in plantation site as fertilizer.

The inorganic waste will be collected in the waste collection bins. Just after filling, these inorganic wastes can be given to the vender free of cost.

The Company will collect construction waste as mentioned above separately and dump in to the designated space near project site. This waste may be sold to vendor for reuse.

The Company will maintain log book for the measurement of quantity of the wastes (especially hazardous wastes) disposed every day.

6. INSTITUTIONAL ARRANGEMENT

Company is mainly responsible for design, construction, maintenance as well as environmental monitoring for the disposal of waste. The PIU of the RHD will setup a 'Waste Management Committee' with the representatives of the PIU and Company to effectively disposing the wastes at designated locations. The committee is also responsible for monitoring procedure for the collection and carrying of wastes without causing any environmental hazards. Environmental staff of the IE will be responsible for monitoring of the waste management and disposal.

Appendix 11: Tree Plantation Plan

1. Objectives

The GOB, as policy encourages road side plantation for two decades past for environmental improvement, restoration of eco-balance and poverty alleviation through biomass energy, timber, food, fodder and other marketable biological products. Trees absorb carbon dioxide and release oxygen in daytime due to photosynthesis, thus clean air from noxious carbon-di-oxide gas. The timber, fruit, fuel and medicine values of tree are immense. Roadside trees intercept dust with leaves and twigs keeping ambient air dust free. Tree plantation has other general advantages like improvement of environment, ecology and economy therefore, planting tree on road side slopes and other available spaces within the ROW would enhance environment, economy and help alleviating rural poverty through work generation. In addition, dense tree plantation at both sides of the road embankment has special positive impact like protection of the coastal area from cyclonic storm.

The objective of the tree plantation and replacement programme is to compensate for the loss of trees due to the proposed implementation of road upgrading. Other major objectives of the programme are to protect the affected cultural/sensitive areas and to enhance the health of the existing ecosystem.

About 10782 of various trees of different sizes will be cut due to clearing of project road to be carried out under the Project.

A Tree Plantation Plan (TPP) is proposed to compensate the loss of these trees. However, this is an indicative TPP, a specific TPP along with specified tree plantation location and timeline will be submitted 30 days prior commencement of construction activities. GIS tool will be used to demarcate the area for plantation. As environmental compensation, a total of 32346 trees will be replanted along the road alignment or any suitable location as selected by the RHD.

The following areas have been identified for development of plantation sites in the Project areas:

- both side slopes of the constructed road embankment as suitable considering safety perspective driving vehicles
- back side of the constructed bus stations
- along the affected cultural/sensitive areas
- suitable areas available for plantation in part of country under RHD.

2. Selection and Planning of Tree Species

The species for the proposed tree plantation has been selected based on the statistics of the lost vegetation and in consultations with the concerned officials of the Forest Department (FD) of respective districts/division. In principal selection of species for the project should rather be on protection of the road embankment from slope erosion, aesthetic and conservation than commercial. The list of tree species to be used for the plantation on the proposed locations along the road is as follows:

- Timber Trees: Arjun (*Terminalia arjuna*), Garjan (*Dipterocarpus turbinatus*), Shal (*Shorea robusta*), Shilkoroi (*Albizia procera*), Kat badam (*Terminalia calappa*), Mehogani (*Swietenia mahagoni*), and Raintree (*Samania saman*)
- Fruit Trees: Date palm (*Phoenix sylvestris*), Olive (*Elaeocarpus floribundus*), Palm tree (*Borossus flabelliformis*)

- Medicinal Trees: Neem (*Azadirachta indica*), Arjun (*Terminalia arjuna*), Bel (*Aegle marmelos*) and Bohera (*Terminalia belliricha*)
- Fuel Wood Trees: Koromcha, Radhachura and Krishnochura (*Delonix regia*)

The tree plantation plan is shown in Figure 1.

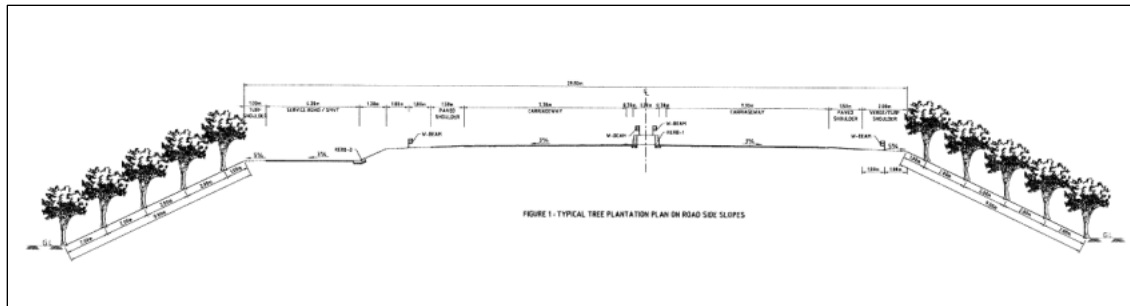


Figure 1: Road cross section showing the typical tree plantation layout

3. Quantities of Trees to be Planted

According to the FD's rule, minimum 2 trees need to be planted in case of cutting 1 tree. However, this plan suggests 3 trees need to be planted in case of cutting 1 tree. Minimum 2m spacing is required for planting the trees as per plan shows in Table 1. Since the project will cut very minimum number of trees thus the space required for tree replacement is also available along the road embankment.

4. Implementation Arrangement

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 RHD, the PAPs, especially vulnerable poor and women, in the plant replacement programme. The Forest Department will provide all technical and other supports in planning and developing the plantations. However, the implementation arrangement for Project is unique than any other tree replacement programme in country that was agreed in consultation with ADB, RHD and Company.

The tasks of the Company are as follows:

- training of the local RHD staff on tree maintenance
- preparation of the tree replacement programmes in accordance with this plan and get them approved by the Forest Department, if necessary
- coordination of sapling procurement process of approved species prescribed above
- supervision of nurseries for raising saplings.

5. Responsibility

It was decided that the Company will be responsible for planting trees throughout the alignment and other areas as prescribed above. The Company will need to procure and raise saplings until they survive. They can set up nurseries in consultation with RHD and the PIU at the early stage of the Project. Alternatively, the Company can purchase saplings from the local nursery. It may be worthy to engage local community following social forestry provision of FD.

The project company with assistance from RHD should consult with the FD if required for the tree replacement programme in the pre-construction stage, so that setting up of nurseries can be done in the early stages of the Project.

6. Budget and Payment

The budget for the proposed tree replacement programme for the project road is provided in Table 2 and this amount is added in the total environmental monitoring budget of Environmental Management Plan chapter of this IEE. The budget also includes maintenance for three years from the date of plantation to ensure that all planted saplings will survive and provision for an additional plantation is available. The plantation on the slopes of road embankment, in the bus stations, within the trumpet and along the affected cultural/sensitive areas will be conducted during construction and operation period subject to the availability of suitable lands for plantation. 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 fertilisers etc. The budget also includes measure required for maintenance of plantation, such as watering, weeding, fertiliser application, replacing of dead saplings (if any), etc. for the first year after planting.

Table 2: Estimated Amount of Compensation for Trees

Sl. No.	No. of Trees to be Cut	No. of Trees to Planted	Cost/Tree	Total (BDT)
1	10,782	32,346	200	6,469,200
Total				6,469,200