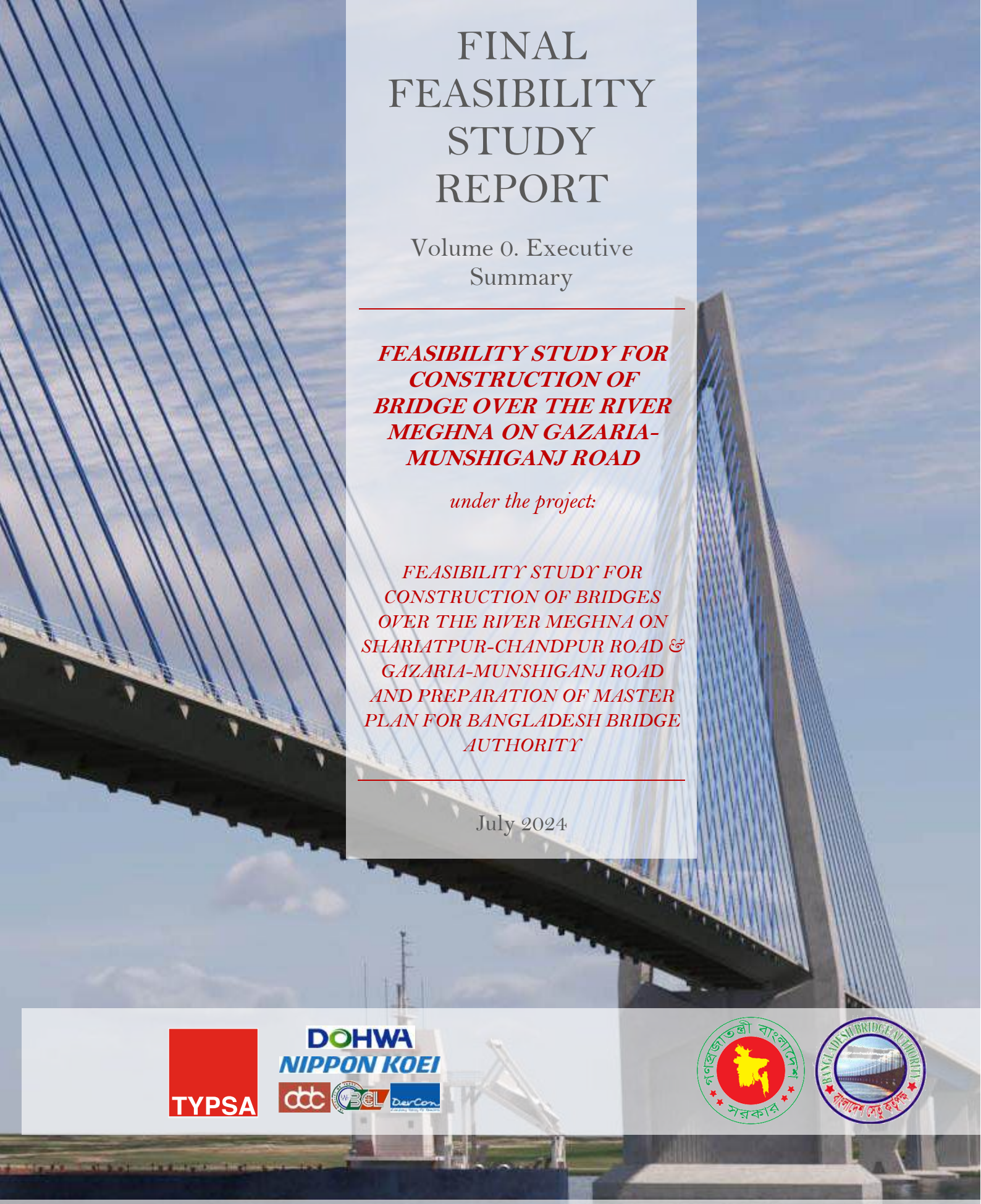

FINAL FEASIBILITY STUDY REPORT

Volume 0. Executive Summary

FEASIBILITY STUDY FOR CONSTRUCTION OF BRIDGE OVER THE RIVER MEGHNA ON GAZARIA-MUNSHIGANJ ROAD

under the project:

FEASIBILITY STUDY FOR CONSTRUCTION OF BRIDGES OVER THE RIVER MEGHNA ON SHARIATPUR-CHANDPUR ROAD & GAZARIA-MUNSHIGANJ ROAD AND PREPARATION OF MASTER PLAN FOR BANGLADESH BRIDGE AUTHORITY

July 2024

TYPSA

DOHWA

NIPPON KOEI

ddc BCL DerCon

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার

BANGLADESH BRIDGE AUTHORITY

বাংলাদেশ সেতু কর্তৃপক্ষ

Government of the People's Republic of Bangladesh
Ministry of Road Transport & Bridges
Bridges Division
Bangladesh Bridge Authority (BBA)

FINAL FEASIBILITY STUDY REPORT FOR CONSTRUCTION OF BRIDGE OVER THE RIVER MEGHNA ON GAZARIA-MUNSHIGANJ ROAD

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Quality Control sheet

DOCUMENT	**FINAL FEASIBILITY STUDY. BRIDGE OVER THE RIVER MEGHNA ON GAZARIA-MUNSHIGANJ ROAD.** **VOLUME 0-EXECUTIVE SUMMARY**			
PROJECT	TR8138-MASTER PLAN BBA			
CODE	TR8138-JV-FS-G204-RP-000001-FFS_Vol0-D01			
AUTHORS:	Signed:	JV		
	Date:	15/07/2024		
VERIFIED	Signed:	MCP	JSJ	JLY
	Date:	29/07/2024	29/07/2024	29/07/2024
RECIPIENT	Bangladesh Bridge Authority (BBA)			
NOTES	Document created by the Joint Venture formed by TYPSA-DOHWA-NIPPON KOEI-DDC-BCL-DEVCON			

Control of Versions

VERSION	CONTROL OF CHANGES
1	First Submission

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1D	One Dimensional
2D	Two Dimensional
AASHTO	American Association of State Highway and Transportation Officials
ADB	Asian Development Bank
ADT	Average Daily Traffic
AP	Affected Person
ARIPA	Acquisition and Requisition of Immovable Property Act
BAU	Business as Usual
BBA	Bangladesh Bridge Authority
BDT	Bangladesh Taka (currency)
BWDB	Bangladesh Water Development Board
CAPEX	Capital Expenditure
CBA	Cost Benefit Analysis
CC	Cement Concrete
CCB	Control Centre Building
CEGIS	Centre for Environmental and Geographic Information Services
CL	Lean Clay
CPR	Common Property Resources
DBFOT	Design-Build-Finance-Operate-Transfer
DC	Deputy Commissioner
DoE	Department of Environment
DSCR	Debt Service Coverage Ratio
EBITDA	Earnings before Interest, Taxes, Depreciation and Amortization,
EFP	Economic Financial Plan
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
ENPV	Economic Net Present Value
EPC	Engineering, Procurement and Construction
EZ	Economic Zone
FIDIC	The International Federation of Consulting Engineers
FIRR	Project Investment Cost
FNPV	Financial Net Present
FS	Feasibility Study
GDP	Gross Domestic Product
GoB	Government of Bangladesh
HGV	Heavy Goods Vehicle
HH	Household
IEE	Initial Environmental Examination
IFC	International Finance Corporation
INGO	International Non-Governmental Organization
IoL	Inventory of Losses
IRC	Indian Road Congress

IRR	Inner Ring Road / Inner Circular Elevated Expressway (Dhaka)
IWM	Institute of Water Modelling
JV	Joint Venture
Ke	Cost of equity
Km	Kilometre
LAP	Land Acquisition and Resettlement
LGED	Local Government Engineering Department
LPV	Light Passenger Vehicle
LRFD	Load Resistance Factor Design
m	Meter
MDB	Multilateral Development Banks
ML	Silt
MSL	Mean Sea Level
MSS	Movable scaffolding system
MUSD	Million United States Dollar
N1	National One (Dhaka–Chattogram Highway)
NPV	Net Present Value
OPEX	Operating Expenses
PAPs	Project Affected Person
PCM	Public Consultation Meeting
PM	Prime Minister
PPP	Public and Private Partnership
PWD	Public Works Datum
PWD	Public Works Department
RAP	Resettlement Action Plan
RC	Replacement Cost
RHD	Roads and Highways Department
RoW	Right of Way
RTW	River Training Work
SCP	Sand Compaction Pile
SHWL	Standard High-Water Level
SM	Silty Sand
SP	Poorly Graded Sand
SRD	Social Rate of Discount
TAC	Technical Advisory Committee
ToR	Terms of Reference
USD	United States Dollar
VAT	Value Added Tax
VfM	Value for Money
VGF	Viability Gap Financing
WACC	Weighted Average Cost of Capital
WB	World Bank
WL	Water Level

Executive Summary

Summary of Key Findings and Recommendations of the Feasibility Study

(Final Report – July 2024)

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1. PROJECT BASIC INFORMATION

Table 1.Basic Information

1.	Name of the Project	:	FEASIBILITY STUDY FOR CONSTRUCTION OF BRIDGE OVER THE RIVER MEGHNA BETWEEN GAZARIA AND MUNSHIGANJ
2.	(a) Sponsoring Ministry/Division (b) Implementing Agency	:	(a) Government of the People's Republic of Bangladesh Ministry of Road Transport & Bridges (b) Bridges Division Bangladesh Bridge Authority (BBA)
3.	Project Objectives (Project to be taken based on the study)	:	To assess the feasibility of a bridge and related infrastructures connecting Gazaria to Munshiganj crossing the Meghna River. The analysis includes technical, socio-economic, financial, and environmental aspects
4.	Estimated project Cost. (Taka in Crore)	:	Estimated project Cost. 10,686.90 Cr BDT
5.	Sector & Sub-Sector	:	Transport Sector / Bridges Infrastructures
6.	Project Category (Based on Environment Conservation Rules 1997)	:	Project Red Category (Based on Environment Conservation Rules 1997)
7.	Project Geographic Location Countrywide Division District Upazila Others (City Corporation/Pourashva)	:	The People's Republic of Bangladesh Division: Dhaka District: Munshiganj Upazilas: Gazaria, Sonargaon and Munshiganj Sadar
8.	Project Duration	:	Investment Period: 6Y – 2025/2030 Construction Period: 4Y (48 months) Operation Period: 30 Y – 2031/2060

2. INTRODUCTION

2.1. Background

With a view to boost up the economy of every corner of Bangladesh equally, a roadmap and action plan (Master Plan) of transport connectivity is being implemented by Bangladesh Bridge Authority. In response to long felt need for easy and quick communication among major cities of Bangladesh, the Master Plan, prepared by BBA includes the construction of several bridges. Among all, one of the important bridges is the **Construction of Bridge over the river Meghna on Gazaria Munshiganj road.**

After the recent opening of the Padma Bridge, a huge opportunity for transportation between the South-Western Zone and Eastern Zone of Bangladesh has been created. Around 50% of the traffic is likely to cross Dhaka city for transporting goods and passengers. Therefore, diverting traffic instead of crossing through Dhaka is highly required as Dhaka city is already in severe problems of traffic jams.

Gazaria-Munshiganj bridge would provide transportation efficiency to the relevant road network and timely circulation of cross-Padma traffic after the opening in 2022 of Padma bridge. The bridge would connect Munshiganj and Gazaria, improving connectivity on both sides of the Meghna and Fuldi rivers and also connecting Chattogram with Munshiganj and Narayanganj districts. As a result of this bridge, the traffic on Padma Bridge would be reduced, time and money would be saved to reach the Chattogram area and traffic from Dhaka would be reduced.

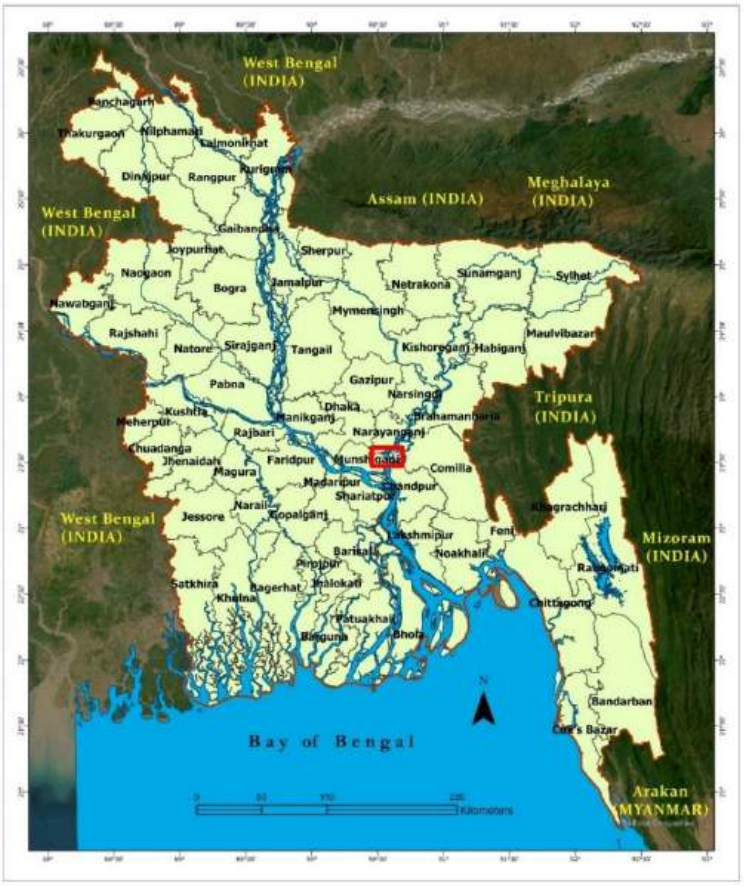

Figure 1. General location of the project.

The proposed project is in the Munshiganj District surrounded by Gazaria, Sonargaon, and Munshiganj Sadar Upazilas.

Munshiganj District is in central Bangladesh, about 30 km south of the capital city, Dhaka. The district with a rich historical heritage, dating back to ancient and medieval periods, was once an important centre of governance and trade during various ruling dynasties, including the Bengal Sultanate, Mughal Empire, and British colonial era. It is known for its historical sites, including mosques, temples, forts, and palaces. The district's economy is predominantly based on agriculture. The fertile land supports the cultivation of crops such as paddy rice, jute, vegetables, fruits, and various seasonal crops. The district also has small-scale industries, including rice mills, oil mills, brick kilns, and cottage industries.

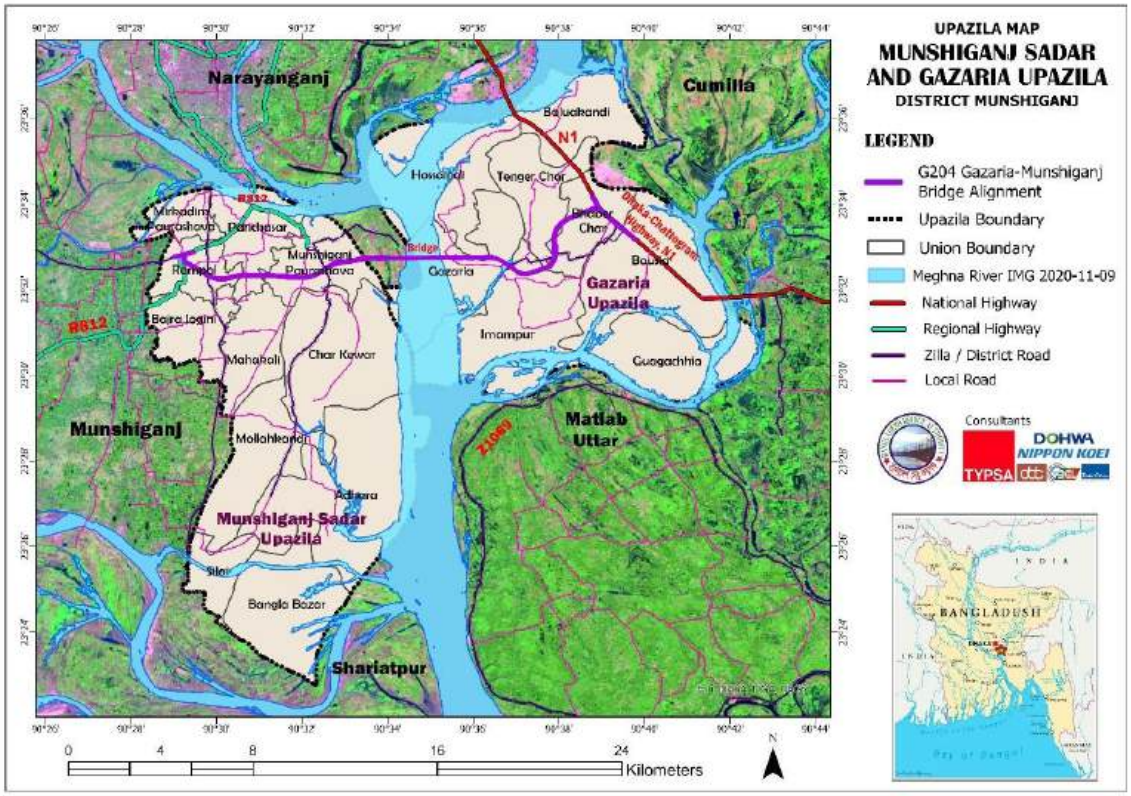

Figure 2. Munshiganj-Gazaria bridge location.

- **Munshiganj Sadar Upazila**

  Munshiganj Sadar Upazila (Munshiganj District under Dhaka Division) has an area of 160.79 square kilometers. The District HQ is located in between longitude-latitude 23.540632°, 90.541233°. It is bounded by Narayanganj Sadar, Bandar (Narayanganj) and Sonargaon upazilas on the north, Bhedarganj and Naria upazilas of Shariatpur district on the south, Gazaria and Matlab Uttar upazilas on the east, Tongibari and Naria upazilas on the west. The river Meghna has run away on the eastern side of this upazila. According to Bangladesh Bureau of Statistics (BBS) census 2020, Munshiganj Sadar Upazila has a total population 436,018.

- **Gazaria Upazila**

  Gazaria Upazila became part of Munshiganj in 1946 and the independent Gazaria Thana was established in 1954. The area of Gazaria is 130.92 square kilometers. The District HQ is located in between longitude-latitude 23.543601°, 90.603154°. It is bounded by Sonargaon and Meghna upazilas on the north, Matlab Uttar upazila on the south, Daudkandi upazila on the east, Munshiganj sadar and Sonargaon upazilas and the Meghna river are on the west. The entire upazila is surrounded by the Meghna River, which separates it from the district headquarters of Munshiganj. Two bridges connect it with the mainland, the Meghna Bridge in the west, and the Meghna-Gumti Bridge in the east. According to Bangladesh Bureau of Statistics (BBS) census 2020, Gazaria upazila has a total population of 185,259.

The bridge and associated road network would be integrated and improved for quick dispatch of incoming and outgoing traffic between western and southeastern region to Comilla, Sylhet and Chattogram regions where international seaport or special economic zones are located. The bridge would also create a bypass to N8 avoiding traffic congestion in Dhaka-Mawa.

The proposed bridge would be located at the connection point between the North-Central and the South-East hydrological regions of Bangladesh over the Meghna River, about 200 m distance upstream from the existing Gazaria Launch Ghat.

The proposed bridge over the Meghna River would connect the future Fuldi River bridge project end point at the Gazaria side to the Z1821 Road at Munshiganj side.

In addition to the main bridge over the river Meghna, under this FS scope, a bridge over Fuldi river is being implemented by RHD, as response to the demand of the local people to have a proper communication due to absence of a bridge over this river. Based on this, an alternative extended option has been studied (included within the Appendix No. 01) that would connect the Matlab Uttar-Gazaria Bridge project at Gazaria side with Hatimara Point on Mawa to Munshiganj Highway (R812).

This alternative option would require also the improvement 3.8 km of the accessing roads of the Matlab Uttar-Gazaria Bridge project connecting to the National Highway N1 at Boberchar.

This option would require, therefore, an appropriate coordination with RHD, focused on the Fuldi River Bridge project and also on the link with the Matlab Uttar-Gazaria Bridge project.

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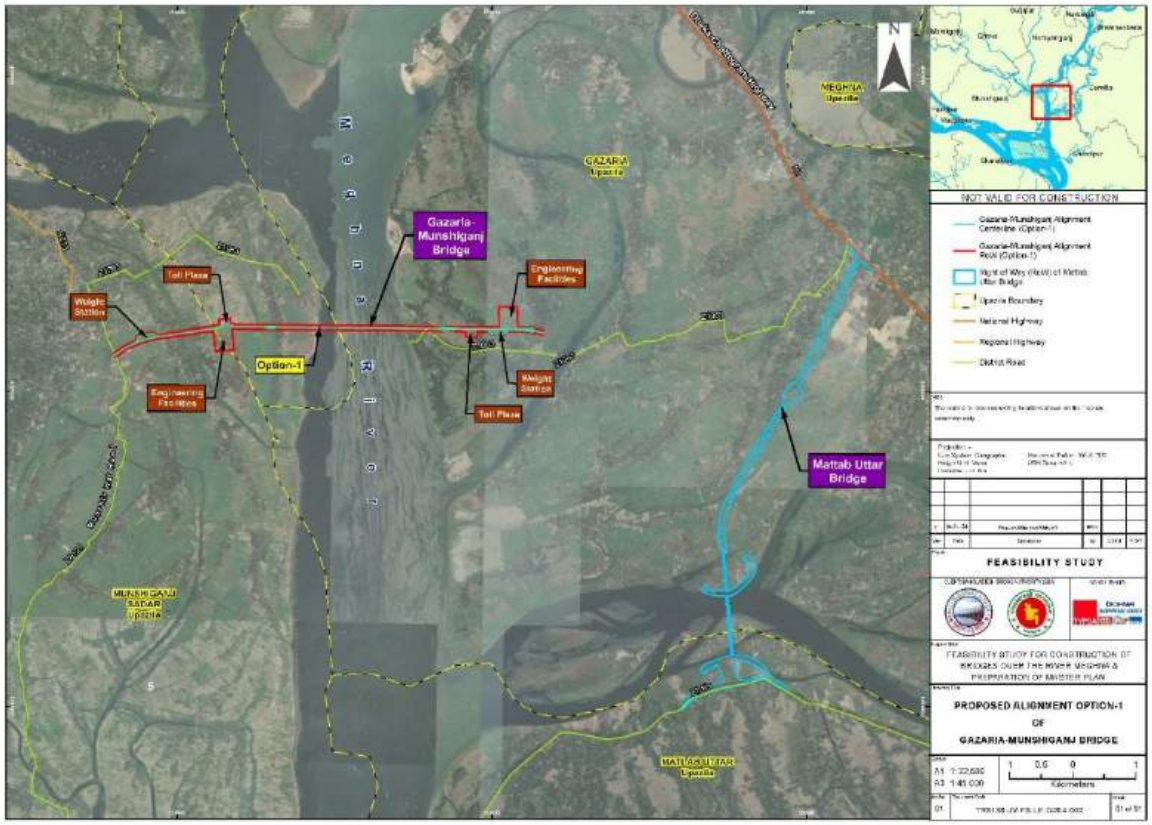

Figure 3.General view of the FS main option under analysis.

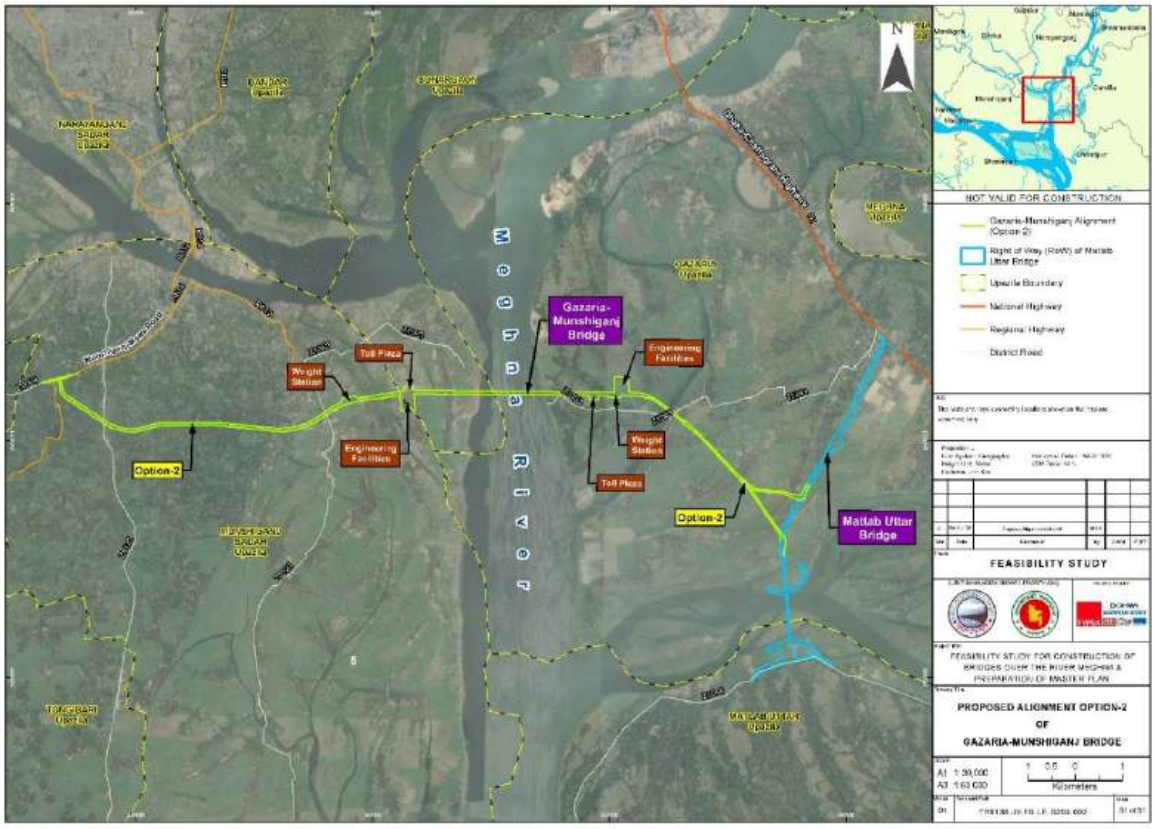

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Figure 4.General view of the FS alternative option under analysis (Appendix).

The project would generate sound benefits for the region and the country, as explained further in sections 3.2 and 3.6. Some of the benefits are outlined hereinafter:

- To provide safe and reliable transportation system connecting Dhaka Division and Chattogram Division.
- To provide direct connections between two significant seaports of the nation (Mongla and Chattogram).
- To reduce traffic load on N1 and on the traffic around Dhaka.
- To increase regional connectivity between south-east and south-west part of the country by connecting N1 and Regional Corridors (Corridor 3: Dhaka-Khulna, Corridor 5: Dhaka-Mongla Port, Corridor 10: Benapole-Tamabil (AH 1))
- Proper local communication over Fuldi River at Gazaria Upazila.

2.2. Objectives of the Assignment

The objective of this assignment is to prepare a concept design and to analyse the viability of the construction of the Gazaria-Munshiganj Bridge that would provide a safe and permanent connection between both upazilas.

For this purpose, a proper alignment of the bridge over the Meghna River shall be selected based on river characteristics and accessibility, along with other technical analysis carried out within the multicriteria analysis. The approach roads would connect the infrastructure to the current road network on the selected location with the following objectives:

The objectives of this study assignment are:

- Collection and review of the previous information available of the study area.
- Find the suitable locations of the bridge.
- Identify the types of bridge or tunnel suitable for the crossings.
- Assess socio-economic status of the area.
- Evaluate technical, social, economic, and financial viability of the projects.
- Recommend the mode of procurement.
- Carry out preliminary design of the bridges and associated facilities.
- Cost Estimate.

Additionally, to the main objective, and base case to be studied, an alternative option has been studied (included within the Appendix No. 01) that would connect the Matlab Uttar-Gazaria Bridge project at Gazaria side with Hatimara Point on Mawa to Munshiganj Highway (R812) through an approach road from Char Kishorganj ferry-ghat in the west bank of Meghna River. This alternative option would require appropriate coordination with the Fuldi River Bridge project.

2.3. Approach and Methodology

The assignment has been completed following the scope provided by BBA in Contractual Terms of Reference (ToR).

The specified scope of services for the consultancy assignment consisted of all necessary survey, investigation, planning, design, and documentation necessary for the development of the Feasibility Study of the bridge.

This includes the following activities according to the ToR of the project.

- Compilation, analysis and review of previous reports, studies, preliminary or detailed designs referred to the current feasibility study.
- Review available traffic count data and other studies and carry out supplementary traffic counts.
- Detail traffic survey with O-D survey, traffic analysis and traffic forecast for a reasonable time horizon establishing traffic model.
- Mapping, Land Use and Topographical Model for the preferred option.
- Geological and Geotechnical Investigation Campaign for the preferred solution (field studies and Reports) for: cuts and fills geometry, pavements, sources of materials, foundation design for viaducts, bridges and other structures.
- Detailed Hydro-morphological study of the river flow characteristics using Mathematical Modelling.
- Determination of the preferred location of the bridge, (Optimization of Length, Location and Alignment of the Bridge).
- Optimization of the approach road. Routes Assessment, Project Road Corridor Alternatives, Geometric Design for the preferred alternative (Typical cross sections, Plan & Profile).
- Pavement Design for trunk road an auxiliary road.
- Structural Design. Comparative study for investment cost and O-M cost and alternatives study.
- Alternatives investment budget.
- Economic and financial evaluation (30-year benefit stream period).
- Estimate the expected distribution of the project net benefits, based on economic analysis.
- Considering the economic evaluation, social benefits, and environmental impact, recommend the most suitable improvement option for each project road section.
- Undertake sensitive tests for the recommended improvements by appropriately varying benefits, project costs, maintenance costs, and the implementation period.
- Initial Social impact Analysis.
- Public meetings and dialogue with the communities in the project areas.
- Initial environmental examinations (IEE) and Environmental Impact Assessment.
- Resettlement Action Plan (RAP).
- Preparation of Land Acquisition Plans.
- Determination of appropriate construction method, configuration and technology.

2.4. Key Findings - Salient Features

Table 2. Summary of project's salient features.

Salient Features of Gazaria-Munshiganj Bridge		
Main Alignment Length	Road and bridge	6,600 m (from Z8212 to Fuldi River)
Total Main Bridge Length over Meghna River		**2,420 m** (from Ch 8+940 to Ch 11+360)
Cable Stayed Bridge	Length	**900 m**
	Main span	450 m
	Back spans	225 m
	Width of cable stayed section	23 m
Approach Spans (Composite Bridge)	Length	**400 m**
	Span Length	100 m
	Munshiganj side	200 m
	Gazaria Side	200 m
Accessing Spans (I girders)	Length	**1,120 m**
	Munshiganj side	560 m (14 spans x 40 m)
	Gazaria Side	560 m (14 spans x 40 m)
	Width of approach bridge	20,25 m
Approach Roads	**Total length**	**4,180 m**
	Munshiganj side	2,740 m (from Ch 6+200 to 8+940)
	Gazaria Side	1,440 m (from Ch 11+360 to 12+800)
	Total road width	39.5 m
	Main road (2+2-Lane Carriageway)	7.30 m = 2 x 3.65 m
	Service road (both sides)	5.50 m
Other Features in approach road		
Minor Bridge		
	Munshiganj side	180 m long (Ch 7+440); 100 m long (Ch 8+600); 40 m long (Ch 8+800)
Culverts		Total: 6 nos (1 Vent- 6.00 mx4.50 m)
	Munshiganj side	3 nos (1 Vent- 6.00 mx4.50 m) Ch 6+550; Ch. 6+950; Ch. 8+280)
	Gazaria side	3 nos (1 Vent- 6.00 mx4.50 m) (Ch 11+700; Ch 12+180; Ch 12+680;
Toll Plaza		7 nos booth each side = Total 14 nos
Weighing scale		1 no each side = Total 2 nos

Salient Features of Gazaria-Munshiganj Bridge		
		4 nos Weigh bridge each side
Engineer's Facilities and Service Area		1 no each side = Total 2 nos 2 x 22.50 = 45.00 acres
River Training Works	Total length	6,225 m
	Munshiganj side	3,900 m
	Gazaria side	2,325 m
Land Acquisition		
	Width of right of way (ROW)	69.5 m
	Total land to be acquired	568.47 acres
	Total number of persons affected	1,107
	Resettlement area	Total 1 nos (5 acres) Munshiganj Side
Construction Yards		69.7 acres
	Munshiganj side	
	Permanent Construction Yard Area-1	35 acres
	Temporary Construction Yard Area-2	5 acres

3. MARKET/DEMAND ANALYSIS

This section asesses the need for public investment, based on the study of market and traffic demand that has been implemented as part of this FS scope. Benefits and need and justification for the implementation of the infrastructure are analysed also:

3.1. Problem Statement

The existing improvement to be addressed by this feasibility study is mainly the lack of adequate infrastructure for efficient river crossing between both sides of the proposed project. Whilst the existing launch service covers part of the need for connectivity, it does it in a manner and timing that, for the population living on both sides, requires it to be enhanced.

The matter to be addressed relates to some direct causes:

- Lack of bridge in the zone under study: Currently, only the launches service is enabled to cross the Meghna River at this location. This is undoubtedly insufficient to meet the currently growing population and the needs of the population.
- Limited investment in infrastructure: A lack of prioritization and allocation of resources for bridge construction in the region may have contributed to the current situation.

And to some indirect causes:

- Population growth: An increasing population puts more pressure on existing infrastructure, exacerbating the problem of inadequate river crossings.
- Economic development: As Bangladesh's economy continues to grow, the need for efficient transportation and connectivity becomes more critical for businesses and industries to thrive.
- Urbanization: Rapid urbanization in cities like Dhaka has led to increased traffic congestion and greater demand for improved infrastructure, including bridges.

A good way for understanding the need of the project is analyzing the consequences of a lack of this infrastructure:

- The lack of efficient transportation and connectivity can limit trade, investment, and overall economic growth in the region. The isolation and remoteness conditions of part of the population living in the area.
- Limited transportation infrastructure can prevent residents from accessing essential services such as healthcare, education, and emergency services, ultimately impacting their quality of life.
- Without the bridge, existing means for crossings would become more congested, leading to longer travel times.
- Limited access to opportunities and services can exacerbate social inequalities, with disadvantaged groups being disproportionately affected.

3.2. Relevance of the Project Idea

Due to the lack of existing bridge in the area, the people living in both sides of the river, normally use launch service, engine boats and trawler services for crossing the river but for the transportation of goods, the vehicles must enter the congested Dhaka area and use the National Highway N1 after surrounding Narayanganj area.

Due to these reasons, the construction of this bridge, would pose a very positive impact on local and regional levels, integrating the outlaying Upazilas with the mainland districts. This project would also be deemed to be a component of a broader transportation enhancement approach, together with other initiatives under study. The industrial sector would be relevantly benefited of this connection as the area is base of several EZ both private or public, existing or under project.

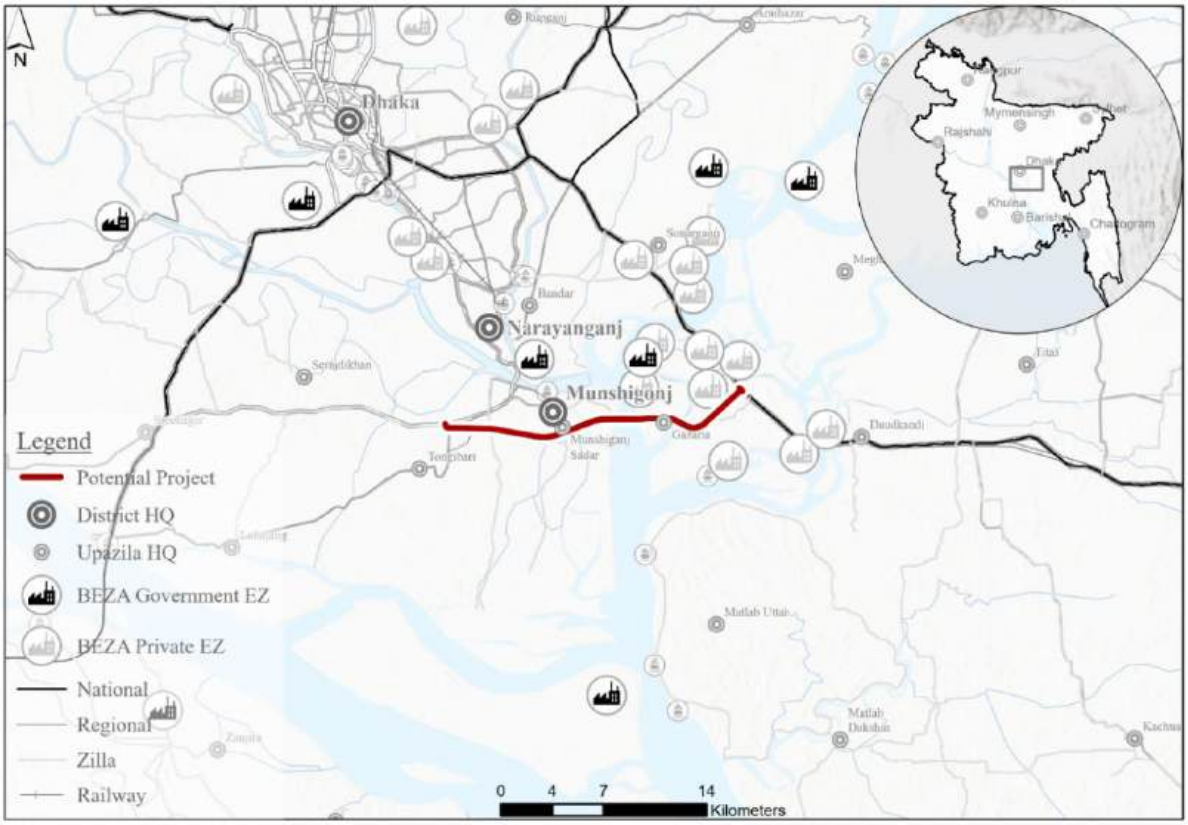


Figure 5. The project benefit area (industrial zones).

The list of benefits of the bridge as a need to improve the lack of infrastructure:

- The bridge in this area would facilitate the movement of people, goods, and services across this major river system. Bangladesh is prone to natural disasters such as flooding and cyclones. Improved infrastructure, such as the proposed new bridge, can enhance the region's resilience to these events by providing better access to essential services and support during emergencies).
- Economic development: the area is an important center for the national industry, as well as agriculture, and trade.

- Population density: the affected subdistricts have a significant population, which is expected to grow in the coming years. A bridge would help meet the increasing transportation demands of the growing population and contribute to improved quality of life for residents (ease of access to high education and healthcare).
- This bridge, as a piece of a larger transportation enhancement master plan and initiative taken by the BBA, would boost the Bangladesh E-W corridor: The bridge would enhance connectivity between those areas and would foster the international transborder corridor. This would enable more efficient transportation and support the development of these regions.

3.3. Proposed Project Interventions

The Project implementation would need not only the address the fundamental intervention which is the construction of the main infrastructure (main bridge and accessing bridges, but as it is explained within the technical features section, the construction of approach roads would be needed to connect with the existing road network. Other interventions are two engineers' facilities compound, two toll plazas and service buildings would be needed to be implemented by the GoB.

In addition, the necessary and critical river training works would be needed, given the relevant riverbank erosion identified in this area of the Meghna River.

3.4. Stakeholders

- Ministry of Road Transport and Bridges: Responsible for overseeing the planning, implementation, and maintenance of transportation infrastructure projects in Bangladesh.
- Local Government authorities: Munshiganj district administrations would be involved in coordinating and facilitating the project at the local level.
- Bangladesh Water Development Board (BWDB): Responsible of the overseeing and coordination of the river training works.
- LGED: Local roads network authority.
- Road Transport and Highways Division: responsible for roads and highways.
- The Roads and Highways Department (RHD): an agency of the Government of Bangladesh responsible for the construction and maintenance of highways and bridges across Bangladesh. The Department is a subsidiary of the Road Transport and Highways Division.
- Bangladesh Fisheries Research Institute, (BFRI): Regulatory agency for Hilsha fish protection
- Bangladesh Power Development Board.
- Bangladesh Telecommunication Company Ltd. (BTCL): Responsible for Telephone and Internet connection and maintenance.
- Palli Bidyut Samity (PBS): Responsible for providing electricity in the rural areas.
- Summit Communications Limited.
- Gas Transmission Company Limited (GTCL).

3.5. Demand Analysis

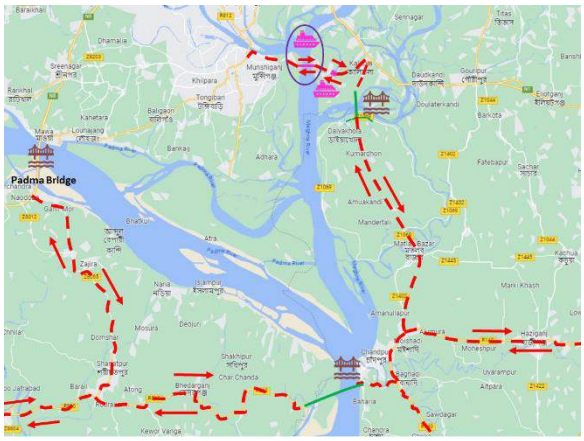
A transportation model implemented by the Consultant has been utilized along with data obtained from **242** survey points to analyze the demand. Both the current demand (i.e., demand currently crossing by ferry and speed boats) and projected demand (i.e., demand that would use the bridge if it existed) were evaluated.

To conduct a thorough economic and financial study, it is necessary to carefully analyze the traffic and compare the situation without the project to the situation with the project. The differences in costs between these two situations would be the benefits of constructing the bridge.

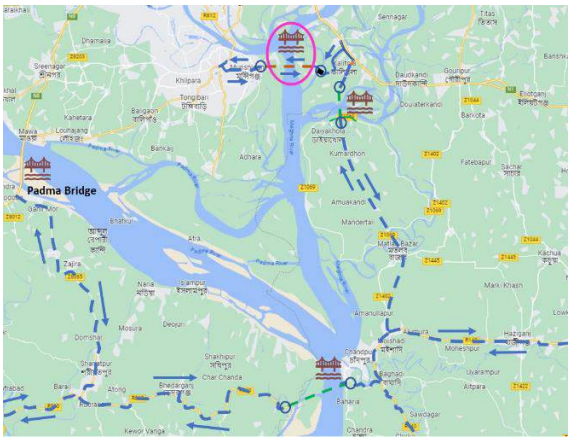
Base Year Demand

It is key to understand the different scenarios that are being analysed, "with project" and "without project". The "without project" scenario is the scenario where the bridge would not be built, in this case, there would be no bridge but some roads improvements as well as the currently operating ferry ghat.

In the following images it can be seen the difference between both scenarios.



Without project scenario (S1)



With project scenario (S2)

Figure 6 .Scenarios analysed.

- **Scenario Without Gazaria-Munshiganj Bridge Project (without project) (S1):**
  In this scenario, a ferry service between Gazaria and Munshiganj, as well as ongoing, future, and potential transport infrastructure developments (including an improved corridor along Gazaria–Matlab-Chandpur-Lakshmipur corridor, Cumilla-Chandpur improvement, Shariatpur-Padma bridge road improvement, R860 road improvement and accesses to ferry improvements) are considered, as illustrated in the figure above.

- **Scenario with Gazaria-Munshiganj Bridge Project (with project) (S2):**
  The *With Gazaria-Munshiganj Bridge Project scenario* is defined as the previous scenario (*S1*) considering the addition of the construction of the Gazaria-Munshiganj Bridge, without the Ferry service. In the following map the "With project scenario" can be seen with the Gazaria-Munshiganj Bridge.

For both the traffic, with and without the project, the Transport Model is applied in the latest updated when this estimation is carried out. It is assumed in both scenarios some roads improvements would be carried out. In the following image the traffic summary for the base year is presented. "Note that the traffic generated as a result of an additional GDP increment is 0, since there has been no increase in GDP in the base year."

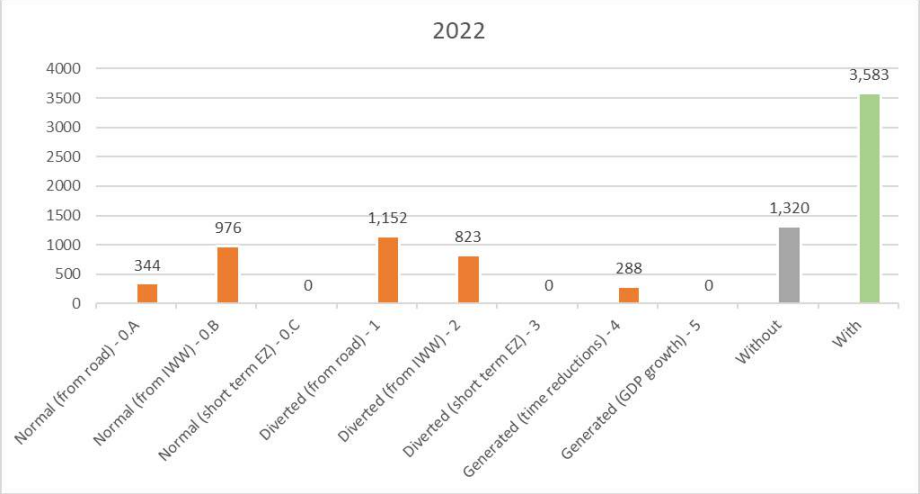


Figure 7. Summary of the base year traffic.

Traffic Forecast

The forward traffic estimation comes from the relation between GDP and traffic growth observed during a series of years in different traffic counts where historical data is available. There is a clear relation between GDP and AADT, since GDP is in line with the movement of passenger and freight.

Table 3. Daily traffic volumes (vehs) by kind of traffic

Year	Normal traffic – without project				Diverted			Generated		With project
	Road	IWW	EZ	Total Without Project (Normal traffic)	From road	From IWW	From EZ	Road – due to time reduction	Due to additional GDP increment	TOTAL
2022	344	976	0	1,320						
2025	1,171	1,213	0	2,385						
2030	2,851	1,762	905	5,518						
2033	3,890	2,146	905	6,941	3,679	1,358	1,038	474	25	13,516
2035	4,585	2,421	905	7,911	5,613	2,042	1,385	714	64	17,728

Year	Normal traffic – without project				Diverted			Generated		With project
	Road	IWW	EZ	Total Without Project (Normal traffic)	From road	From IWW	From EZ	Road – due to time reduction	Due to additional GDP increment	TOTAL
2040	6,308	3,162	905	10,374	7,567	2,667	1,385	932	172	23,096
2045	8,019	3,957	905	12,881	9,563	3,338	1,385	1,167	331	28,663
2050	9,768	4,778	905	15,450	11,609	4,030	1,385	1,408	548	34,430
2055	11,674	5,597	905	18,176	13,771	4,721	1,385	1,650	641	40,343
2060	13,692	6,391	905	20,988	15,992	5,391	1,385	1,884	732	46,372

Table 4. Daily traffic volumes (vehs) by type of vehicles

	Without project (normal traffic)					With project				
	M/Cycles	LPV	Buses	Trucks	Total without project	M/Cycles	LPV	Buses	Trucks	Total With project
2022	711	254	152	203	1,320					
2025	941	404	471	569	2,385					
2030	1,855	1,062	1,285	1,316	5,518					
2033	2,203	1,270	1,688	1,780	6,941	3,939	2,150	5,243	2,184	13,516
2035	2,449	1,412	1,958	2,092	7,911	4,981	2,636	7,430	2,681	17,728
2040	3,100	1,779	2,628	2,868	10,374	6,219	3,232	9,987	3,658	23,096
2045	3,788	2,155	3,295	3,642	12,881	7,542	3,855	12,615	4,651	28,663
2050	4,496	2,542	3,977	4,434	15,450	8,911	4,496	15,347	5,676	34,430
2055	5,216	2,948	4,719	5,293	18,176	10,278	5,156	18,158	6,753	40,343
2060	5,927	3,361	5,502	6,198	20,988	11,617	5,816	21,066	7,873	46,372

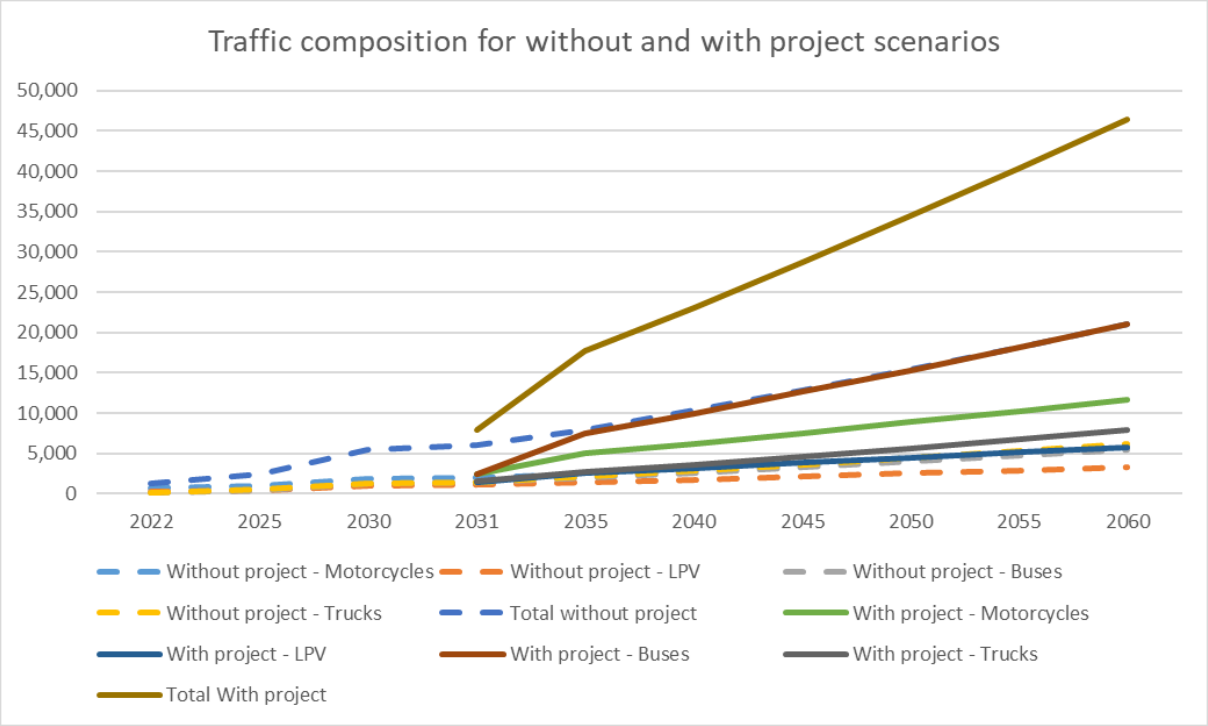


Figure 8. Daily traffic volumes by type of vehicles.

Distance and Time Savings

The distance and time savings, due to the construction and operation of the bridge, is a key element being used in the cost benefit analysis. An analysis has been done for each vehicle type, identifying the average yearly savings for the 30 years of the operation of the project.

The results are illustrated in the tables below.

Table 5. Average annual time savings during the operation of the bridge.

	Motorcycles (M pass-hour per year of operation)	LPV (M pass-hour per year of operation)	Bus (M pass-hour per year of operation)	Trucks (M Ton-hour per year of operation)
Without project	19.51	22.35	478.84	95.32
With project	10.07	13.24	373.71	63.48
Distance Savings	**9.44**	**9.11**	**105.12**	**31.85**

Table 6. Average annual distance savings during the operation of the bridge.

	Motorcycles (M veh-km per year of operation)	LPV (M veh-km per year of operation)	Bus (M veh-km per year of operation)	Trucks (M veh-km per year of operation)	Total (M veh-km per year of operation)
Without project	341.94	192.81	629.12	267.54	**1,431.41**
With project	352.71	197.22	634.18	271.10	**1,455.21**
Time Savings	**-10.77**	**-4.41**	**-5.06**	**-3.55**	**-23.8**

Constraints

- Some improvements are being made in the transport model considering more social data, these may end in changes in traffic demand forecast.
- As said before, the without project scenario is a scenario where some committed projects are built.

3.6. Need and Justification of the Project / SWOT Analysis

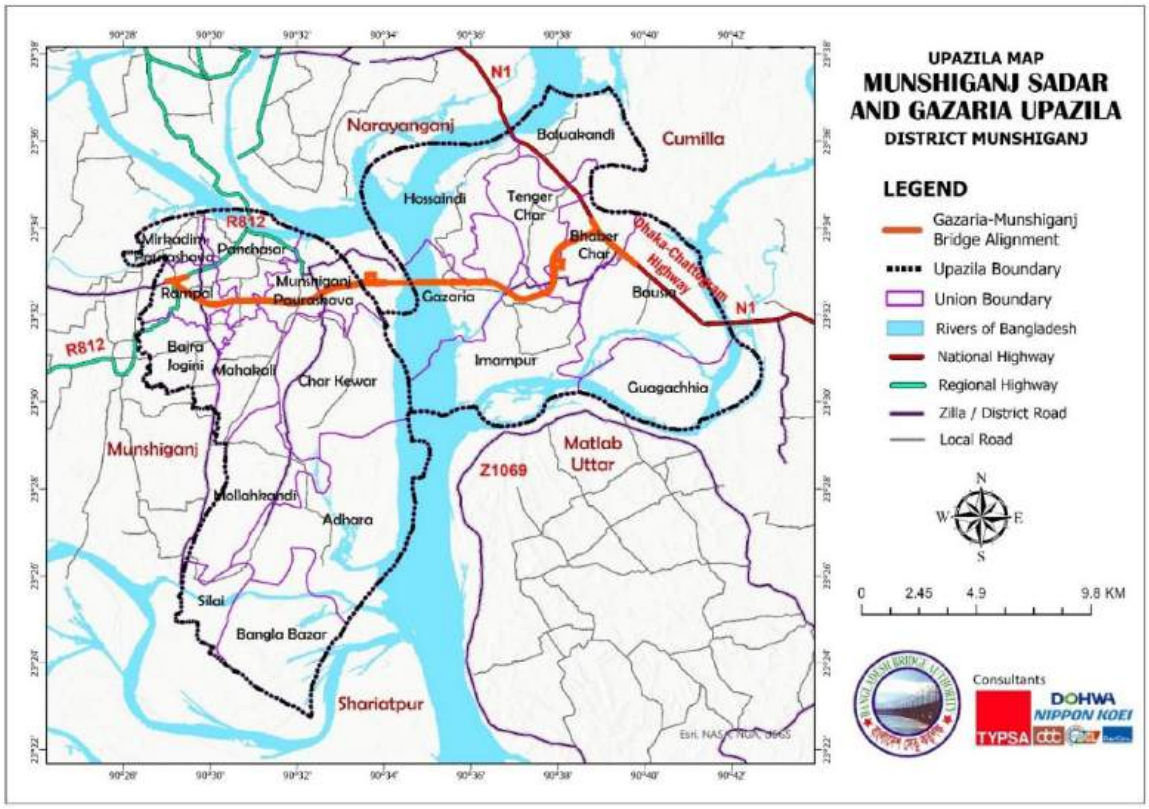


Figure 9. The project and the directly connected Upazilas.

There is no direct road or rail connectivity between the south-west part (Barishal, Faridpur, Madaripur, Shariatpur) and the east part (Noakhali, Cumilla, Chattogram) of Bangladesh. Road communications between these two parts must pass through Dhaka which contributes to traffic congestion in the Dhaka metropolitan area.

In addition, the south-west part is deprived of economic development due to the lack of direct and sufficient connectivity with the main seaport-city Chattogram. The government has initiated many development activities in these two areas of Bangladesh such as the Sonadia deep seaport, Rampal power plant, a cantonment at Patuakhali, Karnaphuli Tunnel, deep seaport at Matarbari, Cox's Bazar etc. A direct road and/or rail connectivity between these two developing zones of Bangladesh would further enhance the social-economic progress of these areas as well as of overall of Bangladesh. A rapid socio-economic growth can be expected in the south-west part of the country if development connectivity is established between the above-mentioned regions.

A direct transportation link of the south-west part with the main seaport Chattogram would provide a scope for developing economic zones in the Munshiganj and nearby areas. In fact, several economic zones (EZ) are planned, such as EZs of Gazaria, Garments Industries Park by BGMEA, Abuk Khair, Standard Global, Hoshendi, Anowar, etc.

The proposed Bridge over Meghna connecting Gazaria and Munshiganj is a very important large scale infrastructure project in the communication sector. Implementation of the project would significantly benefit various sectors of the economy of Bangladesh. Meghna River or Meghna Upper River is a river

in Kishoreganj, Narsingdi, Brahmanbaria, Narayanganj, Cumilla, Munshiganj, Chandpur and Lakshmipur Districts of south-eastern Bangladesh.

By constructing the bridge, economic development of the south and southwest would promote industrial and commercial activity and improve economic and employment opportunities for local people. Easier communication would help expand education and training facilities, and the resulting skills development would ensure the availability of highly skilled workers. In addition, riverbank protection when constructing bridge would reduce bank erosion and the incidence of worsened vulnerability and poverty among people affected by bank erosion.

Some of the main benefits obtained from the implementation of this bridge are summarized as follows:

- Reaching transportation efficiency of the relevant road network, considering the expected traffic growth due to the opening of Padma Bridge.
- It could serve as a local bypass of Dhaka that can also carry traffic from Padma Bridge, (e.g. for trips from the west to east as from Khulna or Jashore to Cumilla). Bypassing Dhaka would provide big savings in terms of travel time.
- It would develop connectivity between National Highway N1 and Regional Highway R812 over the river Meghna.

Table 7. Socio-economic conditions of the area

Division	Dhaka			
District	Munshiganj District			
Upazila	Gazaria Upazila	Munshiganj Sadar Upazila		
		Munshiganj Sadar Upazila (Whole Upazila)	Paurashava Area (Munshiganj and Mirkadim)	Munshiganj Sadar Upazila (excluding Paurashava area)
Area km^2	131	218.97	13.32	205.65
No. of Union/Ward	8	-	9	9
Population (BBS2011) **	157,988	383,263	114,819	268,444
(BBS2022)	185,259	436,018	142,171	293,847
Population Growth Rate	1.46%	1.18%	1.96%	0.83%
Urbanization Rate (%)	4.15%	32.61%		
	Population Projection			
2026	196,303	477,829	153,658	303,669
2031	211,038	535,844	169,331	316,409
2036	226,879	600,988	186,602	329,684
2041	243,910	674,146	205,635	343,516
Density (Persons/km^2)	1,414	1,991	13,673	1,449
Predominant Economy	Poultry, Fishery	Agriculture, Fishery, Foreign Remittance		

Division	Dhaka			
District	Munshiganj District			
Upazila	Gazaria Upazila	Munshiganj Sadar Upazila		
		Munshiganj Sadar Upazila (Whole Upazila)	Paurashava Area (Munshiganj and Mirkadim)	Munshiganj Sadar Upazila (excluding Paurashava area)
		-	Local Business	Animal Farm
Education (Literacy Rate, %) **	57.34%		50.61%	
No. of Health Complex	14	19	8	-
No. of Stadium/Park	0	1	1	-
Hat-Bazar	19	22	4	-
Main Industry	26**(Paper mill, cement, garments, pharmaceutical etc.)		(No big industry, but Cold storages, chicken firm, rice mill, flour mill, etc.)	12**(Salt, cement, ceramic, paper mill, Cold storages, farm etc.
Geographic area	Urban	-	Urban	Urban - Rural
Port	-	-	Mirkadim River Port	-
EZ/SEZ/EPZ	Abdul Monem EZ, 'Garments Industries Park' proposed by BGMEA, Abuk Khair EZ, Standard Global Economic Zone, Hoshendi EZ, Anowar EZ, Gazaria EZ	-	-	-

List of Positive Impacts

The project is expected to contribute with the following specific positive social impacts:

1. The bridge would create new business and employment opportunities.
2. Improved road conditions would facilitate the inter and intra-town movement of people which could translate to more economic and livelihood opportunities as well as improved accessibility of social services.
3. Business activities would increase as micro-entrepreneurs both men and women would be able to bring their commodities to the town easily and sell their goods at reasonable prices. Even vulnerable women would obtain new employment opportunities and income.
4. Working conditions of private and public vehicles drivers would be better-off after improvements of roads that would be free from traffic congestion.
5. Improved roads would increase property and land values of nearby areas which represent the capitalization of access cost savings and travel time savings associated with those locations.
6. The improvement of roads with drains, footpaths and streetlights would improve security.
7. People would secure employment in construction-related activities.
8. It would attract more investment to the planned EZs in the area and its surroundings.
9. The project would increase GOB revenue by contributing to increase of peoples' income level.
10. The project would improve mobility and accessibility as well as Increase the regional connectivity of country.

Anticipated Negative Impacts

The identification of negative impacts that may arise from the implementation of the projects should give particular attention to the urban poor, women and girls, youth, the differently abled and other marginalized groups. In the feasibility study, the Consultant Team identified and quantified number of affected households/population/other type of entities, and loss of land and other properties due to the project. The RAP is prepared to assess potential socioeconomic impacts on the people, identify different type of losses, resettlement and rehabilitation requirement/policies, RAP implementation issues, etc. as well as estimation of necessary cost for the losses to prepare a land acquisition plan

(LAP) and resettlement action plan (RAP) based on the study and considering preliminary design. Local people should be given the opportunity to be engaged as construction workers.

Regional Impact

The proposed Bridge over Meghna River would connect two Upazilas of Munshiganj. After the construction of the proposed bridge, 22 districts of Dhaka, Khulna and Barishal divisions would come under direct road connection with National highway N1. Consequently, with the completion of the Bridge, people or vehicles would no longer need to travel to Dhaka or Narayanganj to reach Chattogram. The most benefits can be obtained in traveling between Munshiganj Sadar and Gazaria. As Dhaka and Narayanganj are densely populated areas with heavy traffic congestion, a new bridge could serve as an alternative route, helping to reduce traffic bottlenecks and improve overall transportation efficiency. According to the concerned, the country's economy would gain new momentum with better connectivity to major urban centers like Dhaka and Narayanganj, Gazaria and Munshiganj would become more attractive to businesses and investors.

Figure 10. SAARC Highway Corridors

Source: https://www.unescap.org/sites/default/files/Moinuddin-Bangladesh-RPDSTCSA-19nov2014.pdf

The South Asian Association for Regional Cooperation (SAARC) is an economic and geopolitical union of eight member nations namely, Bangladesh, India, Pakistan, Nepal, Bhutan, Sri Lanka, Maldives and Afghanistan. SAARC countries are committed to enhance regional cooperation among the countries to promote the welfare and improve the quality of life of the people of the region. Recognizing the importance of transport integration in South Asia as one of the key elements to promote economic cooperation, the Islamabad SAARC Summit in 2004 decided to strengthen transport, transit and communication links across the region. It was in pursuance of this decision that the SAARC, with financial and technical support from the ADB, initiated the SAARC Regional Multimodal Transport Study (SRMTS) with the main objective of enhancing multimodal transport connectivity. SRMTS recommended 10 road corridors for future development based on several criteria namely, volume and trend of traffic, potential to provide direct connectivity, ability to provide access to landlocked countries/states to ports or to major transit transport networks, potential to provide reducing distance

and thereby saving transport costs and revitalizing historical links or provide linkages for meeting socio-political requirements. Out of the 10 SAARC Highway Corridors (SHC), six corridors namely SHC1, SHC4, SHC5, SHC6, SHC8, SHC9 involve Bangladesh[1].

The identified key strengths and weaknesses of the project along with the opportunities and threats are presented in the following table.

Table 8. Project's SWOT

Strengths	Weaknesses
▪ The active participation, willingness, and support of the local government and the citizens involved. ▪ The promoting agency BBA has previous expertise in similar projects like Padma and Jamuna Bridge, which adds to their capabilities and potential success in executing the current project. ▪ Availability of construction material such as cement, stone, and bricks from local market ▪ Due to the river transport system, construction materials can be transported at low cost. ▪ The project is attracting interest from potential contractors and funding agencies, and their availability further enhances its prospects for successful implementation.	▪ High-cost financing challenge. ▪ Supply of some materials source. ▪ Air and noise pollution may have some negative impacts on the environment. ▪ Disturbance to the movement of vehicles and pedestrians may occur during construction. ▪ Tides may pose a problem during construction. ▪ In resettlement and rehabilitation, changes in economic activities, land-use, resource ownership, accessibility of natural resources and common property resources, loss of livelihoods, social disruption, and psychological trauma to affected persons etc. are included.

[1] *Source Regional Road Connectivity Bangladesh Perspective, January 2016*

Opportunities	Threats
▪ To establish better connectivity with the national transport network, particularly in areas that are currently not directly connected due to the lack of proper road infrastructure. ▪ To alleviate the Dhaka city road network by bypassing it for the transportation between the West and East sides of the Meghna River at that side. ▪ To facilitate smooth inter- and intra-town movement of people, goods, and services, thereby enhancing overall transportation efficiency and accessibility. ▪ To increase trade at both the local and regional levels, fostering economic growth and development in the area. ▪ To bring about improvements to the environment and public health, ensuring a sustainable and healthier living environment for the local communities. ▪ To foster sustainable decentralization, regional development, and resilient climate-adaptive practices, promoting long-term growth and resilience in the face of climate change challenges. ▪ To contribute significantly to local economic development, creating employment opportunities for the people in the region.	▪ Influx of migrant people may have a negative impact on the quality of life. ▪ Occurrence of climate change-related and other natural hazards. ▪ The construction process could face hindrance in the event of a sudden natural disaster, impacting its continuity and progress. ▪ Excavation may result in sediments reaching watercourses. ▪ Land acquisition and rehabilitation processes can indeed be time-consuming. Furthermore, social and political obstacles can further complicate and prolong these procedures, potentially impacting the overall progress of the project. ▪ Achieving the target fund for a mega project is a formidable challenge. ▪ Due to various reasons, there is a possibility of not completing the work on time and increasing the cost of the project.

Source: Consultant Team

4. TECHNICAL AND ENGINEERING ANALYSIS

4.1. Design Standards

- The Eurocode has been adopted in the design of the structures: EN 1990, EN 1991-1, EN 1991-2, EN 1993, EN 1994 and EN 1998 along with EN 1337, EN 10080, EN 10138 and EN206.
- Despite being related to building structures, the Bangladesh National Building Code (BNBC) is followed in the determination of wind loads and the earthquake design spectrum.
- AASHTO LRFD 2017 specifications for Highway Bridges, with interim revisions 2020, 2022 and 2023, is considered appropriate to be used in the determination of stream pressure on piers.
- Geometric Design Standard for Bridges and Approaches and Bridge Design Standard by RHD
- Geometric Design Standards Manual (Revised) 2005 (GDSM 2005). Roads and Highways Division.
- A policy on Geometric Design of Highway and Streets" 2018, AASHTO
- Manual of Specifications and Standards for Expressways, IRC: SP: 99-2013
- Manual of Specifications and Standards for Four Laning of Highways, IRC: SP: 84-2019
- Pavement Design Guide for Roads and Highways Department 2005 for pavement design works along with "AASHTO Guide for Design of Pavement Structures 1993".

4.2. Selection of Bridge Site Location

The preliminary selection of the location of Gazaria-Munshiganj Bridge was carried out with the support and collaboration of the specialized subcontractor Institute Water Modelling (IWM).

For this task, three potential sites were selected initially for investigation. These three potential options (A, B, C) were meticulously investigated by analyzing observed hydro-morphological characteristics of the Meghna River to find the most suitable site. The hydro-morphological modelling has supplemented the analysis. A detailed satellite images analysis around the vicinity of the proposed bridge was carried out. The bankline shifting around the proposed Munshiganj-Gazaria bridge site is shown in the Figure 12.

It can be seen from the figures that the bankline for the last 30 years has been most stable in Site B. Some historical bankline shifting can be observed in Site C. While significant bankline shifting can be seen near Site A. Upstream of Site A, towards the confluence of Dhaleshwari and Upper Meghna, historical erosion can be seen. Similarly, further downstream of Site C, historical bankline shifting can be observed. Generally, bridge construction near any confluence or outfall is not recommended. Since Site A is near a confluence and Site C is located near an outfall, Site B is the best suited based on this criterion.

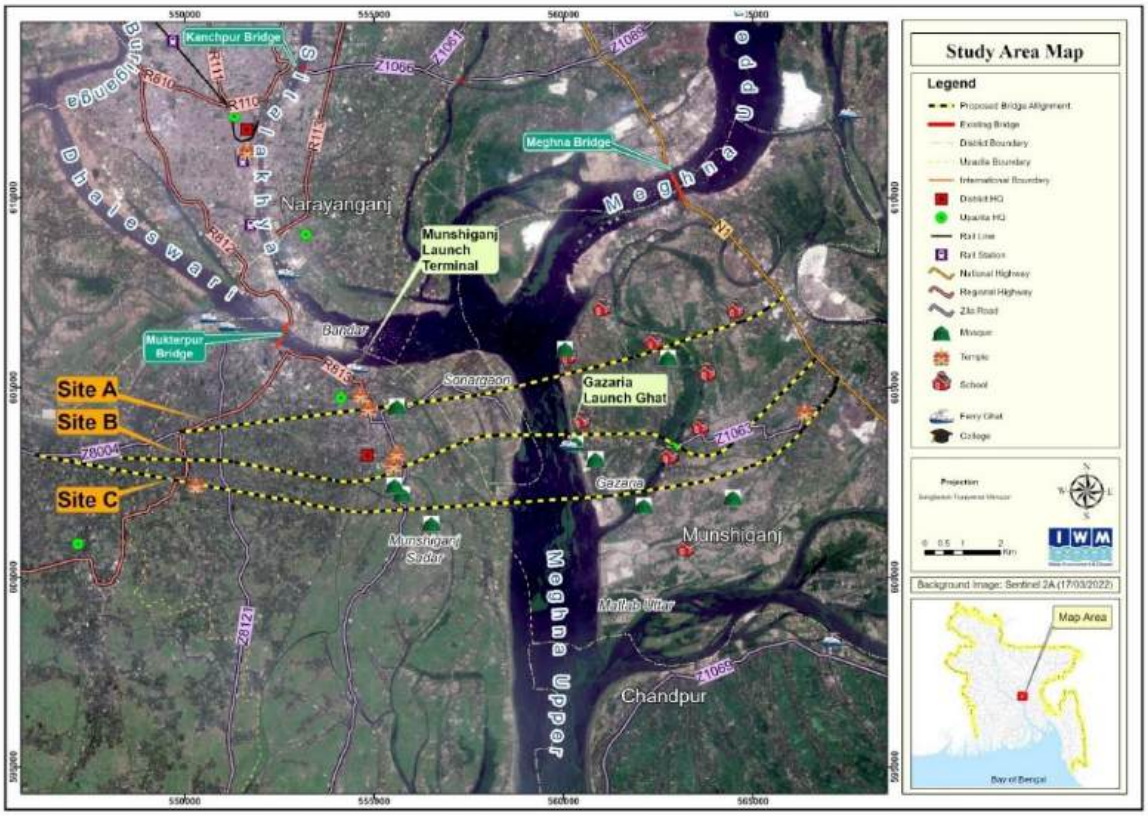


Figure 11. Three potential alignments for the proposed Munshiganj-Gazaria bridge.

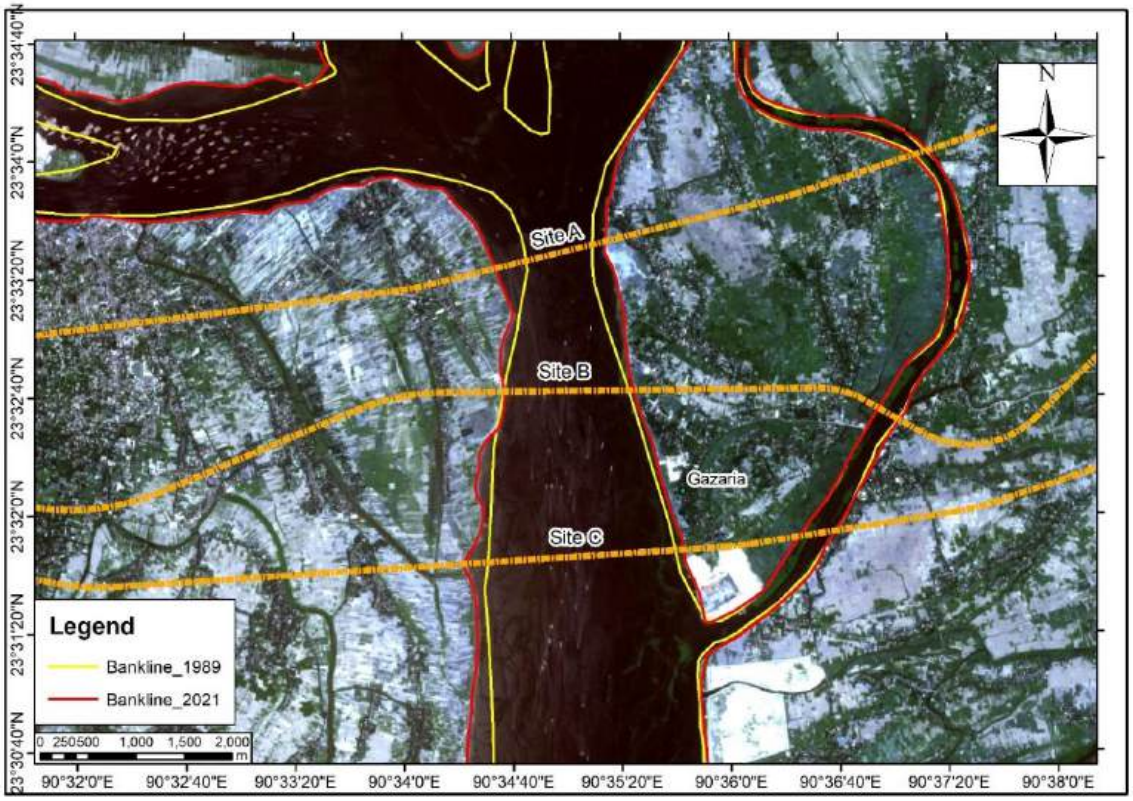


Figure 12. Bankline shifting around the proposed Munshiganj-Gazaria bridge sites.

The results from different analyses based on historical data, recent data, field observation, model simulations and planform analysis have been summarized in the Table 9 to show the relative advantages and disadvantages of the probable bridge locations in terms of different hydraulic, morphological and other factors, which lead to the selection of the bridge site.

For each factor a weight is given to each likely bridge site out of the highest 10. From the above results, **Site-B has been the pre-selected one for the construction of the bridge.**

Table 9. Decision Matrix for Preliminary Selection of Proposed Gazaria-Munshiganj Bridge River

Site Selection criteria	Given Weight		
	Site A	Site B	Site C
Planform Analysis	6	10	8
Minimum width of river cross-section	10	8	5
Present condition of cross-section	9	10	8
Maximum Velocity	10	8	9
Velocity distribution pattern across the cross-section	8	8	10
Riverbed Erosion	7	10	5
Vulnerability due to bank erosion around bridge sites	7	10	9
Total	**57**	**64**	**54**

This section briefly describes the design criteria selected and preliminary design of the components of the project along with the preliminary cost estimates.

These tasks are developed in more detail in Volume 5 of this FS, where the following aspects are summarized:

- The main constrains for the crossing.
- The different alignment alternatives considered.
- The design criteria used during the development of the feasibility study.
- The applicable structural solutions for each specific location.
- The result of the comparison among solutions, both in a conceptual and numerical approach.

This project develops only the crossing of the Meghna River and its access roads. Separate studies for the crossing of the Fuldi River (narrower channel on the East side of the alignments) would be developed the RHD, but some considerations have been made to make the three proposed alignments comparable.

The primary design standards and assumptions adopted for the conceptual bridge design are summarised in Chapter 4 “Design Standards and Conditions for Preliminary Design of the Volume 5 (TR8138-JV-FS-G204-RP-SE-000005-FFS_Vol5 Technical Report). Those mentioned there are major preconditions to be considered for preliminary design of the Gazaria-Munshiganj Bridge at the selected site:

- Highway and structural design.
- Bridge cross section.
- River Navigation Clearances.
- Meghna River – Key hydraulic parameters.
- Subsoil profile.
- Vessel Impact.
- Public utilities.
- Seismic force.

Each one of these listed assumptions has been developed in more detail in Volume 5, Technical Report. Three alignment options were examined: A, B and C from North to South.

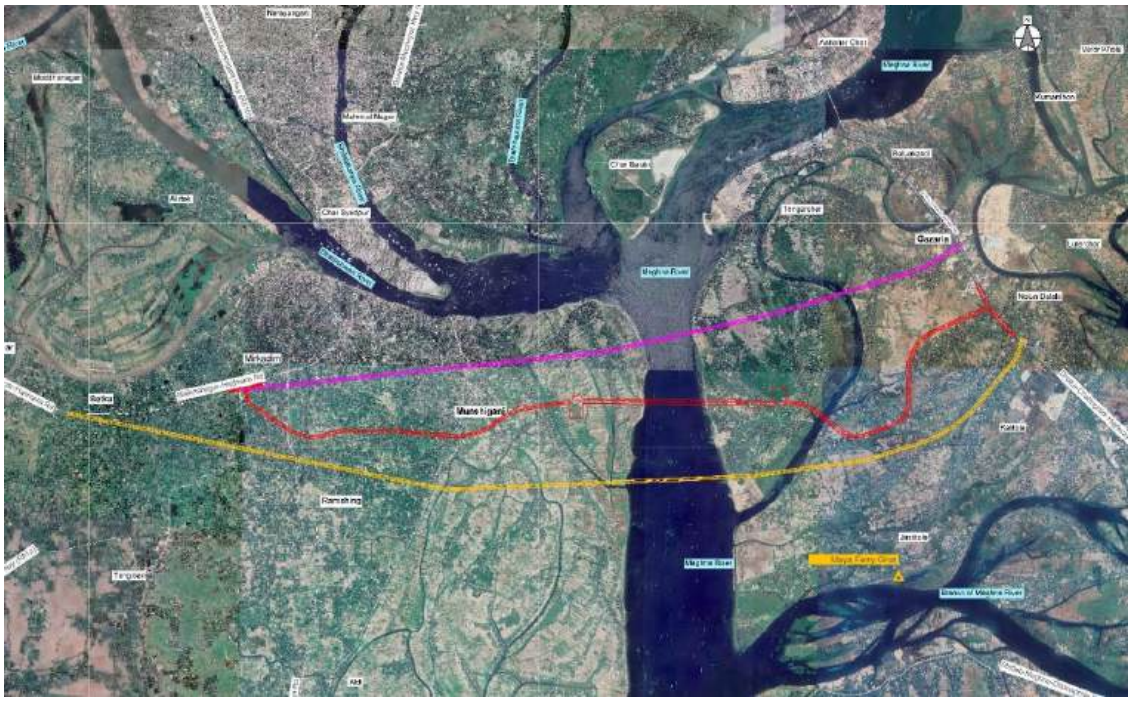


Figure 13. Overlay of alignment options and satellite image.

For the comparison between alignment options, the three layouts were overlayed against the bathymetry. Bridge lengths and foundation types and sizes were regarded as the main factors for selecting one prospective site from the three alternative crossing alignments A to C, from north to south. The next figure shows how:

- The alignment Option C reaches higher depths for an also higher length than any other option.
- The minimum depth is for option B.
- The bridge length in Option A is smaller than in Option B. However, the depth is significantly lower in Option B (around 10 m) when compared to both Alignment A and C.
- Fuldi River, on the east of Meghna River, is not part of this project but would have to be spanned to connect the Gazaria-Munshiganj Road to the N1 and its analysis is relevant to choose the most appropriate alignment. The length of this crossing in Options A and C would require around 100 m more in length than Option B.

Thus, from the riverbed depth versus bridge length point of view, the Alignment Option B provides the minimum total structure cost.

The riverbed depth has an important effect on the cost of the structure. While studying which is the span leading to minimum total cost, the deeper the riverbed is, the longer the optimum span results. As a general criterion, if possible, foundations at higher depths than 15 m in the dry season have been avoided and the number of those for depths over 10 m have been minimized. In the case of Gazaria Bridge, this leads to a central span of 450 m (length over 15 m deep) and a total length over 10 m of 900 m. Thus, these constraints are compatible with one of the proposed solutions: a cable stayed bridge with span arrangement 225+450+225. As said before, this is a general criterion only, and the comparison has been completed including other structural solutions with smaller typical spans, generally in the range between 100 and 200 m.

Indicative bridge lengths were used for a comparison of the alternative crossing sites. Total bridge length consists, in a general case, of the lengths of:

- The west access spans.
- Main spans (class I clearance) length over the current navigation channel. The minimum span for this area has been fixed as 100 m.
- The east access spans.
- The east crossing over the Fuldi River.

Major factors to govern these lengths are:

- Navigational requirements such as location and navigation clearance.
- Location of river facilities.
- Longitudinal geometry of approach roads and maximum embankment height.

Longitudinal grade of approach is limited to 3.0 % slope for approach roads as discussed in Chapter 8 Highways Design of this report. Maximum embankment height has been fixed at 10.0 m. Bridge abutments would be placed at the location of maximum embankment height of the approach roads.

Figure 14, Image of the Cable Stayed Bridge proposed.

The same vertical clearance has been used for all the solutions. The following list includes the types of solutions considered for the spans equal or greater than 100 m from thicker depth to more slender deck:

- Balanced cantilever bridge (up to 200 m span)
- Steel composite box (up to 100 m span)
- Cable stayed bridges (composite deck up to 700 m span)
- Extradosed bridge (up to 200 m span)
- Cable stayed bridges (concrete deck up to 450 m span)
- Truss bridge (up to 200 m span)

Given the length of the cable stayed bridge main span in option C (700 m) the deck would be either of steel or composite steel/concrete with a depth around 5 m. This means using the steel/composite box girders for the Class 1 spans would provide continuity to the depth of the cable stayed bridge in this case.

Regarding the vertical alignment, it is considered necessary to keep a minimum vertical clearance of 30 m in the centre of the river in order not to constrain the future traffic under the bridge. Those 30 m of clearance are however not proposed for the full length of the bridge, but for the central 400 m. For the rest of the length over the river, Class 1 navigational clearance is proposed.

The solutions with higher alignment impose:

- The need for higher piers, leading to higher eccentricities of loads like wind.
- The need for longer ramps.

With a 2.5% slope for the ramps, when compared with the steel truss solution, the balanced cantilever solution would require around 240 m longer ramps while the solution with extradosed bridges would require 120 m longer ramps. Thus, the ramp length should not impose a large difference in total cost, when compared to the total bridge length.

Given the length of the cable stayed bridge main span (450 m) the deck is in the economic range of the concrete solution with a depth around 3 m. Steel/composite box girders for the Class 1 spans like those proposed in G205-Chandpur could be used here, even if those would have bigger depth than the one used for the cable stayed bridge.

As a result of this comparison, the difference in riverbed depth between options A and B would lead to a more expensive solution in option A. Thus, option B leads to a cheaper and with lower risks viaduct.

Consequently, and as a conclusion from this section:

Alignment Option B is the recommended solution from the structural point of view.

4.3. Hydro-morphological Study

The main outputs from the hydro-morphological studies are shown in this summary table. The detailed description, methodology and results are provided in the report submitted by IWM and is appended to this report. (Volume-2).

Table 10. Summary of hydraulic variables

Hydraulic Parameters	Magnitude	Source
Design Discharge, m3/sec	26,938	Based on the developed 1D model
Design Flood Level (m, PWD)	6.63	1D model simulated
SHWL, mPWD	6.55	1D model simulated
Low water surface level, mPWD	0.80	1D model simulated
Lowest Bed Level, mPWD (1998)	-26.11	2D Model Simulated
Observed lowest bed level (2022), mPWD	-22.25	Surveyed data (2022)
General Scour level, m	0.25 m	2D Model Simulated
Constriction Scour, m	3.41 m	2D Model Simulated
Local Scour, m	36.73 m	Using Breuser's Type-II equation using variables from 2D model and observed data

The river training works, RTW, including 6.26 Km of protection of banks at both sides, is shown in the following image. Further details are conveniently developed within Volume 2 of this FS.

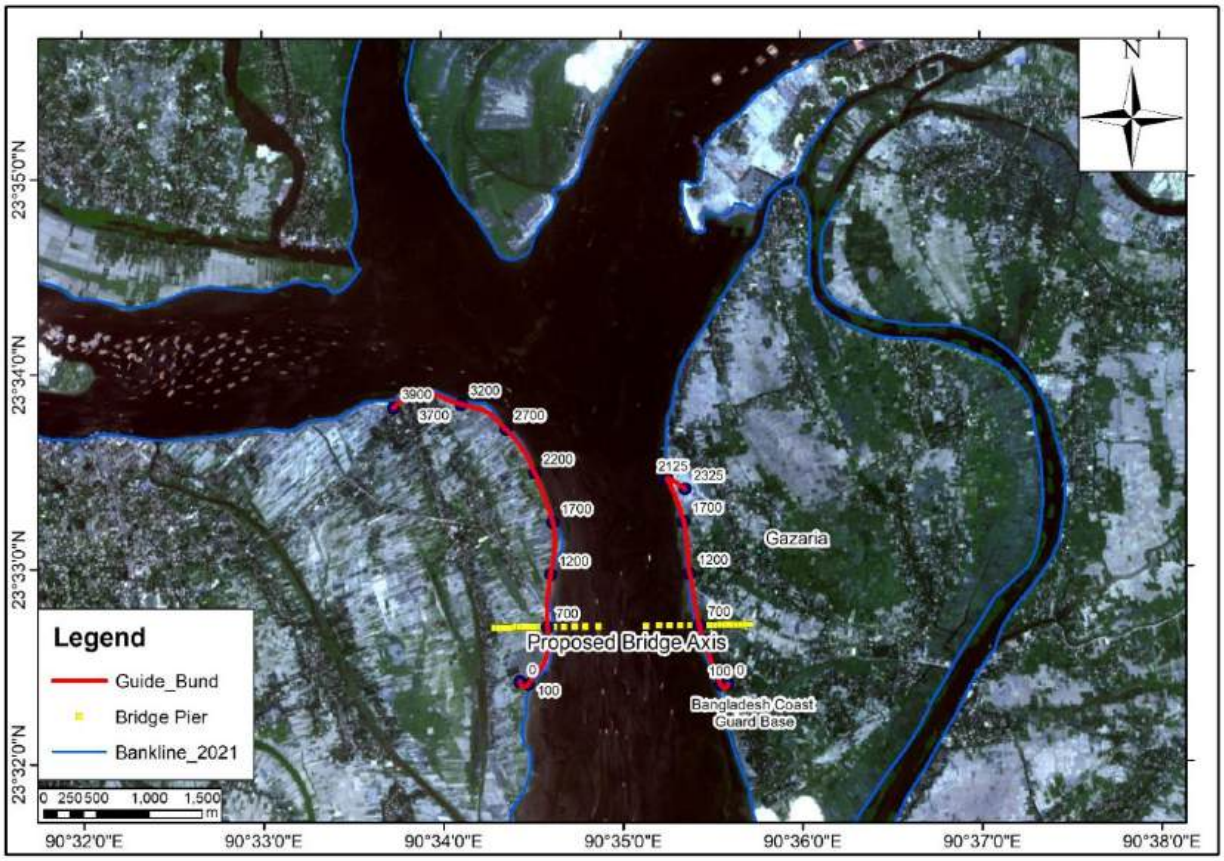


Figure 15. Bank protection works along both banks of the Meghna River.

4.4. Geotechnical Study

The Geotechnical Investigation of this study comprised the drilling of six boreholes (GBH-1 to GBH-6) and excavation of six trial pits (GMTP-1 to GMTP-6) during the period between February 25th, 2022, to December 3rd, 2022, and 17th July 2023 to 31st July 2023.

The main objectives of the geotechnical works are to determine:

- Identify the presence of soft silts and clays on the riverbed.
- The geological stratification along the Bridge alignment.
- The thickness and distribution of the various riverbed sediment layers.
- To derive and determine the engineering properties of each soil type for the purpose of undertaking design works for the main bridge of the project.

A total of six boreholes were drilled to determine the profiles and properties of the different soil strata by the rotary drilling method. The maximum depth of the borehole is 120 m from the existing surface level.

Information on the type of subsoil stratification, geotechnical parameters, and its behaviors are obtained from a comprehensive soil investigation program that incorporates the drilling of boreholes, the geotechnical investigation was carried out on Gazaria-Munshiganj Bridge over Meghna River and approach road. The geotechnical investigation details are shown in the next table.

Table 11. The quantities of the geotechnical investigation

Item		Unit	Quantity	Remarks
Borehole	Onshore	BH No	4	Identify Geological conditions and characterization
	Offshore		2	
Field Test	SPT	Set	6	Prediction of soil strength and calculation of design parameters
	G.W. L	BH No	6	Recording of Ground Water Level
	Borehole Undisturbed Sampling	Nos.	8	Sampling for the mechanical test of clayey soil
Basic Physical	Natural Moisture Content Test	Nos.	78	Identify basic characteristics of soil
	Atterberg Limit Test	Nos.	44	
	Specific Gravity Test	Nos	58	
	Grain Size Analysis	Nos	87	
	Bulk density Test	Nos	8	
	Mica Content Test	Nos	15	
Mechanical Tests	Direct Shear Test	Nos	45	Determine the Shear strength of a soil
	California Bearing Ratio	Nos	6	Determine the strength of the subgrade soil
	One-Dimensional Consolidation	Nos	4	Determine the consolidation Properties
	Unconfined Compression Strength (UCS)	Nos	4	Determine the compressive strength of soil
	Triaxial Test-Consolidated Undrained (CU)	Nos	3	Determine the shear strength of the soil
	Chemical Test (Water)	Nos	2	Determine Chemical composition of Water

Location of boreholes and trial pits

There are Six (06) boreholes for the bridge and two trial pits for the approach road and engineering facilities as shown in Figure 16. Volume 3 of this FS shows all the specifics of the geotechnical undertaken campaign.

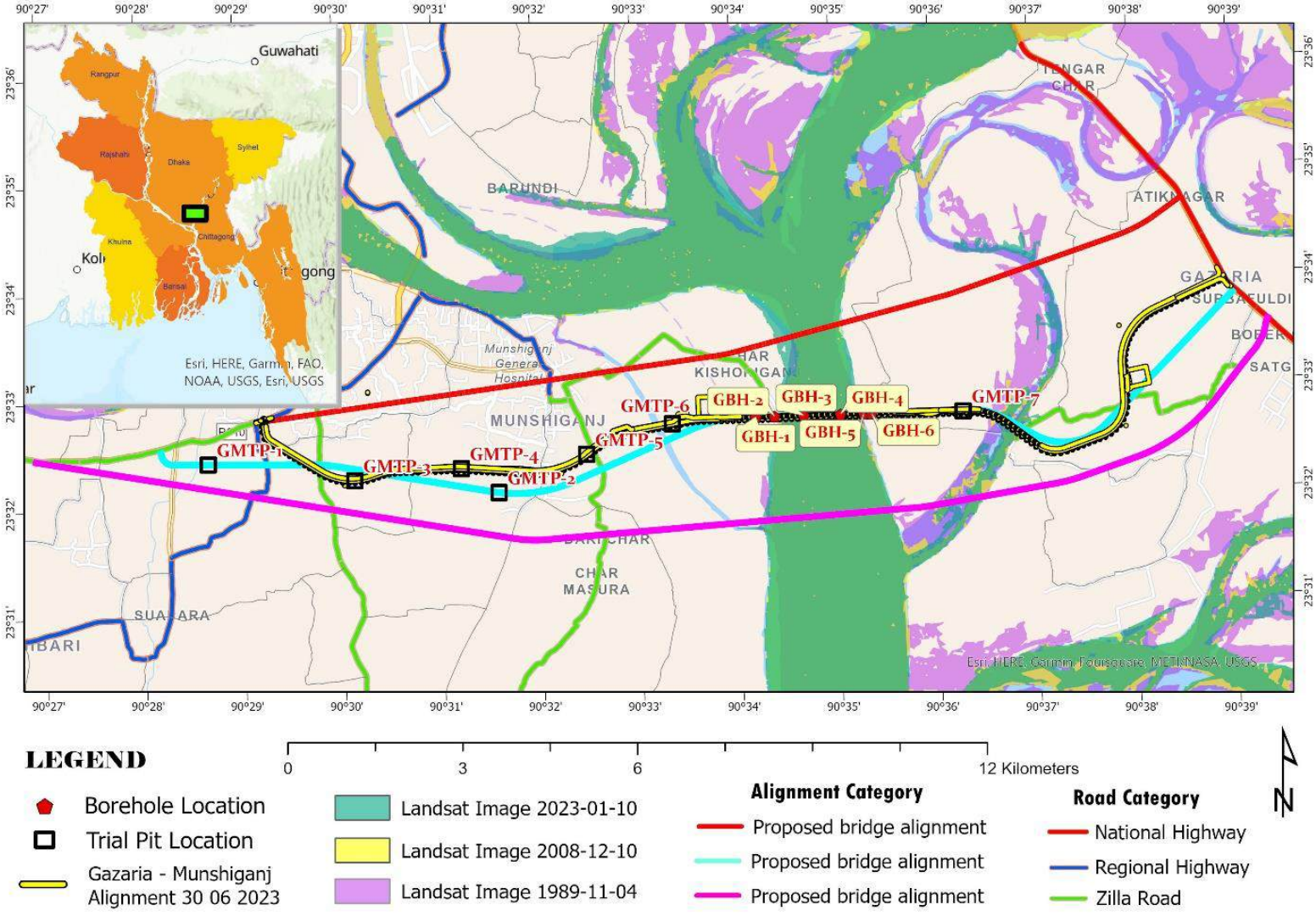


Figure 16. Location of boreholes and trial pits.

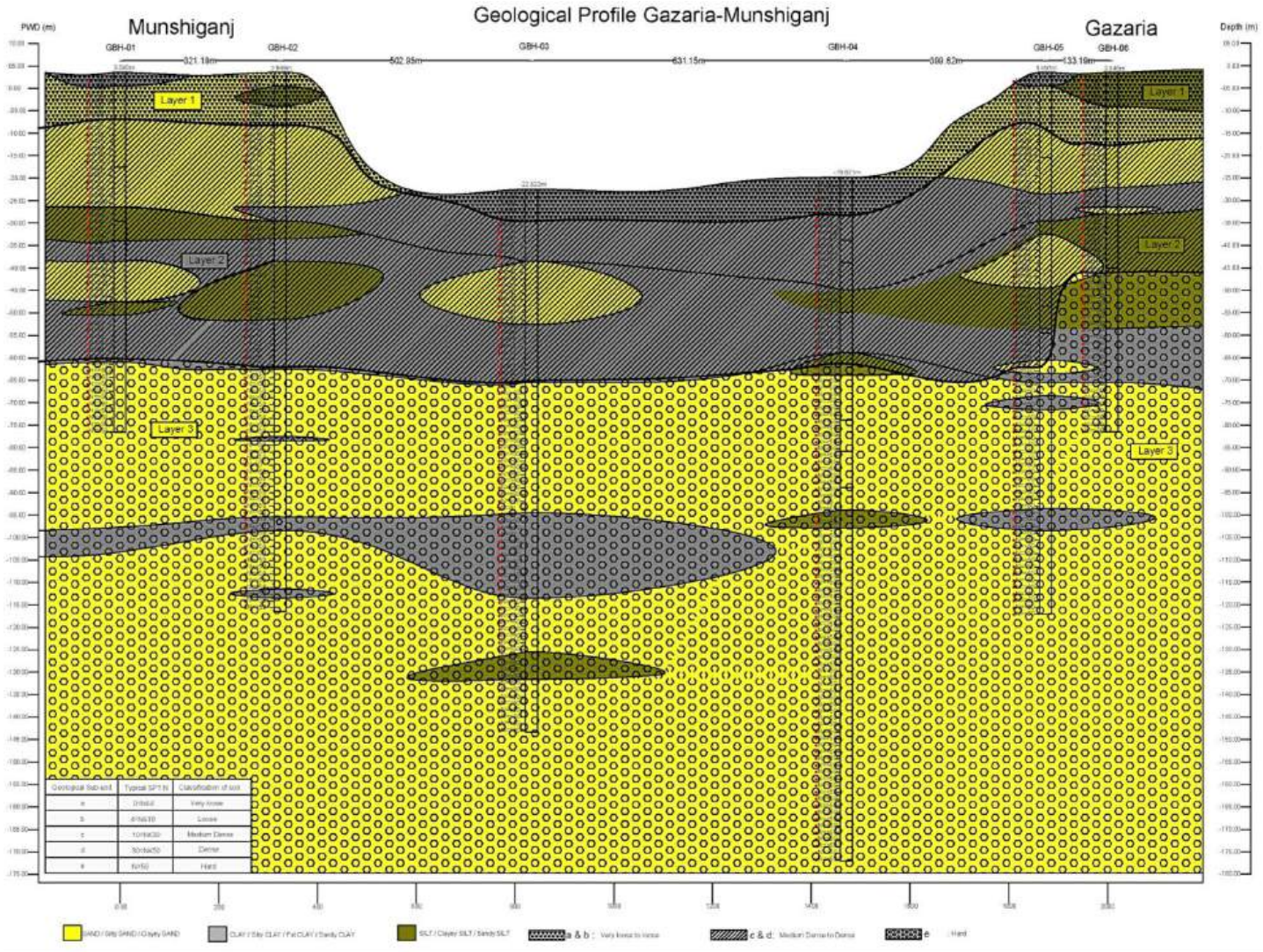


Figure 17. Sub-soil profile of Gazaria-Munshiganj Bridge.

Subsoil Profile

The soil properties for the soils Layer 1 ~ Layer 3 encountered at the site are presented in subsoil profile figure 14.

The properties of the soils were determined from a series of field and laboratory tests to assess the site conditions. It was found that sub soil deposits comprise of some cohesive and cohesionless layers from the soil layers encountered in the project site. The cohesive layers are mostly consisting of low plastic to high plastic, CLAY(CL/CH)/ Silty CLAY/ Lean inorganic CLAY/ Sandy CLAY and SILT (CL/ML)/ Clayey SILT/ Sandy SILT. The layers are combination of cohesionless soil consisting of various types of SAND with some silt SP/SM/ SP-SM/SC.

The subsoil profile of each layer is presented as follows.

- Layer 1:

Layer-1 starts from the surface. Layer 1 materials are very loose to loose SAND/Silty SAND/Clayey SAND mainly. In the case of GBH-01 and GBH-02 the encountered sandy soil layer-1 has an average thickness 26 to 28.5m. Layer-1 is not encountered at boreholes GBH-3 and GBH-4. The GBH-05 consists of 22m thick very loose to loose sandy soil.

- Layer 2:

The Layer-2 starts after surface layer (Layer 1). Layer 2 consists of a mixture of sand, silt and clay materials which are extended to both sides continuously. This mixture is mostly medium dense in nature. There is no overlying deposition of layer-2 in the zone of GBH-03 and GBH-04. On the strength of the material this layer SPT “N” ranges $10<N\leq30$. In the zone of GBH-01, GBH-03, GBH-GBH-05 and GBH-06 cohesionless layers exist in between cohesive layers.

- Layer 3:

Layer 3 is cohesion less soil layer mainly SAND. On the strength of the material this layer SPT “N” ranges $10<N\leq30$.In the zone of GBH-02, GBH-03, GBH-04 and GBH-05 cohesive layers exist in between cohesionless layers. Layer 2 and 3 both consist of a mixture of sand, silt and clay materials which are extended to both sides continuously.

4.5. Proposed Engineering Solution

The proposed technical solution for the bridge over the Meghna River is a **Cable Stayed Bridge with span arrangement 225-450-225, and approach spans with 40 m I girders for the area outside the river and 100 m composite spans in the river area**. The **total length** of the **main bridge** including access spans is **2.42 km**.

The foundation of the piers for the main spans, which are planned to be executed in wet conditions, have been estimated to require 6 steel driven piles Ø2.5 m of 120 m in length for the 100 m spans and the retaining piers and 35 steel driven piles Ø2.5 m of 120 m in length for each one of the pylons on either side of the 450 m span. Further development of the current calculations during detail design may allow for the use of a different diameter for the steel driven piles. For the approach spans with I girders, the foundations have been estimated to require Ø1.8 m bored reinforced concrete piles of 70 m in length.

Figure 18. Image of the Cable Stayed Bridge proposed for Gazaria-Munshiganj.

The approach road would be 2-lane dual carriageway with a design speed of 80 Km/h plus 1 service road lane for SVL. The bridge and approach road would connect with the Munshir Hat Road at Munshiganj side and to the National N-1 through a road carried out in a separate project by the RHD at Gazaria side.

Two toll plazas (one per direction) have been located before the crossing of the bridge as well as two weight stations and two engineering facilities as BBA required.

As shown in Volume 5, the best alignment option in terms of total project estimate is **Alignment Option B**. Also, among the different solutions analysed for Alignment Option B the solution that proved better both in terms of cost, construction process duration, aesthetics and constriction of the river section

was the one called B3-I: Cable Stayed Bridge with span arrangement 225-450-225, and approach spans with 40 m I girders for the area outside the river and 100 m composite spans in the river area.

The foundation of the piers for the main spans, which are planned to be executed in wet conditions, have been estimated to require 6 steel driven piles Ø2.5 m of 120 m in length for the 100 m spans and the retaining piers and 35 steel driven piles Ø2.5 m of 120 m in length for each one of the pylons on either side of the 450 m span. Further development of the current calculations during detail design may allow for the use of a different diameter for the steel driven piles. For the approach spans with I girders, the foundations have been estimated to require Ø1.8 m bored reinforced concrete piles of 70 m in length.

Figure 19. Image of the full proposed bridge crossing the Meghna River.

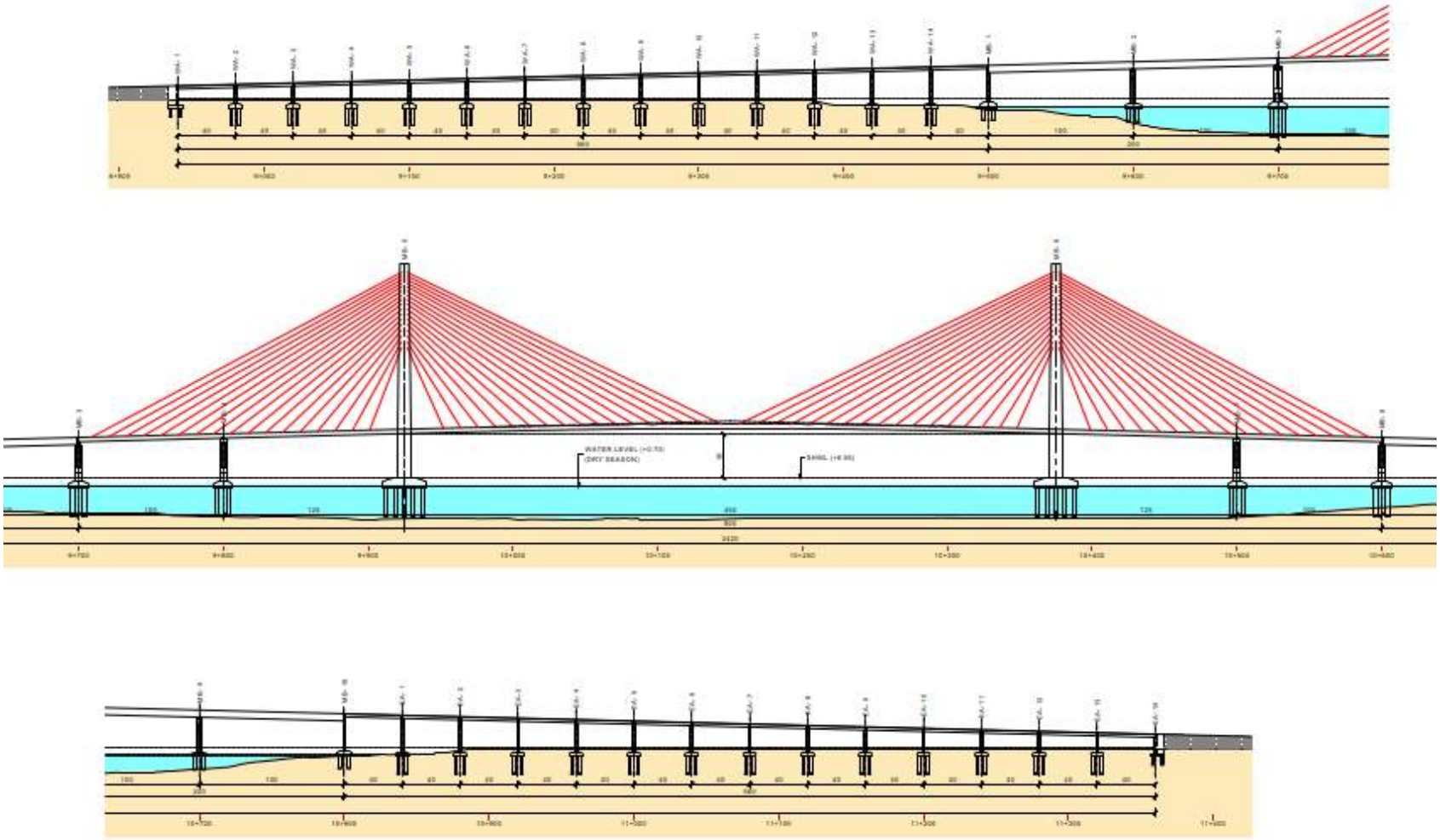


Figure 20. Elevation of the full bridge proposed for Gazaria-Munshiganj.

4.6. Approach Roads

The four-lane approach road has been designed primarily as per RHD standard supplemented by AASHTO specifications where needed.

The design envisages a four-lane dual carriageway with an unpaved median of 3.5 m. The approximate length of the project is 19.114 Km, including the bridge and viaducts and the connections roads with the existing road. The geometric design of the project has been developed for a speed of 80 kph. The design of curves is compatible with the adopted design speeds and Geometric Standards as laid by the American Association of States Highway and Transportation Officials (AASHTO) 2018 have been incorporated.

The approach roads would connect the regional road R812 with the National N1 on the selected location with the following objectives (project justification):

- To provide safe and reliable transportation system connecting Dhaka Division and Chattogram Division.
- To provide direct connections between two significant seaports of the nation (Mongla and Chattogram).
- To reduce traffic loads on National Highway N1 and through traffic around Dhaka.
- To increase regional connectivity between south-east and south-west part of the country, by connecting NH1 and Regional Corridors (Corridor 3: Dhaka -Khulna, Corridor 5: Dhaka-Mongla Port, Corridor 10: Benapole-Tamabil (AH 1))
- Proper local communication over Fuldi River at Gazaria Upazila.

Salient elements of the project are as follows:

- **General data:**
    - **Main Bridge length**
        - Total main bridge Length: 2,420 m
            - Cable Stayed Bridge: 900 m long.
        - Approach Composite Bridge: 400 m
        - Approach Bridge I Girder Length: 1,120 m.
    - **Approach road length:** 4,180 m (excluding the bridge over Fuldi River)
        - At Munshiganj side: 2,740 m
        - At Gazaria side: 1,440 m
    - **Total main alignment: 6,600 m.**

- **Cross section for the approach Road:**

    - Total road RoW variable with a medium value of over 69.5 m width.
    - 2-lane carriageway width 7.30 m plus 1.5 m outer shoulder and 0.50 inner shoulder.
    - Central Median (3.5 m wide).
    - 2-Service Road Lanes 5.5 m, plus 1.5 m outer soft shoulder and 0.50 m inner side safety.
    - 2 additional truck lanes with 7.30 m width for the entry and exit from the axle load stations along 1 Km length approximately.
    - At grade intersection (roundabout) with the regional road R812; elevated intersection providing directional ramps with the National N1.
    - 2 Toll Plazas at both Munshiganj and Gazaria sides (7 toll booths).
    - 2 Axle Load Stations and Service Yards at both Munshiganj and Gazaria sides (4 weights bridges/each).
    - 2 Service Area and Engineering Facilities.
    - 965 m long bridge over Fuldi river at Ch 0+900 approximately
    - Overbridge at Ch 7+400 (180 m long); Ch 8+600 (100 m long); Ch 8+800 (40 m long); Fuldi river bridge (970 m long); Ch 15+980 (120 m long); 16+610 (530 m long).
    - Box culverts at locations as drainage structures: Ch 0+400; Ch 0+800; Ch 1+525; Ch 2+500; Ch 3+400; Ch 4+100; Ch 4+600; Ch 5+070, Ch 5+800, Ch 6+550, Ch 6+950, Ch 8+280, Ch 11+700, Ch 12+180, Ch 12+680, Ch 14+500, Ch 15+500 and Ch 17+600,
    - Underpasses at Ch 1+380, Ch 3+570, Ch 5+228,

- **Cross section for the Cable Stayed Bridge: 23.00 m**
- **Cross section for the Approach Bridge: 20.25 m**

    - 2-lane carriageway width 7.30 m plus 0.70 m outer shoulder and 0.50 m inner shoulder.
    - 1 footpath of 0.80 m width.
    - Central safety barrier width 0.65 m.
    - Side safety barrier width (each side) 0.50 m.

Geometry Design Criteria

The design criteria as per the Design Standards of the approach roads conforms to the following requirements:

Table 12. Road design criteria.

DESIGN STANDARDS			
Design Elements	Unit	Design Parameters	Source
Road Standard		Type 2	Figure 4.1, RHD Standard, Page 12
Design Speed	kmph	80	RHD, Table 2.2, Page-5
Stopping Sight Distance (SSD)	m	120	RHD, Table 2.3, Page-5
Intermediate Sight Distance (ISD)	m	250	RHD, Table 2.3, Page-6
Cross-Sectional Elements			
Carriageway Width	m	7.30	In each direction
Lane Width	m	3.65	RHD, Table 2.1, Page-4
Service Road/NMT	m	3.0-6.0	RHD, Table 4.1, Page-20
Outer Shoulder Width	m	1.5	RHD, Table 2.1, Page-4
Minimum Inner Shoulder Width	m	0.5	RHD, Table 4.13, Page-72
Central Median	m	1.2	AASHTO
Minimum Median Width with Barrier	m	3.5	RHD, Table 4.12, Page-70
Normal Cross fall	%	3	RHD, Table 4.7, Page-17
Cross fall of Shoulder soft	%	5	RHD, Table 4.7, Page-17
Embankment Slope (Absolute Min)	H:V	2:1	RHD, Table 4.9, Page-18
Embankment Slope (Desirable Min)	H:V	3:1	RHD, Table 4.9, Page-18
Horizontal Alignment			
Minimum Radius	m	500	RHD Table 5.1, Page-75
Maximum Super Elevation	%	3 to 5	RHD, Table 5.2, Page-76
Min. Transition Length	m	25 to 65	RHD, Table 5.3, Page-75
Vertical Alignment			
Maximum Grade	%	3 to 6	3 % as per Asian Highway Standard, 6 % maximum on the approach to structures
Minimum K Value			
Crest Vertical curve		35	RHD, Table 6.1, Page-82
Sag Vertical curve		26	AASHTO

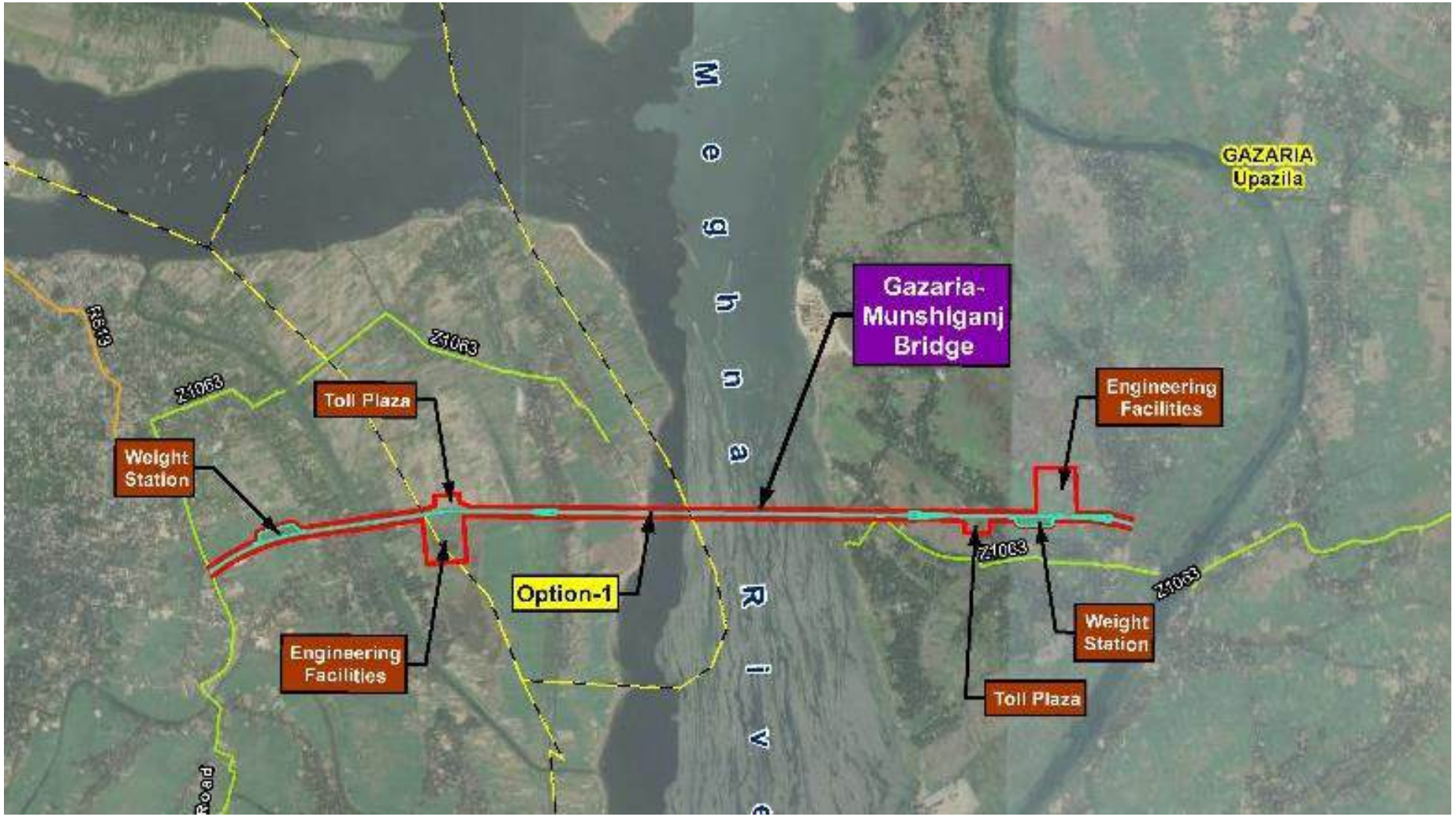


Figure 21. Complete alignment for the proposed project.

4.7. Cost Estimate

The preliminary cost estimation for Munshiganj-Gazaria Bridge has been estimated based on several sources, as following (see Volume 11 for the detailed information).

- Roads and Highways Department (RHD) Schedule of Rates 2022 (updated March 2023).
  Zone: Dhaka, Mymensing & Cumilla.
- Public Works Department (PWD) Schedule Rates 2022 (Revised).
  Zone: Dhaka and Mymensingh.
  Bangladesh Water Development Board (BWDB) Standard Schedule of Rates (Sept 2022):
  Zone C: Southern Zone- Barishal; Jhalkathi; Pirojpur; Patuakhali; Barguna; Bhola.

If any item is missing in the above rate schedules, the unit price considered would be the one included in the previously published available rate schedule, e.g., RHD 2019, increased 20%. If it cannot be found in any official source, the unit price would be taken by benchmarking from current market rates analysis and from previous feasibility studies implemented by the BBA in recent years.

Table 13. Summary of Preliminary Cost Estimation

		Alignment Option B	
No.	Item	Amount (BDT)	Amount (Cr BDT)
1	General and Site Facilities	2,498,131,360	249.81
2	Main Span	25,883,110,007	2,588.31
3	Access Span	4,875,349,321	487.53
4	Approach Road including small structures	8,247,649,407	824.76
5	Toll Plaza & Engineering Facilities	5,423,958,955	542.40
6	Bank Protection Work	21,003,201,422	2,100.32
(A)	**Subtotal**	**67,931,400,472**	**6,793.14**
(B)	Provisional Sum for Physical Contingency = 3% of (A)	2,037,942,014	203.79
(C)	**Sub Total (A+B)**	**69,969,342,486**	**6,996.93**
(D)	Provisional Sum for Price Contingency = 6% of (C)	4,198,160,549	419.82
(E)	Engineer's Estimate = (C+D)	74,167,503,035	7,416.75
(F)	**Land Acquisition and Resettlement Costs**	**27,946,287,385**	**2,794.63**
(G)	Design Cost = 2% of (A)	1,358,628,009	135.86
(H)	Construction Supervision = 5% of (A)	3,396,570,024	339.66
(I)	Project Estimate = (E+F+G+H)	106,868,988,453	10,686.90

4.8. Implementation Timeline

The considered implementation project timeline, according to the criteria based on other recent studies undertaken by the Consultant and after conversations held with BBA officials was estimated as follows (GANNT is shown in the next page figure).

PRE-CONSTRUCTION PHASE

- GOB's Approval of the Project – Mid of 2024
- Y0 July 2024 to June 2025 – DPP implementation – Procurement process for Detailed Design and RAP+LAP implementation - **12 months**.

INVESTMENT PERIOD (BEFORE OPERATION): 6Y

- Starting year of investment: Y1 = Jan 2025. / Financial Arrangement.
- Project Detailed Design Phase - **15 months.**
- RAP and LAP implementation phase - **12 months.**
- Main Contractor Tender Process - **6 months.**
- **Construction period** including Testing and commissioning - **48 months**.
  Starting: Jan 2027. Finishing (48 months) including T&C: Y5 = Dec 2030.
- Defects Notification Period (DNP 1 year) Jan 2031 to Dec 2031.
  OPERATION PERIOD: 30Y = Jan 2031 to Dec 2060.
- **TOTAL PROJECT PERIOD: 30 + 6 = 36Y**

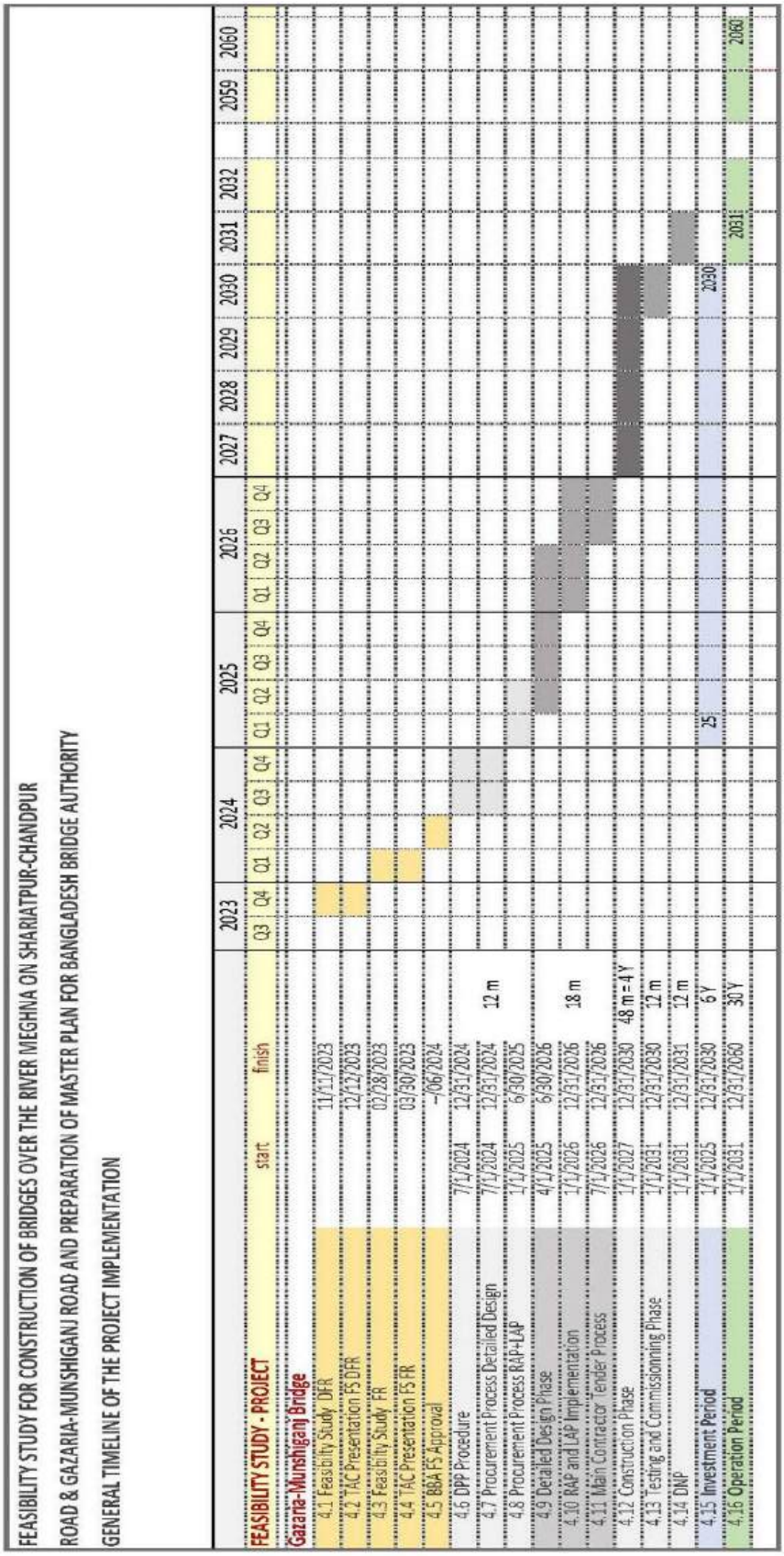


Figure 22. Project proposed implementation timeline.

5. ENVIRONMENTAL SUSTAINABILITY, CLIMATE RESILIENCE AND DISASTER RISK ANALYSIS

5.1. Environmental Assessment Considerations

The Gazaria-Munshiganj Bridge has been proposed to be constructed over the Meghna River some 200 m upstream from the existing Gazaria launch Ghat. The project comprises as major components: the main bridge with total length of 2.42 km, a four-lane approach road of 2.74 km towards Munshiganj side and a four-lane approach road of 1.44 km towards Gazaria side.

Environmental issues pertaining to the project should be incorporated properly in the design and assessed to incur benefits from the project by enhancing the environmental positive impacts and offsetting the negative impacts. A cable stayed bridge has been proposed over the river to minimize the impact on the aquatic ecosystem. Proper navigational clearance has been adopted for movement of ships and to avoid water transport hazards. Piles with improved soil stabilization chemicals adopted in the design would generate minimum noise and vibrations which would create minimum disturbance to the aquatic animals including Dolphin and Hilsa fish. As the bridge is located 8 km away from the nearest government notified Hilsa sanctuary hence bridge would not impact the Hilsa breeding.

The Initial Environment Examination (IEE) / assessment for the proposed project has been carried out through the following methodologies: screening of the significant environmental impacts, assessing them, enhancing the positive impacts, and recommending the mitigation measures for the negative impacts. These have been done based on available secondary data, field data and discussion with the project affected people (PAPs). Based on the impact assessment, it is observed that the project has positive impacts mainly on commercial facilities, industrial activities, job opportunities, landscape and professional diversity, and some negative impacts mainly on noise, erosion and siltation, housing, and commercial structures loss as well as community split. Environmental Management Plan (EMP) has been proposed to minimize the negative impacts and achieve sustainable bridge project.

Asian Development Bank (ADB), World Bank (WB), Department of Environment (DoE), Roads and Highway Department (RHD) and Local Government Engineering Department (LGED) guidelines have been followed for IEE preparation of the proposed Bridge Projects. Checklists for IEE have been completed and found no significant negative environmental impacts due to the project.

No highly significant negative environmental impacts are expected during the construction period of 3 years except the normal construction hazards. However, during construction close monitoring is required over the following issues: interruption of traffic, contamination of surface and ground water, disruption of drainage, pollution of air, noise and soil, disturbance of wildlife mainly water birds and reptiles, aquatic life, health and sanitation hazards and social disruption including split of communities.

About 568.47 acres of land acquisition is required for the proposed project. A total of 242 nos. of residential and 4 CPRs will be affected by the project who will be compensated as per provisions of the RAP of this project. A total of 5,725 nos. of trees including new plantation as saplings are going to be affected due to the project. This loss can be mitigated by planting 53,625 nos. of tree seedlings and

64,000 vetiver roots on embankment slopes and other vacant lands which will enhance the environmental condition of the area.

It should be mentioned that as per Environment Conservation Rules (ECR), 1997 (Amended in 2002 and 2003) and Environment Conservation Rules (ECR), 2023 of DoE, GoB, construction / reconstruction / extension of bridges with length of 500 m or more is included (Under item 39) in the list of Red Category of projects.

Table 14. Summary Environmental Risks

Project Activity	Anticipated Environmental & Social Risks Description
Land Acquisition and Resettlement	
Pre- construction	A negative impact due to land acquisition and resettlement. About 568.47 acres of agriculture land acquisition is required for the proposed project. A total of 242 nos. of residential and 4 CPRs would be affected by the project
Construction	Limited impacts since minimal land acquisition and resettlement is anticipated during project implementation if there are some minor changes in the project design during implementation.
Operation & Maintenance	Associated developments such as road network development and induced development such as industrialization would induce negative medium impacts.
Agriculture Agriculture is the major dominant economic activity in the project area.	
Pre-construction	High negative impact due to acquisition of about 568.47 ha of agriculture land leading to an annual loss of 1,100 tons of crop.
Construction	High negative impact due to clearing/reducing of agricultural lands for construction camps, yards and other facilities.
Operation &Maintenance	Induced developments at the regional scale would have medium negative impact.
Fisheries/Aquatic Life Fisheries production from the river and flood plain are of high economic importance to the country. The Meghna River supports the life of several important aquatic species such as dolphin, and Hilsa	
Pre- construction	Medium negative impact due to filling of floodplain area. The resettlement Site would be prepared in 1 piece of land on one side of the bridge with 5 acres.
Construction	Medium negative impact due to pile driving activities. It generates high underwater noise levels which would affect the fishes, dolphins, and other aquatic life. On the other hand, high impact due to filling of floodplain for development of project sites by digging pond/borrow pits
Operation & Maintenance	No significant impact
Vegetation	

Project Activity	Anticipated Environmental & Social Risks Description
Vegetation in the project area is quite common and would provide the habitat for wildlife, and food and wood to the local community.	
Pre- construction	High negative impact due to clearing of sites for approach road since about A total of 5,725 nos. of trees are going to be affected due to the project
Construction	High negative impacts encountered during clearing of all construction sites. It is estimated that about 5,725 trees would be cut.
Operation &Maintenance	High positive impacts due to plantation of about 53,625 plants along approach roads, char lands and bridge end facilities.
Dredge Materials and Disposal No dredged materials would be generated from the river.	
Pre- construction	No impact
Construction	Medium impact
Operation &Maintenance	No impact
Noise Quality Noise quality in the project area is generally low except along the roads and boat ghats. Project activities generate high air and underwater noise levels that significantly affect aquatic habitat and wildlife, and nearby communities.	
Pre- construction	Low negative impact due to mobilization of equipment, construction materials/ vehicles during the construction.
Construction	High negative impacts due to construction of bridge substructures, especially during pile driving, which generates high underwater and air noise levels that affect migratory birds' habitat. There would be also medium negative impacts due to (i) construction of main bridge superstructure, (ii) mobilization of equipment, construction materials/ vehicles at all the construction sites, and (iii) activities at construction yards.
Operation &Maintenance	Medium negative impacts during O/M of approach roads, bridge, and induced development activities.
Air Quality Ambient air quality in the project area is affected by ferry operations. Air pollution may occur using vehicles and equipment, cleaning of materials, coating of construction materials, dust from stone/brick crushing. Severe air pollution may lead to health hazard.	
Pre- construction	Mobilization of equipment and vehicles at the resettlement site has a low negative impact. Development of green areas and other plantation activities in the resettlement sites would have positive impact on the air quality.
Construction	Medium negative impact due to mobilization and operation of vehicles and equipment, asphalt and concrete plants, and construction yards. Local air quality would be deteriorated from the emission of vehicles, construction equipment, dusts generated from construction activities, crushing of stones/rocks.

Project Activity	Anticipated Environmental & Social Risks Description
Operation &Maintenance	Medium negative impact during O/M of approach roads and bridge. Widening of road network also has medium negative impact. Positive impact on environment due to plantation of about 53,625 tree saplings
Health, Safety and Hygiene Large immigrant work force during construction works and their camp sites are hot spots for health, safety, and hygiene.	
Pre- construction	High positive impact due to the construction of hospitals, water supply and sanitations facilities at the resettlement site.
Construction	Medium negative impacts at the construction yards and camps due to placement of large work force. Safety hazards during construction of main bridge.
Operation &Maintenance	Medium negative impact during installation and maintenance of public utility crossings, such as high-power transmission lines and high-pressure gas main. Also, there would be medium positive impacts due to faster access to the health facilities to the Dhaka.
Employment and Poverty Construction require a huge workforce, both skilled and unskilled. There is an enormous potential for employment during construction and O/M stages as well as from induced economic growth and activities.	
Pre- construction	High negative impact since about 1,107 agricultural workers and employees of businesses would temporarily lose employment due to land acquisition.
Construction	Construction of Project activities would provide short term employment (both skilled and unskilled) to around 1,500 local people including women workers, and hence would have a medium positive impact.
Operation &Maintenance	High positive impact due to (i) employment opportunities in the O/M of the project, (ii) induced roadside development and industrialization, (iii) access to bigger and wider markets to sell local products, agriculture produce and fisheries. Consequently, there would be poverty reduction effect in the regions.
Transport/Road Accidents Road transport is a key to overall development. Enormous quantities of material transport over road would produce significant risks to traffic safety.	
Pre- construction	Low negative impacts during construction of resettlement site
Construction	High negative impacts due to (i) transport of enormous quantities of materials over road, (ii) mobilization of vehicles/equipment and their movement in the construction sites. Hence road safety and local traffic jams are the major concerns.
Operation &Maintenance	High positive impact due to connectivity south-east part of the country with the south- west part of country through the Project, which is now connected only through boat. This coupled with new

Project Activity	Anticipated Environmental & Social Risks Description
	road network development in both sides would promote regional development.
Erosion/Scour Riverbanks in the Project area both sides are unstable and susceptible to severe bank erosion. Construction of the main bridge and RTW may induce changes in the erosion and scour. Soil erosion from project sites and subsequent siltation may affect agricultural lands in the immediate vicinity.	
Pre- construction	Low negative impacts due to soil erosion from the construction activities of Resettlement Sites and Engineering facilities and clearing of the sites.
Construction	High negative impacts on soil erosion due to construction activities.
Operation &Maintenance	Medium negative impact on scour due to piers of main bridge. High positive impact due to protection of riverbanks from further erosion through RTW.
River Flow River flows are crucial for maintenance of regional hydrology and normal annual floods. Regional hydrology and flooding are the dominating natural process that governs the floodplain activities including agriculture, fisheries, erosion, and siltation. It is required to keep regional hydrology and flooding characteristics undisturbed as much as possible.	
Pre- construction	No impacts
Construction	Medium impact anticipated due to dredging of the river.
Operation &Maintenance	Low impacts. It is anticipated that afflux in the upstream is 1 cm and in the downstream about 2mm after bridge construction.
Drainage Natural cross drainage and floodwater flows are key natural resources for sustenance of agriculture and fisheries in the flood plains. Blocking of floodwater flow and natural drainage path would occur due to the filling of the project sites above flood level. Drainage congestion from infrastructure works puts an excessive cost on the natural resources and agriculture in terms of crop damage and loss of fisheries.	
Pre- construction	Low medium impact due to clearing of the site.
Construction	Medium negative impacts encountered during, (i) earth works and (ii) earth filling and compaction for road and other project sites due to blocking of natural drainage.
Operation & Maintenance	Low negative impact during O/M of the approach roads
Wildlife Project area supports an ecosystem for migratory birds and terrestrial birds, and variety of mammals. Some of this wildlife is listed endangered in the IUCN Red list.	
Pre- construction	Medium negative impact during site clearing,
Construction	Medium negative impacts due to noise levels from the main bridge construction, especially the pile driving activities that would have impact on the migratory birds' habitat.

Project Activity	Anticipated Environmental & Social Risks Description
Operation &Maintenance	Medium negative impacts. O&M have long-lasting effects, due to habitat destruction.
Wetlands Wetlands provide habitat for fish and migratory birds. The Project area consists of two types of wetlands, (i) permanent wetlands, which include streams, canals, and ponds; and (ii) temporary wetlands consist of floodplains.	
Pre- construction	Medium negative impact during site clearing.
Construction	High negative impacts were encountered due to development of all project sites over temporary wetlands (floodplains) and fishponds. There are 1 river and 2 canals (Munshiganj Sadar side) within the ROW of the approach road and bridge alignment. All the ditches are in small to medium in size and privately owned.
Operation &Maintenance	Long-lasting impacts because of interruption of fish migration and medium negative impacts are expected due to induced development activities.
Charland Charland contains a unique ecosystem within the Project area and harbors significant population, flora as well as fauna.	
Pre- construction	Medium negative impact during site clearing.
Construction	Low negative impact due to the construction activities along the main bridge alignment requires no dredging of the existing char. Since the formation and erosion of Charland is a continuous process, the impact on the inhabited char is expected to be low.
Operation &Maintenance	Positive impact by provision of plantation in Char area
Water Quality The physical and chemical quality of the river water and other surface water bodies is crucial for sustenance of aquatic habitat. Groundwater is the major source of drinking and irrigation in the project area.	
Pre- construction	Low negative impact during construction of resettlement sites
Construction	Medium negative impacts on surface water quality due to (i) mobilization activities, (ii) construction of main bridge and other structures over water bodies (and ii) construction activities near river. Further, accidental spillage of fuels, lubricants, chemicals/solvents, and construction waste would contaminate both surface and ground Waters.
Operation &Maintenance	No significant impact. However, there could be medium to high level risks due to accidental spillage of fuels, lubricants, chemicals/solvents.
Construction Materials Availability and procurement of construction materials as well as activities are critical issues.	

Project Activity	Anticipated Environmental & Social Risks Description
Pre- construction	High significant impact. As per specification quality materials to be identified with source and made available in time from nearby areas.
Construction	High negative impacts encountered during making available as per original budget/price. Impact on agriculture land
Operation & Maintenance	No impact.
Religious and Cultural Sensitivity Construction activities may raise social and cultural issues due to influx on non-local labours and construction near the settlements of approach roads Construction activities may raise social and cultural issues due to influx on non-local labours and construction near the settlements of approach roads.	
Pre- construction	Medium negative impact due to mobilization of workforce from different parts of the country and world
Construction	Medium negative impacts encountered during disposal of wastes from construction yard and other construction sites. 2 religious structures would be affected.
Operation &Maintenance	Medium negative impact during O/M due to roadside development and industrialization.
Navigation and Water Accidents Water transport is the important riverine transport in the project area. Normal navigation in the river may be hindered due to movement of barges and dredgers, dredging works and cargos.	
Pre- construction	Medium negative impact due to mobilization activities of the equipment & workforce
Construction	High negative impact to navigation due to movement of barges, dredgers, cargos, and dredging works. Most of the construction material required for the project mainly comes through water transport.
Operation &Maintenance	No impact
Gender Women in general believed to be vulnerable group in Bangladesh and their empowerment is crucial for country's development.	
Pre- construction	Medium positive impact during construction of resettlement sites due to hiring of women workers and development of livelihood restoration facilities targeting women.
Construction	Construction of Project activities would provide short term employment to around 1,500 local people, including women (500 nos.), and hence would have a medium positive impact.
Operation &Maintenance	High positive impact due to (i) induced roadside development and industrialization, and (ii) access to bigger and wider markets to sell their products, agriculture produce and fisheries.
Non-Road Accidents (including power grid line, gas transmission line & telecommunication line)	

Project Activity	Anticipated Environmental & Social Risks Description
Non road accidents are related to public utility crossings and would be a cause for potential concern, especially, if they are constructed after the bridge is in operation.	
Pre- construction	Medium negative impact due to mobilization activities of the equipment & workforce
Construction	High negative impacts due to installation of public utility crossings such as high-power transmission line, high-pressure gas pipeline and telecommunication line.
Operation &Maintenance	Negative impacts due to possible industrialization through induced development.
Land use The land use in the project area is rural with the dominance of floodplains and agriculture. Change in land use due to filling of flood plains and construction works. With the implementation of the project, the rural areas may gradually get urbanization eventually and this could introduce secondary impact which might change the existing land use.	
Pre- construction	Low positive impact due to construction of construction Sites with all civil amenities.
Construction	Since aesthetic values would be considered for the design of bridge and bridge end facilities, there would a medium positive impact during and after construction.
Operation &Maintenance	High Positive impact due to plantation and landscaping. Induced developments at the regional scale would have medium negative impact.

The proposed bridge would be having length of more than 500 m in each instance, so it is in red category as per DoE, GoB and requires Site Clearance as well as Environmental Clearance from DoE. Which requires various documents – IEE is one of them.

The impacts during construction can easily be mitigated by taking advance adequate precautions and some additional measures appropriate to the construction. An Environment Management Plan (EMP) has been formulated to control/mitigate the negative impacts arising from construction related activities. Contractors would be directed to follow the suggestions mentioned in Chapter 7 and 8 of the Environmental Assessment Plan (Initial Environmental Examination) Report. Supervision consultants would check and ensure that EMP is working well according to the plan.

The impacts associated with the change in landscape after the construction of the project can be negative unless proper landscape plan is formulated by the government and adhered to. The impact on housing and commercial structures can be compensated by providing adequate compensations and alternative job opportunities as proposed in the Resettlement Action Plan (RAP) of the project.

Environmental risk and disaster assessment has been conducted for the Gazaria-Munshiganj Bridge project. It was found that all the measures needed to protect the bridge and approach road from the impact of climate change and disaster have been incorporated in design hence the impact of the environmental risk and disasters were found to be low in nature.

The impacts after construction of the project, unless regulatory measures are taken in time, could be uncontrolled settlement, environmental pollution from industries and innumerable places of possible access to the road leading to traffic congestion and hazard. It would therefore be desirable to institutionalize some form of effective control of the growth of settlements on the Right of Way (ROW) land. One of the measures could be to have an exclusion zone up to a certain distance, for instance 100 m on each side of the road where no structure would be allowed to be erected and no access from any individual property would be allowed directly on the land considering future expansion of road.

It can therefore be concluded that the proposed Gazaria-Munshiganj Bridge project is environmentally sound and sustainable. It can be said in the context of Gazaria-Munshiganj Bridge project that aggregated positive impacts outweigh the negative impacts through the recommended mitigation measures.

Environmental & Social Risk Assessment have been undertaken through a series of consultations and review sessions. The principals in AS/NZS ISO 31000:2009, as well as the proponent's internal risk assessment documentation, guided the risk assessment.[2] The risk assessment approach is not designed to identify and evaluate positive impacts associated with the project. It is, nevertheless, important to consider these impacts to ensure that benefits are maximized and to obtain a full understanding of the project. Social and Environmental risk associated with the project has been listed in table below, but risk ratings are not assigned to positive impacts.

5.2. Induced Impacts and Risks

Table 15. Summary of environmental induced impacts

Impact/Consequences	Degree of Impact/Consequences	Period/Interval	Risk Hedge
Land acquisition and resettlement	High negative impact	Long term impact	Partly mitigable
Air and Noise Pollution	Medium negative Impact	Long term impact	Partly mitigable
Waste Generation	High negative impact	Long term impact	Fully mitigable
Health Impacts	High negative impact	Long term impact	Fully mitigable
Business Development	High positive impact	Long term impact	Enhancement
Industrialization	High positive impact	Long term impact	Enhancement
Tourism	High positive impact	Long term impact	Enhancement
Employment opportunities	High positive impact	Long term impact	Enhancement

[2] AS/NZS ISO 31000:2009. This Joint Australian/New Zealand Standard was prepared by Joint Technical. Committee OB-007, Risk Management. ISO 31000:2009 **provides principles and generic guidelines on risk management**. ISO 31000:2009 can be used by any public, private or community enterprise, association, group or individual. Therefore, ISO 31000:2009 is not specific to any industry or sector

It is expected that the connectivity of the would provide increased accessibility to markets, land ports, and growth centres. This would lead to development of business (including agriculture and fisheries), industry, communication, tourism, and urbanization. The induced development has both negative and positive impacts. The positive impacts are increased in the socio-economic conditions of the region through employment generation and poverty reduction. There are also negative impacts like air and noise pollution due to construction activities, increase in traffic levels and industrial development, generation of wastes due to increased living standards, consequent health impacts due to pollution and waste generation, loss of biodiversity, and land acquisition and resettlement.

5.3. Risks Assessment / Natural Disaster and Climate Change

Bangladesh is a country prone to natural disasters such as floods, cyclones, and earthquakes. The government and various organizations have implemented disaster mitigation strategies to reduce the impact of such disasters. Here are some of the strategies that have been implemented in Bangladesh:

Early warning systems: The government has established a network of early warning systems to provide timely alerts about impending disasters. This includes the use of sirens, text messages, and radio broadcasts.

Emergency response plans: The government has developed emergency response plans that outline how different agencies should respond to disasters. This includes the deployment of rescue teams, medical teams, and the provision of relief supplies.

Infrastructure development: The government has invested in infrastructure development to reduce the impact of disasters. For example, the construction of embankments and cyclone shelters has helped to protect coastal communities from storm surges.

Community-based disaster risk reduction: The government has encouraged community-based disaster risk reduction initiatives. This includes the formation of community disaster response teams, the development of evacuation plans, and the identification of safe places to take shelter during disasters.

Climate change adaptation: Bangladesh is one of the most vulnerable countries to climate change. The government has developed strategies to adapt to climate change, including the promotion of climate-resilient agriculture and the implementation of flood-resistant housing.

Education and awareness: The government has launched education and awareness campaigns to inform people about the risks of disasters and how to prepare for them. This includes the development of educational materials and the use of media campaigns.

These strategies have helped to reduce the impact of disasters in Bangladesh, but more work needs to be done to improve disaster preparedness and response.

There is high risk of Cyclone, erosion. Sea level rise and flood in the project area. The river training work including guide bunds would help mitigate soil erosion and flooding. Structural design & construction (Bridge & approach road) have been conducted keeping the flood level rise due to

climate change and earthquake risk in consideration. Considering the geography and geological feature of the project area following risk index has been assessed related to the climate related changes and natural disasters.

Table 16. Climate/Disaster Risk assessment

District / Risk Area	Gazaria (Munshiganj)	Munshiganj (Munshiganj)
	Risk Index	
1. Cyclone	Moderate	Moderate
2. Drought (Kharif)	Very Low	Very Low
3. Drought (Pre Kharif)	High	High
4. Earthquake	High	High
5. Erosion	Very High	Very High
6. Flood	High	High
7. Flash flood	Very Low	Very Low
8. Salinity	Very Low	Very Low
9. Sea-level rise	Very Low	Very Low
10.Landslide	Very Low	Very Low
11.Storm Surge	Very Low	Very Low

A comprehensive Environmental Management Plan (EMP) has been developed to reduce and mitigate the impacts of the project. The estimated EMP cost for the project has been assessed to be 35.64 million BDT.

The EMP would be the part of the contract document hence cost is mandatory and there is no viable alternative to these measures. Environmental Impact Assessment (EIA) is required by the Ministry of Environment, Forests and Climate Change (MoEFCC). The Terms of Reference (ToR) provided by the Department of Environment (DoE) outline the scope and are the basis of the EIA.

5.3. Risks Assessment / Vessel impact - Infrastructure

The construction of the bridge presents several risks that need to be addressed to ensure safety and successful completion of the project. Some potential risks include:

To mitigate these risks, detailed engineering analysis, thorough planning, and strict adherence to safety protocols are essential. Regular inspections, quality control measures, and collaboration among the project team can help identify and address any potential risks throughout the construction process.

Vessel Impact Risk detailed assessment has been included in Vol 01 and Vol 10 of this FS.

6. SOCIAL SAFEGUARD ASSESMENT

6.1. Socio-Economic Profile and Impacts

The social impact of the project has been assessed through the implementation of the RAP and LAP, with the assistance of a specialized sub consultant and the Consultant in-house team of experts. The impacts of the project have been assessed based on the preliminary design of the project. In this connection, a dedicated land survey team has been mobilized to conduct LAR and related surveys and finally to prepare LAP and RAP.

According to the detailed census and IOL survey, total 246 project affected units including 242 HHs and 4 CPRs would be affected by losing their immoveable assets. Apart from the primary structures a significant quantity of secondary structures would also be affected. The assessment was also identified that 45 business premises including running business would be affected by the project interventions. Table below shows summary of land acquisition impacts by Interventions.

It was estimated that around **568.47 acres** of land would require acquisition for the project. Of the total land, 158.63 acre would be required for Right of Way. Additional 409.84 acres of land would be required for other project relevant interventions. It was estimated that, about 5.00 acres of land would be required for one resettlement area. It is identified that the land acquisition would require from 1864 plots of 13 administrative mouzas.

Table 17. Summary of project impact

Sl. No.	Project Impacts	Gazaria	Munshiganj	Sonargaon	Total
A.1	Affected Land for RoW (Acre)	62.11	69.53	26.99	158.63
A.2	Affected Land for Resettlement area, Construction Area, and River Training Activities etc.	172.81	-	237.03	409.84
A	**Amount of affected land (acre)**	**234.92**	**69.53**	**264.02**	**568.47**
B	Number of Mouza	10	1	2	13
C	Number of Household	83	92	67	242
D	Number of CPRs affected	-	3	1	4
E	**Total number of Project Affected Units (C+D)**	**83**	**95**	**68**	**246**
F	Number of Businesses affected	6	9	30	45
G	Number of Employees affected	-	-	36	36
H	Number of Trees affected	2,340	2,311	1,074	5,725
I	Total number of Persons affected	365	439	303	1,107

Table 18. Summary of affected land

Land category	Gazaria in acres	Munshiganj in acres	Sonargaon in acres	Total
Nal/ Agriculture	172.08	58.90	249.94	480.91
River/ Khal	36.56	5.75	1.23	43.54
Road/ Gopat/ Halot/ Sarak	3.97	1.80	3.28	9.05
Vita/ Highland/ Embank/ Graveyard	4.90	0.05	1.70	6.64
Home/ Madrasa/ School/ Mosque	13.31	2.87	7.38	23.56
Orchard/ Panboraj /Bamboo Groves	0.83	0.16	0.04	1.03
Pond	1.75			1.75
Doba/ Beel/ Noyanjuli	1.42		0.14	1.56
Fallow and Others	0.12		0.33	0.45
Total	234.92	69.53	264.02	568.47

6.2. Consultation and Participation

During the stakeholder's consultation meetings, people were briefed about the project benefits, roles and responsibilities of the project authority, local government institutions and other stakeholders. Mitigation measures of potential adverse impacts including compensation at replacement cost, resettlement benefits, income and livelihood restoration, grants to vulnerable people and employment opportunity of the eligible PAPs in project civil works were also discussed in the meetings. Upon disseminating information by the consultant/project authority, stakeholders identified some pertinent issues relating to the compensation, displacement, resettlement, livelihood restoration, etc.

A total of two PCM (public consultation meeting) were held at separate locations in September 2023 with the involved people, BBA officials, Consultant and Sub-consultant representatives and other stakeholders. A total of 232 people were present at the meetings. Stakeholders were briefed about the project goals and objectives, potential impacts on the people, mitigation measures as per the Acquisition and Requisition of Immoveable Property Act (ARIPA 2017) and GOB Resettlement Policy for the affected people on involuntary resettlement, ultimate benefits of the local people, land acquisition requirements and process, roles of the affected people and project authority in delivering compensation and grievance redress. The opinion of the people was sought and well recorded during the consultation meeting. Major consultation discussion and responses are described in Chapter 4 of Resettlement Action Plan Volume 8. There were also some small consultation meetings conducted to disseminate project information to the local people during the Social Survey.

6.3. Legal and Policy Framework

To address the legal framework for land acquisition and resettlement of the affected people by the project, the Acquisition and Requisition of Immovable Property Act, 2017 (ARIPA) would be endorsed.

6.4. Grievance Redress Mechanism

This project would follow specific grievance redress mechanism to ensure that the voices of the APs merge with implementation decisions.

6.5. Cost and Budget

A total of **568.47** acres of land would be affected during the project implementation.

The preliminary assessed land acquisition and resettlement budget for the project amounts to 27,946,287,363 **BDT**.

The total estimated DC budget amounts to 17,795,461,265 BDT.

Top-up cost has been estimated as 10,150,826,098 BDT considered as resettlement benefits.

Table 19. Summary of cost, LAP and RAP impact

SL.	Category of Loss	Total (BDT)
A	Land for RoW (Govt)	1,439,786,950
	Land for RoW (Private)	16,460,359,797
	Compensation for structure	273,632,353
	Compensation for Trees	24,592,300
B	**LAP Budget (A+B+C)**	**18,198,371,400**
C	Other Resettlement Benefits	7,801,349,173
D	Operation cost for RAP Implementing Agency/ INGO	90,000,000
E	Operation cost for External Monitoring Agency	28,305,000
F	Contingency @5% of the Sub-total	522,360,511
G	Administrative cost @ 2% on the DC budget	1,305,901,279
H	Grand Total (LAP and RAP Budget - BDT)	27,946,287,363

7. ECONOMIC AND FINANCIAL ANALYSIS

7.1. Economic Analysis - CBA

The methodology carried out for the economic and cost-benefit analysis (CBA) , is based on undertaking economic adjustments during the life of the project, considering initial required investment plus transportation operational impacts during period of analysis. Capital expenditures are estimated and valued from market and reevaluated applying standard conversion factors. In a sum, direct social costs and benefits, as well as externalities are appraised from the point of view of the entire country's economy.

(a) Identify the direct, indirect, and associated cost and benefit components.

In the case of the implementation of a new public transport infrastructure, within a pre-existing network transport system, the sources of benefits to be assessed are as follows:

- Change in travel time costs (savings), for users in the system, before and after the construction of bridge. Diverted traffic and generated traffic should be analysed separately.
- Net savings in system vehicle operating costs of all modes involved: energy, fuel, lubricants.
- Lower accident costs for travellers.
- Investment and conservation cost variation (maintenance and repairs) in infrastructures
- Lower environmental costs (emissions reduction, pollution reduction, etc.).

In the table below are summarized some basic elements that compose total project Capital expenses. These costs are indicated without VAT and based (capitalized accordingly) on year 2025, when the estimation was carried out:

Table 20. Basic elements that compose total project Capex (2025 monetary units).

Number	Item	Cr BDT
1	General and Site Facilities	243.54
2	Main Span	2,523.30
3	Access Span	475.29
4	Approach Road including small structures	804.05
5	Toll Plaza & Engineering Facilities	528.77
6	Bank Protection Work	2,047.57
7	Land acquisition and Resettlement costs	2,928.77
8	Design costs	123.81
9	Supervision costs	309.53
10	Contingencies	607.95
	TOTAL	10,592.58

(b) Adjust them where necessary.

Capex costs are adjusted considering inflation dynamics from 2022 to 2025 (starting year of investments) and other correction factors. Also, a realistic chronogram of investment disbursements is required (expenses split by years 2025 to 2030) and the following deployment was applied:

Table 21. Capital expenses deployment with project.

	2025	2026	2027	2028	2029	2030
CAPEX Split by year	2 %	3 %	25 %	20 %	25 %	25 %

Table 22. Capital expenses deployment with project (Cr BDT).

Capital expenditures	2025	2026	2027	2028	2029	2030
TOTAL	211.9	317.8	2,648.1	2,118.5	2,648.1	2,648.1

Table 23. Maintenance expenses with and without project. Values per year (Cr BDT).

	With project		Without project	
Maintenance	Ordinary maintenance [Cr BDT/year]	Extraordinary [Cr BDT/year (when applied)]	Ordinary maintenance [Cr BDT/year]	Extraordinary [Cr BDT/year (when applied)]
Main bridge	25.23	252.33 (Y15, Y25)	-	-
Approaching viaducts	4.75	19.01 (Y10, Y20, Y30)	-	-
Approaching roads	8.04	48.24 (Y10, Y20, Y30)	6.05	36.29 (Y10, Y20, Y30)
Bank protection and river training	40.95	122.85 (every 3Y)	16.38	49.14 (every 3Y)
Toll Plaza & Facilities	10.58	42.30 (Y15, Y25)	-	-
Ferry-ghat terminal	-	-	19.52	-
TOTAL (sum of the 30 years of operation)	**2,686.60**	**2,019.57**	**1,258.44**	**600.28**

The study outcome of the split of main positive impacts (in terms of present values), showed that the variation in Consumer Surplus for transport users (92.3 %) is by far the main expected economic impact, much higher than the changes in Producer Surplus (30.04 %), with other contribution being negative since some external effects increase their impact in incremental terms (due to generated traffic).

More precisely, passenger time savings represent 91.12 % of the positive impacts. The effects from freight activities are much less relevant (1.59 %) in terms of net economic impacts.

On the other side, the impact from variation in Producer surplus is less relevant (30.04 %), and more precisely the key source of potential impacts here comes from cost savings (27.54 %) rather than (net) generated income (2.5 %).

(c) Convert the value of cost and benefit components into economic price by using Standard Conversion Factors (SCF) determined by the Government.

The conversion factors (CF) are employed to transform the market input prices into shadow prices. They represent ratios that connect both prices and they consider a more realistic value for the considered inputs. The values used frequently in ADB's Technical Assistance Consultants reports[3] have been applied for some of the outflows in this socioeconomic analysis. In particular:

Table 24. Considered Conversion factors.

Item	CF
Initial Capex	0.90
O&M costs	0.88
Reinvestment costs	0.88
Residual Value	0.90

(d) Construct the cash flow.

After having presented and described the main assumptions, as well as some methodologic elements, the project economic flows were calculated and projected for the period of analysis Project economic flows for the different years considered in the period have been estimated and projected (in Cr BDT).

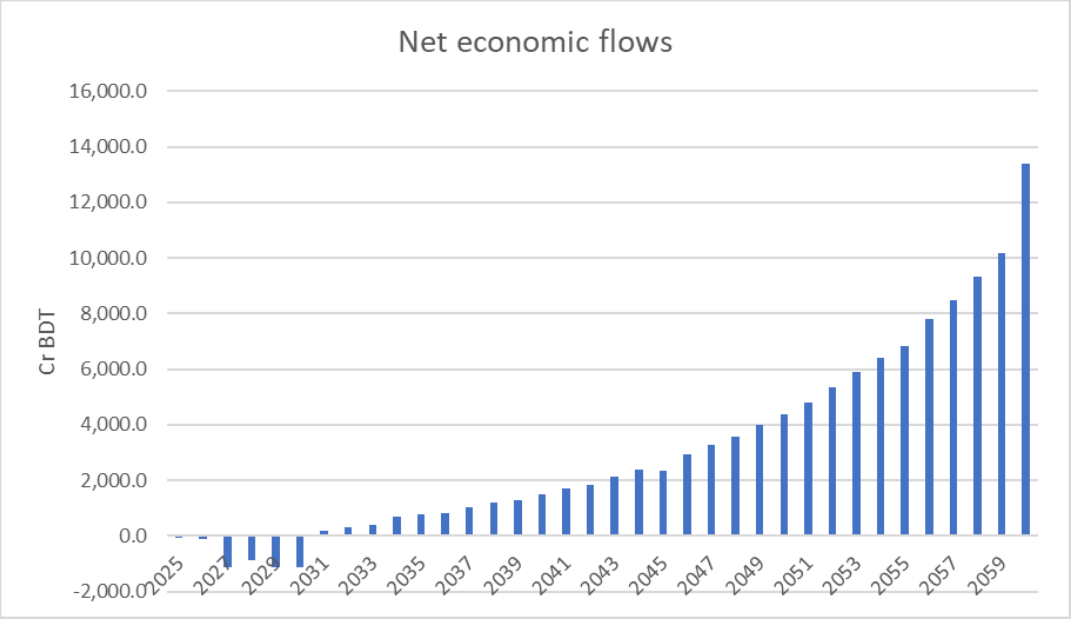


Figure 23. Undiscounted economic flows (Cr BDT).

[3] *For instance, ADB TAC report: "supporting Sustainable Urban transport I Aizawl City" (2016). Same CF values are present for instance in: "Detailed Project Report for Rail Based Mass Transit system in Kanpur" (RITES, 2019)*

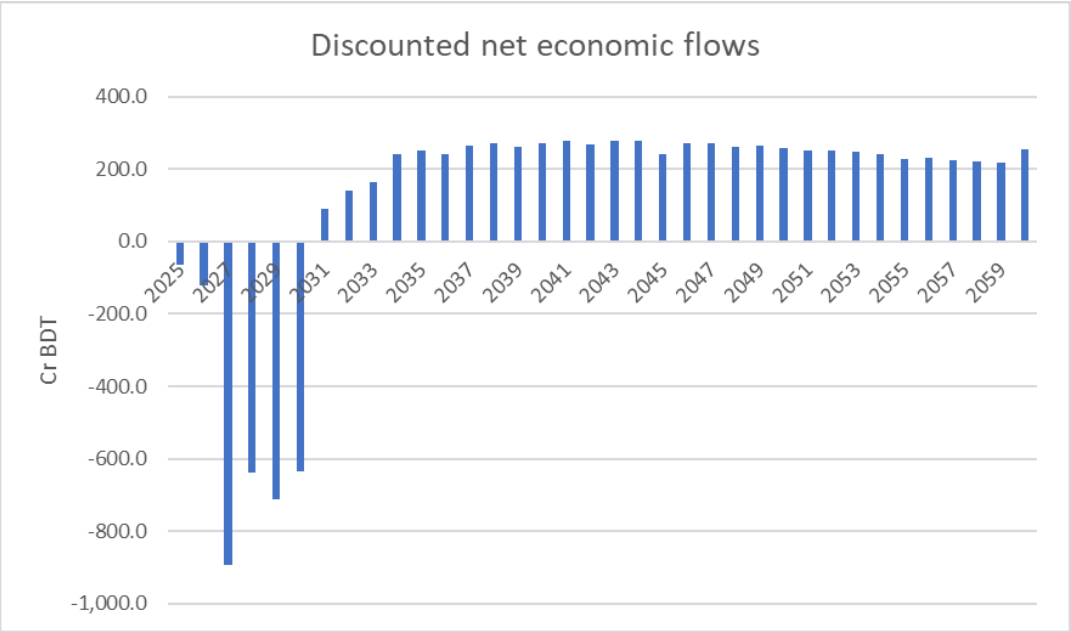


Figure 24. Discounted economic flows (Cr BDT).

(e) Mention the Assumption.

The base year for study projections has been set in 2025 (1st January) and the horizon year in 2062 (31st December)

- Total Investments period: 6 years (2025 – 2030)
- Total operations period: 30 years (2031 – 2060)

Since socioeconomic analysis is referred to the first year of operation, prices and costs initially estimated today (end of 2023) have been converted to 2025 applying the following inflation rates[4].

Table 25. Inflation considered.

Year	Inflation
2024	6.80 %

It is important to highlight the use of recent official estimation and forecasts for CPI figures in Bangladesh, for the period 2023 – 2025. The consultant has included in the economic and financial analysis the current situation of high inflation (9.0 % in 2023, and 6.8 % expected for 2024) which penalizes the budget for required capital expenses and therefore potential project returns.

At the same time the consultant has considered the possibility of a certain moderation in CAPEX automatic price increases (due to CPI forecasts) by the fact of permitting some competitive bidding element that would eventually generate incentive to contractors to present competitive offers to GoB.

[4] *https://www.imf.org/,International Monetary Fund, World Economic Outlook Database, October 2022*

The consultant has estimated the possibility of a relative price reduction of 2 % per year in Capital expenses prices. Therefore, total price capitalization would result in the following figures:

prices forecast impacts IN CAPEX (only in Capex!)		
general price increase	2023→2025	**6.80%**
price reduction (competitive bidding)		**2.00%** per year
Tot reduction		**4.80%**

Figure 25. CAPEX price capitalization 2023-2025.

The Values used for VoT in the model are clearly conservative values considering the different recent studies (ADB, JICA, etc.) and projects analysed in Bangladesh as well as other international references.

Table 26. Values for VoT.

Mode	VoT BDT/pass-h (2022)	VoT BDT/pass-h (2025)
Motorcycles	93.5 BDT/pass-h	101.85 BDT/pass-h
Light vehicles	104.5 BDT/pass-h	113.83 BDT/pass-h
Buses	82.5 BDT/pass-h	89.87 BDT/pass-h
Truck	3.85BDT/ton-h	4.19BDT/ton-h

Value of time is escalated by 4.50 % yearly. The value is obtained by applying some conservative real GDP per capita long run growth rate and assuming elasticity of 70 %.

This is the result of applying 70 % to 6.43 % that is the real GDP pc growth foreseen in 2024 according to data provided by Bangladesh bank to International Monetary Fund:

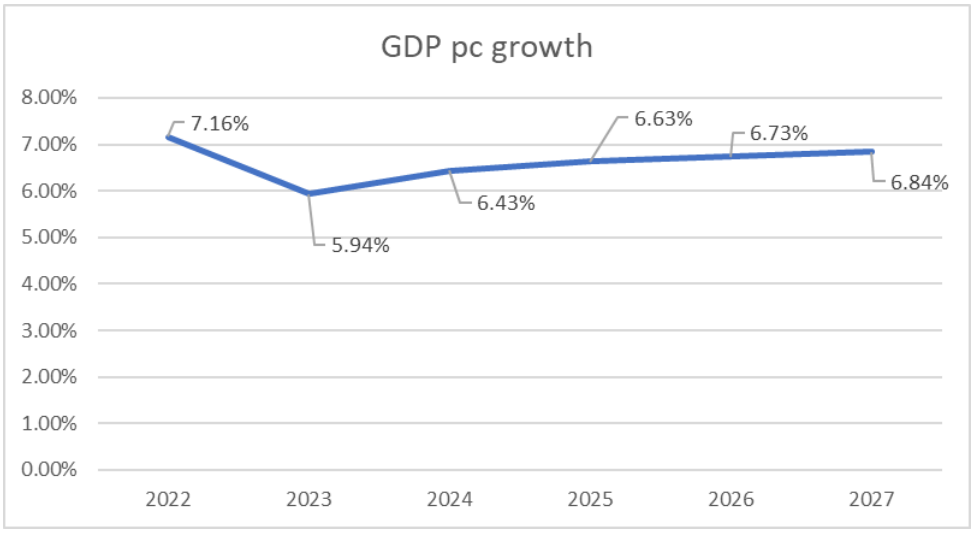


Figure 26. GDP per capita growth.
Source: International Monetary Fund, World Economic Outlook Database, April 2022

Vehicle Operating costs (VOC's) adopted were obtained in a case- by- case modal basis, undertaking a comparative study with cases mostly from Bangladesh, but also from India, or other international benchmarks references. In general, it has been adopted (likewise the adoption of figures for Value of Time) a quite conservative approach when selecting VOC values. The figures adopted are:

Table 27. Vehicle operating costs by mode.

Mode	BDT / veh – km (2022)	BDT / veh – km (2025)
Motorcycles	11.00	12.81
Light vehicles	15.40	17.94
Buses	33.00	38.43
Truck	44.00	51.24

It has been considered a reference of 12.00 % for the economic analysis is selected following the Memo no 20.804.014.00.00.014.027.18-177 sent by the Planning Division of the *Ministry of Planning*.

Residual value has been estimated according to traditional procedures and international best practices: EU Cost- Benefit handbook, ADB guidelines, World Bank, etc. More precisely a standard approach of estimating the amount of depreciation not computed in the analysis period (*net book value or remaining depreciation costs method) was adopted*. In general, the "Net Book Value" approach[5] is a less distorting approach compared with the alternatives.

(f) Compute the following indicators and interpret the results:

- Economic Net Present Value (ENPV)

The project Net Present Value has been estimated taking as reference the first year of the considered period (2025) when investments would start. **ENPV estimated in real terms would reach 4,161.38 Cr BDT, which is a positive economic result:** in economic terms **the benefits generated by the project outweigh the rise in costs, both in construction and operation of the bridge.**

In more precise economic terms: **potential social benefits, understood as what society is willing to pay to have access to the new bridge, are higher than social costs, or the group of goods and services to which society must renounce if it decides to implement the new bridge.**

- Economic Benefit Cost Ratio (EBCR) and Pay- Back Period (PBP)

Project benefit cost ratio reaches **2.96 (> 1.00)** indicating the positive economic value creation from the projection of economic discounted flows. Pay Back period it is estimated that the initial investments would be fully recovered by **2044.**

[5] *CBA handbook EU 2014, pages 34, 35*

- **Economic Internal Rate of Return (EIRR)**

Project Economic IRR was obtained from the economic flows estimated for each year in all scenarios. **The result is an E-IRR equal to 18.17 %.**

This figure is higher than the considered social rate of discount (12 %) or opportunity cost of capital, so t**he project could be considered as feasible (IRR >SRD and E-NPV positive).**

7.2. Financial Analysis

A financial analysis has been carried out to evaluate whether the bridge project could generate enough operating income above operating expenses, repay easily external funding and remunerate equity investors under market conditions.

The procurement alternatives considered in the financial analysis are the following ones:

- Traditional procurement or Public Project: The Government of Bangladesh ("GoB") oversees project implementation as well as of the operation and maintenance of the Bridge and related works. During operation period, GoB collects toll fares from users.
- PPP procurement or PPP Contract: A private PPP company oversees the construction, operation and maintenance of the Bridge and collects tolls from users. Should expected revenues are not enough to cover total project costs, GoB grants and equity (from Public Budgets) would be part of the funding to implement the Project, in addition to those funds provided by a combination of the PPP investors and banks term loans.

In the case of the PPP contracts, the government has designed by law a viability gap funding (VGF) to estimate the required grant to support projects that are economically feasible and necessary but financially unviable. The aim of VGF is to make commercially nonviable infrastructure projects attractive to private investor through PPP arrangement. But the VGF in the form of the capital grant or annuity or both shall not exceed 40 % of the total estimate project cost.

The approach to determining the most effective contract structure is as follows:

- Firstly, the project is analysed as a Public Project or Traditional Procurement, as more reasonable for this type of projects.
- Besides, the PPP contract alternative is analysed as it is typically more efficient to alleviate the use of GoB resources, and to shorten construction schedule.
- If the PPP contract is not viable on its own, the Viability Gap Funding ("VGF") needed to make it viable is calculated:
    - If it does not exceed 40 %, the PPP structure is considered viable.
    - If the VGF required exceeds 40 %, PPP structure is discarded.

(a) Components of cost & revenues

From the point of view of the revenues, the implementation of a user toll system is planned to minimize the budgetary resources from the GoB. The toll revenues should be used to cover the operation and maintenance expenses during the life of the Project as well as part of the initial investments,

considering the forecasted demand and the toll fares structure. Concerning the toll fares, four categories or vehicle classes have been considered: motorcycles, light vehicles, buses and trucks.

(b) Cost & revenues in monetary value

Costs are presented in monetary values, starting by the initial investments and, secondly, by operation and maintenance expenses.

Table 28. Investment budget.

Investment budget (VAT included)	Cr BDT (2024)	Cr BDT (2025)
General and Site facilities	249.8	261.8
Main Bridge	2,588.3	2,712.5
Approach Bridges and Connection Bridge	487.5	510.9
Approach Road including small structures	824.8	864.4
Toll plaza & CCB	542.4	568.4
Bank protection work	2,100.3	2,201.1
Land acquisition and Resettlement costs	2,794.6	2,928.8
Design costs	135.9	142.4
Supervision costs	339.7	356.0
Contingencies	623.6	653.5
CAPEX	10,686.9	11,199.9

The following table shows the detail of the sources and application of funds:

Table 29. Sources and application of funds year by year. PPP contract structure.

Sources & Application of Funds (Cr BDT)	2025	2026	2027	2028	2029	2030
Government grants	2,206	3,309	27,574	22,059	27,574	27,574
Private equity	640	7	423	662	1,251	1,723
Long term financing resources (debt)	1,921	21	1,269	1,985	3,752	5,169
Investments	2,119	3,337	29,196	24,524	32,188	33,798
Other initial costs (capitalized interests)	2,648	0	70	181	389	669
Total	4,767	3,337	29,266	24,706	32,577	34,467

Table 30. Operating expenses.

Operating expenses (VAT included)	Cr BDT / year
Operation	7.50
Overall expenses. Company structure	5.00

The resulting ordinary and extraordinary maintenance amount per year is shown in the following table:

Table 31. Maintenance expenses. Amount per year.

Maintenance (Cr BDT. VAT included)	Investment	Maintenance / year
Main bridge	2,523	42.1
Approaching viaducts	475	6.7
Approaching roads	804	12.9
Bank protection and river training	2,048	81.9
Toll Plaza	529	13.4
Total		156.87

Once detailed de project costs, the revenues are detailed. They come from the tolls to users and are projected in four categories of vehicles, as shown in the following chart:

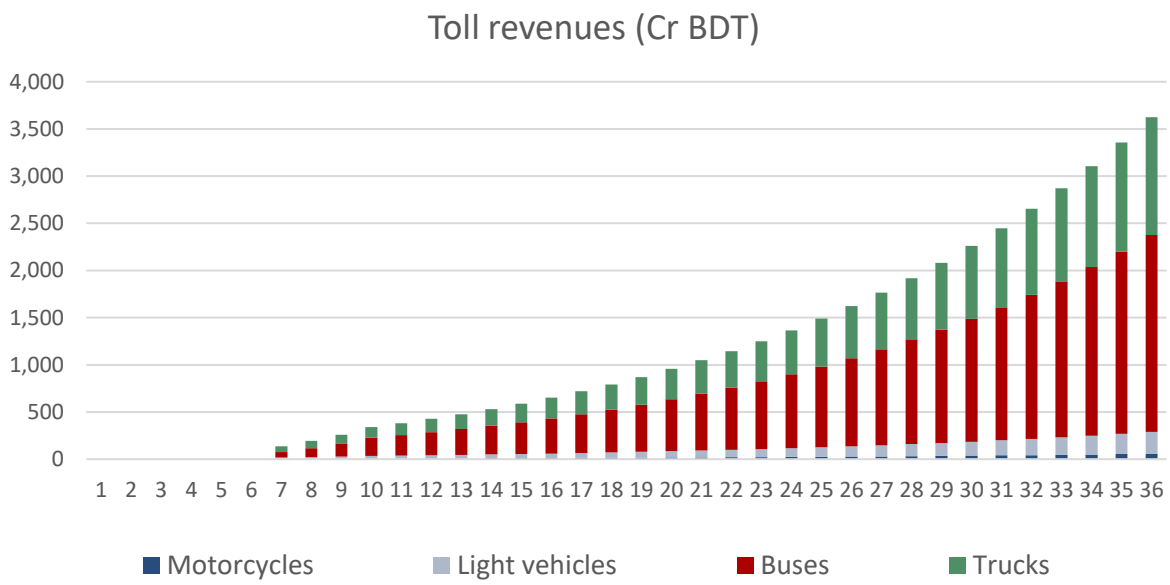


Figure 27. Toll revenues.

Despite of the number of vehicles projected, the toll revenues have different impacts on the Project cash flows: both buses and trucks are the most important classes, representing together over 90 % of total revenues, being buses almost 60 %.

(c) Cash flow

The following tables show the 36 years of projected cash flows during the period of analysis for both contract alternatives: Public Project and PPP Contract, respectively. Notice that the cash flow projections include the construction period, the first two years of operation and every five years of the operation period:

Table 32. Project cash flows. Public Project or Traditional procurement.

CASH FLOWS (Cr BDT)	2025 Year 1	2026 Year 2	2027 Year 3	2028 Year 4	2029 Year 5	2030 Year 6	2031 Year 7	2034 Year 10	2039 Year 15	2044 Year 20	2049 Year 25	2054 Year 30	2059 Year 35	2060 Year 36
Operating revenues	**0**	**0**	**0**	**0**	**0**	**0**	**138**	**339**	**589**	**957**	**1,489**	**2,259**	**3,356**	**3,624**
Toll revenues	0	0	0	0	0	0	138	339	589	957	1,489	2,259	3,356	3,624
Other commercial revenues	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Operation & Maintenance expenses	**0**	**0**	**0**	**0**	**0**	**0**	**-140**	**-162**	**-468**	**-263**	**-336**	**-972**	**-547**	**-1,702**
Maintenance & Overhaul	0	0	0	0	0	0	-129	-149	-452	-243	-310	-940	-506	-1,658
Operation	0	0	0	0	0	0	-11	-12	-16	-20	-25	-32	-41	-43
Net Cash Flows due to Operations	**0**	**0**	**0**	**0**	**0**	**0**	**-2**	**177**	**121**	**694**	**1,153**	**1,287**	**2,809**	**1,922**
Cash Flows due to Investments	**-446**	**-363**	**-3,153**	**-2,707**	**-3,581**	**-3,819**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**458**
Initial CAPEX	-446	-363	-3,153	-2,707	-3,581	-3,819	0	0	0	0	0	0	0	0
Other CAPEX	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residual Value of Investments	0	0	0	0	0	0	0	0	0	0	0	0	0	458
Project cash flows	**-446**	**-363**	**-3,153**	**-2,707**	**-3,581**	**-3,819**	**-2**	**177**	**121**	**694**	**1,153**	**1,287**	**2,809**	**2,380**

CASH FLOWS (Cr BDT)	2025 Year 1	2026 Year 2	2027 Year 3	2028 Year 4	2029 Year 5	2030 Year 6	2031 Year 7	2034 Year 10	2039 Year 15	2044 Year 20	2049 Year 25	2054 Year 30	2059 Year 35	2060 Year 36
Outflows	**-446**	**-363**	**-3,153**	**-2,707**	**-3,581**	**-3,819**	**-876**	**-860**	**-1,102**	**-834**	**-844**	**-1,417**	**-928**	**-1,613**
Project Development (Initial CAPE	-224	-353	-3,087	-2,593	-3,403	-3,574	0	0	0	0	0	0	0	458
Financing Fees	-222	-10	-66	-114	-178	-246	0	0	0	0	0	0	0	0
Operating expenses	0	0	0	0	0	0	-140	-162	-468	-263	-336	-972	-547	-1,702
Loan Repayments														
Interest	0	0	0	0	0	0	-374	-336	-273	-209	-146	-83	-19	-6
Principal Repayments	0	0	0	0	0	0	-362	-362	-362	-362	-362	-362	-362	-362
Inflows	**382**	**267**	**2,352**	**2,066**	**2,780**	**3,018**	**138**	**339**	**589**	**957**	**1,489**	**2,259**	**3,356**	**3,624**
Borrowings	382	267	2,352	2,066	2,780	3,018	0	0	0	0	0	0	0	0
Operating revenues	0	0	0	0	0	0	138	339	589	957	1,489	2,259	3,356	3,624
Future Developments	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GoB net cash flows (FIRR / FNPV)	**-64**	**-96**	**-802**	**-641**	**-802**	**-802**	**-738**	**-521**	**-514**	**123**	**645**	**842**	**2,427**	**2,011**

Table 33. Project cash flows. PPP Contract.

CASH FLOWS (Cr BDT)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 10	Year 15	Year 20	Year 25	Year 30	Year 35	Year 36
Operating revenues	**0**	**0**	**0**	**0**	**0**	**0**	**138**	**339**	**589**	**957**	**1,489**	**2,259**	**3,356**	**3,624**
Toll revenues	0	0	0	0	0	0	138	339	589	957	1,489	2,259	3,356	3,624
Other revenues	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public contributions	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Availability payment	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Operating subsidy	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Operating expenses	**0**	**0**	**0**	**0**	**0**	**0**	**-138**	**-159**	**-446**	**-259**	**-331**	**-928**	**-539**	**-1,615**
Maintenance	0	0	0	0	0	0	-120	-139	-421	-226	-289	-874	-470	-1,543
Operation	0	0	0	0	0	0	-11	-12	-16	-20	-25	-32	-41	-43
SPV Structure	0	0	0	0	0	0	-7	-8	-10	-13	-17	-22	-28	-29
Corporate tax	0	0	0	0	0	0	0	0	0	-75	-274	-326	-741	-519
EBITDA	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**179**	**142**	**623**	**884**	**1,005**	**2,076**	**1,490**
Investments	**-477**	**-334**	**-2,927**	**-2,471**	**-3,258**	**-3,447**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Initial CAPEX	-477	-334	-2,927	-2,471	-3,258	-3,447	0	0	0	0	0	0	0	0
Other CAPEX	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Project cash flows	**-477**	**-334**	**-2,927**	**-2,471**	**-3,258**	**-3,447**	**0**	**179**	**142**	**623**	**884**	**1,005**	**2,076**	**1,490**
Public Contributions	**221**	**331**	**2,757**	**2,206**	**2,757**	**2,757**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Government capital contributions	110	165	1,379	1,103	1,379	1,379	0	0	0	0	0	0	0	0
Multilateral capital contributions	110	165	1,379	1,103	1,379	1,379	0	0	0	0	0	0	0	0
Project cash flows (after contributions)	**-256**	**-3**	**-169**	**-265**	**-500**	**-689**	**0**	**179**	**142**	**623**	**884**	**1,005**	**2,076**	**1,490**
Funding	**256**	**3**	**169**	**265**	**500**	**689**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Equity	64	1	42	66	125	172	0	0	0	0	0	0	0	0
Multilateral term loan	192	2	127	198	375	517	0	0	0	0	0	0	0	0
Cash flow before debt service (multilateral)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**179**	**142**	**623**	**884**	**1,005**	**2,076**	**1,490**
Debt service. Multilateral term loan	**0**	**0**	**0**	**0**	**0**	**0**	**-85**	**-138**	**-109**	**0**	**0**	**0**	**0**	**0**
Interest	0	0	0	0	0	0	-85	-83	-53	0	0	0	0	0
Debt repayment	0	0	0	0	0	0	0	-55	-56	0	0	0	0	0
Cash flow after debt service (multilateral)	**0**	**0**	**0**	**0**	**0**	**0**	**-85**	**41**	**33**	**623**	**884**	**1,005**	**2,076**	**1,490**
Commercial banks credit line. Drawdowns	0	0	0	0	0	0	85	0	0	0	0	0	0	0
Cash flow before debt service (commercial)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**41**	**33**	**623**	**884**	**1,005**	**2,076**	**1,490**
Debt service. Commercial term loan	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-32**	**-25**	**0**	**0**	**0**	**0**	**0**
Interest	0	0	0	0	0	0	0	-17	-12	0	0	0	0	0
Debt repayment	0	0	0	0	0	0	0	-15	-13	0	0	0	0	0
Free cash flows	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**8**	**623**	**884**	**1,005**	**2,076**	**1,490**
Dividends	0	0	0	0	0	0	0	0	0	0	-722	-858	-1,953	-1,490
Annual cash	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**8**	**623**	**162**	**147**	**123**	**0**
Initial cash balance	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-12**	**27**	**561**	**1,891**	**2,657**	**3,319**	**3,442**
Cash movements of the year	0	0	0	0	0	0	0	10	8	623	162	147	123	0
Ending cash balance	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-3**	**35**	**1,184**	**2,053**	**2,804**	**3,442**	**3,442**

The projected CF of the above table, as well as in the following chart, can be classified in two periods: investment CF during the construction period and operating cash flows (EBITDA) during the operation period. The resulting Project CF are negative during the construction period, because the annual investment costs are higher than annual capital grants, while positive during the operation period:

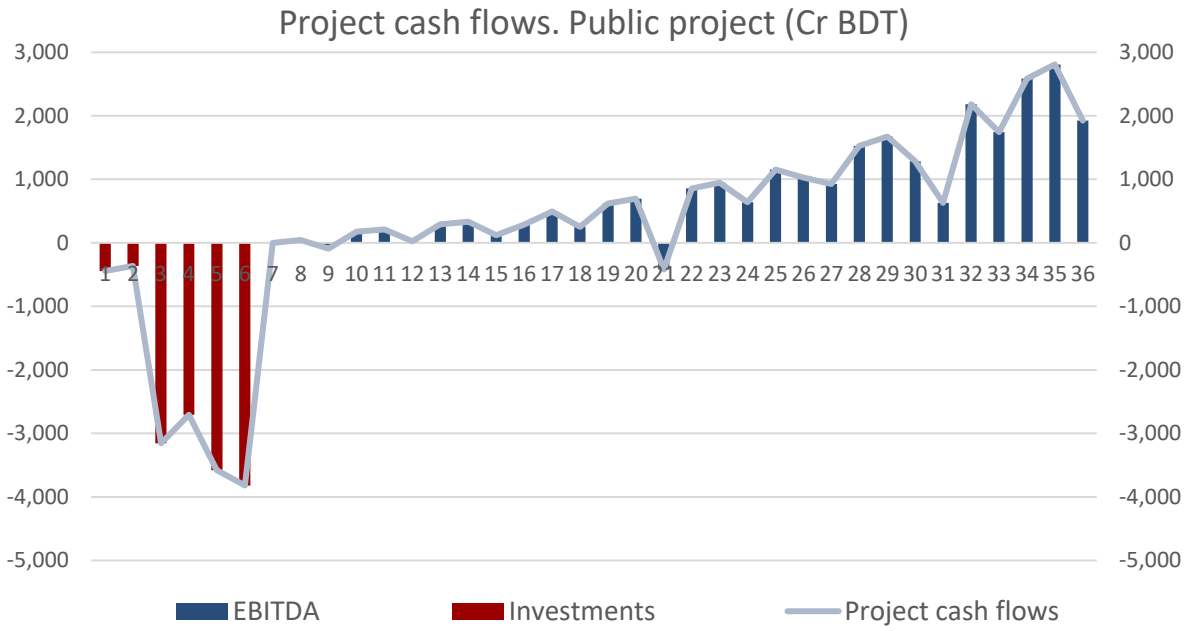


Figure 28. Projected cash flows. PPP Contract.

As above mentioned, first years represent the investment period, with cash outflows and negative project cash flows; these cash outflows represent the amount of investments. From year 7 to year 12, EBITDA is not high even with a negative value in year 9. Since year 13, EBITDA becomes positive, with operating revenues higher than operating expenses, generating positive project cash flows (right-hand vertical axel of the above figure) during the remaining period of analysis, except in year 21 (year 15th of operation), with negative EBITDA when certain extraordinary maintenance costs are considered.

(d) Key Assumptions considered.

Table 34. General assumptions. Macroeconomic assumptions.

General assumptions	
Inflation rate	5.00 %
Financial Discount Rate (Project). WACC	12.0 % [6]
Exchange rate USD / BDT	110

[6] *Nonetheless, in case of a traditional procurement (Public Project scheme) there are no private funds whereas the institutional funds (multilateral funds) complete funds from the GoB (budgetary contributions).*

Following Government regulation[7], financial discount rate ("FDR") is fixed at 12.00 %. It would be used as a financial discount rate to estimate the financial indicators in the financial analysis of all contract structures. Considering that the average FDR being used in this analysis is 12.00 %, a reasonable estimation of the cost of equity for investors could be around 16.00 %.

Table 35. General assumptions. Terms related to assumptions.

Terms	Years
Analysis	36
Construction period (including Detail design)	6
Operation	30
Base year for analysis	2025
Starting year of operations	2031

Maintenance expenses have been estimated as an annual percentage over the respective investment amount, for ordinary maintenance. In the case of extraordinary maintenance, a percentage over the respective investment amount has been calculated every certain period, as detailed in the following table:

Table 36. Maintenance expenses. Assumptions.

Maintenance expenses	Over CAPEX
Main bridge	
Ordinary	1.0 %
Extraordinary (years 15, 25, 35, 45...)	10.0 %
Approaching viaducts	
Ordinary	1.0 %
Extraordinary (years 10, 20, 30, 40...)	4.0 %
Approaching roads	
Ordinary	1.0 %
Extraordinary (years 10, 20, 30, 40...)	6.0 %
Bank protection and river training	
Ordinary	2.0 %
Extraordinary (every three years)	6.0 %
Toll plaza	
Ordinary	2.0 %
Extraordinary (years 15, 25, 35, 45...)	8.0 %

7 Memo no 20.804.014.00.00.014.027.18-177, dated 04/09/2018

From the point of view of the revenues, the assumptions considered are those related to the demand projections as well as the toll rates, as described below:

Table 37. Toll fares structure.

Toll rates (BDT)	BDT (with VAT 2023)	BDT (w/o VAT 2023)	BDT (w/o VAT 2025)
Motorcycles	25.00	21.74	24.61
Light vehicles	200.00	173.91	196.88
Buses	500.00	434.78	492.21
Trucks	800.00	695.65	787.53

In the alternative of Public Project, GoB would provide funds (grants) to the project company during implementation period. The remaining funding would be provided to the project company by the private investors, as private equity (share capital), and as long-term financing (from multilateral and commercial banks) in the typical 25 %/75 % structure, respectively, of project financing.

(e) Financial indicators and results:

Above cash flows generate the following financial indicators for the Project,

(i) Public Project or Traditional procurement

The following table shows the financial indicators for the Traditional procurement structure:

Table 38. Financial results. Traditional procurement.

FINANCIAL RESULTS	After Grants
Project F-IRR (unlevered)	2.49 %
Project F-NPV (@ 12.0 %). Cr BDT	-8,190.76
GoB F-IRR (levered)	2.09 %
GoB net contributions (@12.0 %). Cr BDT	-3,293.41
Financial Benefit-Cost ratio	0.27 x

As detailed in the table above, the Project cash flows after GoB contributions would generate a positive Project FIRR of 2.49 %, with a FNPV of -8,190.76 Cr BDT. Total net GoB contribution to the Project, in discounted BDT is estimated in 3,293.41 Cr BDT. As a conclusion, the Project does not reach the target financial values considering the FDR of 12.00 %.

(ii) PPP Contract

The following table shows the financial indicators for the PPP Contract structure:

Table 39. Financial results. PPP Contract.

FINANCIAL RESULTS	Bf Grants	After Grants
F-IRR. Project	1.90 %	12.00 %
NPV (@ 12.0 %). Cr BDT	-6,786.98	0.0
GoB Grants required. Cr BDT		11,029.72
VGF (% over total Project costs)		52.22 %
F-IRR. Investors		14.68 %
NPV (@ Ke %). Cr BDT		-59 .37
Term of multilateral loan (drawdown + repayment)		19 years
DSCR. Minimum		1.30x
DSCR. Average		1.66 x

As shown in the above table, results before and after grants have different values because of the capital grants. Both FIRR and FNPV for the project after capital grants are positive and they show that the feasibility of the Project would be reached with 11,030 Cr BDT of GoB grants, representing a VGF of 52.22 %, higher than the maximum 40 % limit by law. As a conclusion, the Project cannot be recommended to be implemented through a PPP scheme.

(iii) Value for Money (VfM)

The VfM involves estimating the net cost to the GOB of implementing and operating the project in two alternative processes:

- Alternative A: the Project is developed as a public project with the resulting CAPEX and OPEX payments by the BBA as well as the corresponding toll revenues to be collected.
- Alternative B: the Project is developed as a PPP contract, with the resulting VGF payments by the BBA. In this case, neither CAPEX nor OPEX are costs for the GoB, but for the PPP project company. Furthermore, the operating revenues from tolls are also revenues from the PPP project company rather than GoB revenues.

Again, as shown in the above table, results before and after grants have different values because of the capital grants. Results before grants are clearly not sustainable. FNPV for the project after capital grants is positive and shows that the feasibility of the Project is reached with 11,030 Cr BDT of GoB grants.

Results generated by VfM analysis are shown in the following figure and table:

Net cost to BBA under PPP (Cr BDT)	=	P.V. of CAPEX by BBA	+	P.V. of OPEX by BBA	-	P.V. of Revenue to BBA	+	VGF	+	P.V. of risks retained by BBA
7,915	=	0	+	0	-	0	+	7,601	+	314

Net cost to BBA for not doing PPP (Cr BDT)	=	P.V. of CAPEX by BBA	+	P.V. of OPEX by BBA	-	P.V. of Revenue to BBA	+	P.V. of risks retained by BBA
5,520	=	9,654	+	1,501	-	8,500	+	2,866

Net benefit of BBA in case of PPP (Cr BDT)	=	Net cost to BBA for not doing PPP (Cr BDT)	-	Net cost to BBA under PPP (Cr BDT)
-2,395	=	5,520	-	7,915

Figure 29. Value for Money process of calculation.

Results of the above chart are summarised in the following table.

Table 40. Value for Money results.

Total costs (NOT including cost of risks)	Cr BDT
[1] 'Net costs to BBA (Traditional procurement)	5,520
[2] Net costs to BBA (PPP Contract)	7,915
Net benefit of BBA in case of PPP ([3] = [1] - [2])	-2,395
Net benefit of BBA / Total CAPEX (= [3] / CAPEX)	-24.81 %

The above table shows that there is not a potential benefit for the GoB in case the Project is implemented through a PPP contract, estimated a potential loss of -2,395 Cr BDT (equivalent to 24.81 % of CAPEX) despite most of the risks would be assigned to the private partner. This difference means that, in case the Project is implemented because of VGF maximum limit is not reached, even then it should not be convenient for the GoB to implement it as a PPP Contract.

(iv) Factors of potential financial improvement

Even though the Project shows financial results that indicate that it is not financially viable, there are a number of factors that may have a positive influence on such indicators and, therefore, could facilitate financial viability. These factors have been classified into two types: endogenous and exogenous.

- Endogenous factors: One of the most relevant factors is the tax treatment of the Project, which could favour its profitability. Furthermore, other endogenous factors of the Project are potential activities to be operated by the tolled bridge operator itself, such as service areas, parking areas (mainly for truck and buses), etc.
- Exogenous factors: These factors are mainly related to the economic development of towns and poles in the Project's area of influence, which would favour the movement of people and goods and, therefore, increase the demand for the use of the Bridge.

Recapping, the main conclusions arisen from the financial assessment are the following ones:

- The projected demand is mainly coming from buses, that are expected to generate almost 60 % of total toll revenues.
- Operating expenses come mainly from maintenance of the infrastructure and installations, with several years of particularly high extraordinary maintenance costs (year 15 of operation).
- Operating result (EBITDA) is expected to be positive and growing during the period of analysis, with several years of reduced EBITDA due to the high extraordinary maintenance costs (year 15 of operation).
- Financial indicators, with the Public Project contract structure, show a Project with a positive FIRR of 2.49 %, which is lower the FDR (12.00 %), representing that the total net GoB contributions to the Project during the period analysed are 3,293.41 Cr BDT.
- The Project requires significative GoB grants to reach the target FDR of 12.00 % in case of PPP Contract, amounting 11,030 Cr BDT, which represents 52.22 % of total project costs.
- The financial analysis with the PPP Contract structure, including the GoB grant, shows positive financial indicators. 12.00 % FIRR of the project (unlevered) and 14.68 % FIRR for investors, being lower than the target opportunity cost for investors IRR of 16.00 %. The high amount of investments of the Project and not so high levels of demand, despite the positive EBITDA series, require capital grants (VGF) to reduce the net investment cost and to make the Project feasible, as above mentioned, amounting 11,030 Cr BDT, which represents 52.22 % of total project costs.
- Such estimated VGF is higher than the maximum of 40 % set up by law for PPP Contract structures and so, the PPP Contract structure cannot be recommended to be implemented via PPE scheme according to the VGF regulations.
- VfM analysis does not generate a potential benefit for the GoB in case the Project is implemented through a PPP contract, estimated in a potential loss of -2,395 Cr (equivalent to -24.81 % of CAPEX). This negative benefit would not recommend implementing and operating the Project under a PPP contract structure should the VGF rule is accomplished.
- There are several factors that could make the project more attractive to private investors by increasing the economic activity in the zone and, consequently, increasing the demand of the tolled bridge Besides, there are fiscal issues which could increase Project's profitability.

8. INSTITUTIONAL AND LEGAL ANALYSIS

When addressing the approach considerations for a specific procurement strategy plan, the following aspects of a project need to be carefully examined:

- Expediting the procurement process is a key aspect.
- Cost Uncertainty: Rates and construction cost estimate certainty is a challenging matter given today the current global macro-economic environment of high inflation and raw materials scarcity. In any case during the forecasting stages of the financial model implemented it has been taken into consideration this abnormal level of prices increases.
- Time certainty for completion of the project (Client and the Contractor/Concessionaire). Minimum time over-run should be a key fact to be considered within the type of contract being implemented. Schedule constraints and responsibility to be very well determined in the type of contract (delay damages/penalty clauses).
- Design aspects: the Detailed Design to be provided by the BBA to the awarded contractor. The Ability to contractually cope and to technically accommodate design changes in the final set of shop drawings at construction phase shall be considered within the type of contract.
- Responsibility: throughout the project's life, each party's accountability must be very critically stipulated within the contract documents.
- Complexity: Client may involve a specific innovative component to be executed or finally design. The option of awarding the project to a joint venture, led by a top worldwide international contractor together with domestic subcontractors for some sections of the project is a recommended.
- Quality Assurance: Client may involve an independent agency to regulate and monitor Quality Controls during execution and maintenance of work.
- Risk Allocation: Clearly defined areas of risk allocation, a thorough risk assessment to be implemented before tendering the project. Main risks could be considered the following ones: construction risks (cost or time overrun risk, geotechnical risk) and demand risk.

From financial perspective, the project cannot reach by itself operating or financial sustainability, which leads to a strong problem of credit solvency, requiring therefore an important support from GoB. But the high level of required grant (VGF higher than the limit 40 %) leads one to not to recommend a toll-based PPP Concession Agreement.

A simple Government Contract following open international bidding process for construction and a year of maintenance is recommended to be adopted. After the completion of works, mandatory maintenance period of 1-2 years. BBA to decide. Demand risk should be retained by the Government to avoid that this relevant risk implies a high additional cost in case it is transferred to a private operator.

The classic risk sharing format for such a contract shall be as follows.

Table 41. Risk sharing format

BBA-Government	EPC-Contractor
Arrange for funding	Design review and proof checking
Land Acquisition	Construction and timely completion
Open bidding process and contract award for Construction and Long-term maintenance and toll collection	Maintenance for a period of 1-2 years

It is recommended that BBA may opt for a FIDIC Multilateral Development Bank Harmonized (MDB) Edition (June 2010) for General and Particular Conditions of Contract as it opts for open bidding and Contract Award process.

Two main factors must not be overlooked while preparing the bidding documents.

1. Proof checking of structural design by an independent consultant selected by the BBA/ Government.
2. The successful bidder shall carry out his own Geo Technical investigation to confirm the accuracy of the data furnished in the feasibility studies. Design work to proceed only after such confirmation in writing by the successful bidder.

BBA may provide a supervision consultant to ensure monitoring of the quality, progress, and cost of the project during construction.

9. CONCLUSION

9.1. General

The essential purpose of any public investment is to foster socio-economic development and growth. In this regard, a feasibility study assesses a plan, a proposal for an intended future condition considering social and economic activities, their locations and linkages, and the development of essential land, structures and other components.

Viewed from the implementation standpoint and as a summarizing outcome derived from this feasibility study, considering all technical, social, and environmental standpoints, it may be concluded that the project, located at Munshiganj district, consisting of the 2,42 km long bridge, crossing the upper Meghna River at the selected alignment B, through the designed cable-stayed combined with composite bridge and a series of other needed associated components would be technically and socially viable. Financial implementation scheme shall be particularly assessed and decided by the Promoting agency, following the considerations derived from this study and the best strategy adopted aiming to optimize the process and the benefit for the country.

The Consultant recommends this project to be implemented by the BBA, as it would provide sound social and economic progress and benefits to the population living in the directly related areas. Undoubtedly, the project would also foster and enhance potential connectivity corridors, as it is the case of the East-West connection.

The regional connectivity enhanced by the bridge would soundly improve. If the proposed bridge is built, the people from more than 22 districts in Dhaka, Khulna, and Barishal divisions would benefit. As Dhaka and Narayanganj are densely populated areas with heavy traffic congestion, the new bridge could serve as an alternative route, helping to reduce traffic bottlenecks and improve overall transportation efficiency. It would not only boost the growth of the agriculture and industry sector in those areas, but also directly connect the two most important ports of the country, Chattogram and Mongla, and the Munshiganj industrial zone with rest of the country.

Any project, however, must be approached with careful planning, considering various aspects such as environmental impact, infrastructure investment, and social implications. Engaging with local communities and stakeholders during the planning and implementation stages is essential for the success of such a project.

Environmental assessment has been carried out accordingly with the current DOE guidelines and recommendations, being the project under red category, and its risks would be duly mitigated through the implementation of the proper Environmental Impact Assessment (EIA) and Environmental management Plan (EMP) during the construction phase.

Social safeguard aspects have been assessed following the current legislation and guidelines, and the project impact, that would require resettlement of part of the affected areas, would be mitigated to the implementation of the Social Impact Assessment Action Plan. Consultation to the community of the affected area was carried out with a positive response from both local authorities and population.

9.2. Main Alignment Option - Conclusion

In the main alignment option, the proposed bridge over the Meghna River would connect the point near Fuldi River bridge project end point (west side) in Gazaria to the Z1821 Road in Munshiganj.

The proposed technical solution for the bridge over the Meghna River is based on:

Cable Stayed Bridge with span arrangement 225-450-225 along with a **Composite Bridge** 100 m span. The accessing spans are designed with 40 m I girders. The total length of the main bridge including access spans is **2.42 km**. The project total length is **6.60 km.**

The completion of this project construction has been estimated in 48 months. After 6 years of investment phase (2025 to 2030), operation phase would start in 2031, ending in 2060 (30 years).

The estimated cost investment is **10,686.90 Cr BDT**. The traffic studies forecast for the final year of operation (2060) is estimated as **46,372 vehicles** (3 wheelers are precluded from the study). Economic Cost-Benefit Analysis (CBA) has been assessed running the traffic scenario, obtaining the following results: **EIRR 18.17 %, C/B ratio 2.96** and **pay-back year 2044.**

The financial indicators, in the case of Public Project scheme, show a FIRR **of 2.49 %.** GoB total net contributions are estimated in 3,293.41 Cr BDT during the life of the Project.

The project cannot be recommended to be implemented under a PPP structure as it would require a grant of 11,030 Cr BDT, which represents 52.22 % of project costs. This level of required grant (or VGF) exceeds the limit of 40 % set up by law for PPP contract structures.

The project impact on the national GDP during the period of operation has been assessed as 0.50 %.

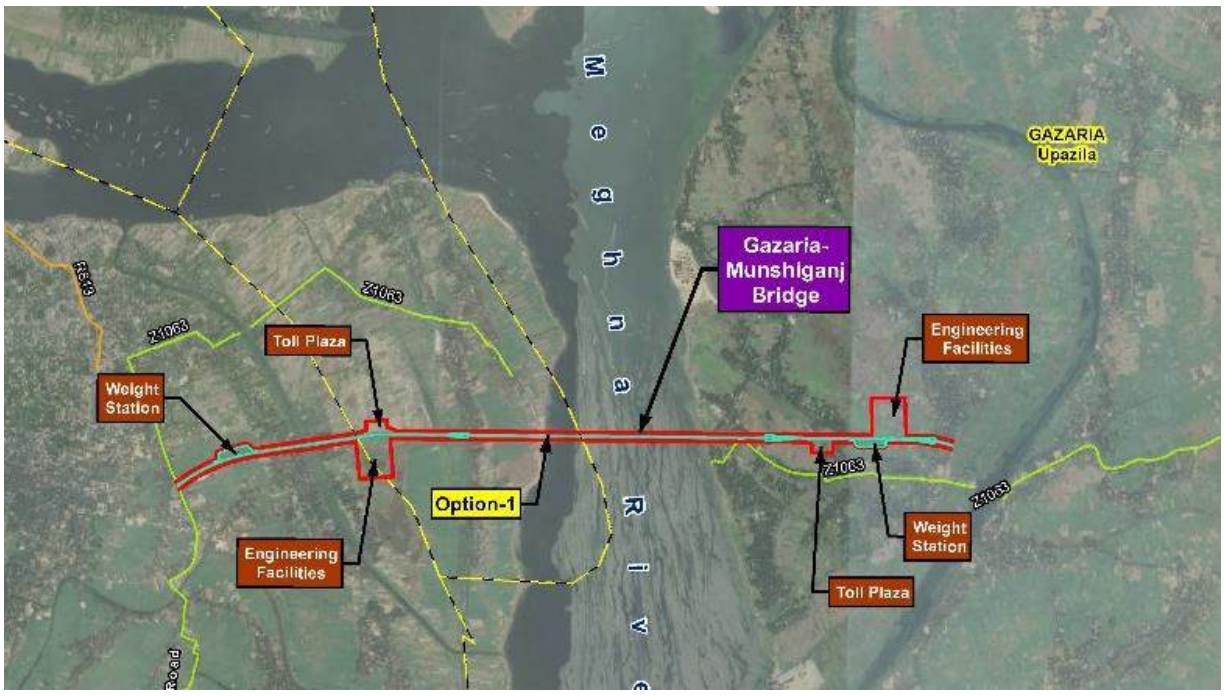


Figure 30. General view of the FS under analysis main option.

9.3. Alternative Option (Appendix) - Conclusion

Additionally, an alternative option has been studied (included within the Appendix No. 01) that would connect the Matlab Uttar-Gazaria Bridge project at Gazaria side with Hatimara Point on Mawa to Munshiganj Highway (R812) through an approach road from Char Kishorganj ferry-ghat in the west bank of Meghna River. The bridge crossing the Fuldi Riber is also included withon this studied option.

This alternative option would require appropriate coordination with RHD, for the Fuldi River Bridge project and for a proper coordination regarding the link with the Matlab Uttar-Gazaria Bridge project.

The proposed technical solution for the bridge over the Meghna River is based on:

Cable Stayed Bridge with span arrangement 225-450-225 and a **Composite Bridge** with 100 m span. The approach spans are designed with 40 m I girders. The Fuldi River crossing has been pre-designed with a **Balance Cantilever Bridge** solution.

The **total length** of the **main bridge over the Meghna River,** including access spans, is **2.42 km** plus 890 m of the Fuldi River Bridge. The **project total length** for this option is **22.00 km**. requiring also an additional improvement of 3.8 km of the Matlab Uttar-Gazaria Bridge project connecting road to N1.

The completion of this project construction has been estimated in 48 months. After 6 years of investment phase (2025 to 2030), operation phase would start in 2031, ending in 2060 (30 years).

The estimated cost investment is **16,662.81 Cr BDT**. The traffic studies forecast for the final year of operation (2060) is estimated as **54,319 vehicles** (3 wheelers are precluded from the study). Economic Cost-Benefit Analysis (CBA) has been assessed running the traffic scenario. The results obtained from the economic model are as follows: **EIRR 15.89 %, C/B ratio 1.99** and **pay-back year 2048.**

The financial analysis indicators, in the case of Public Project contract structure, show a Project with a **FIRR -0.17 %.** Net GoB total contributions in the Public Project structure are estimated in 5,557 Cr BDT during the life of the Project.

The project cannot be recommended to be implemented under a PPP structure as it would require a grant of 18,615Cr BDT, which represents 63.47 % of project costs. This level of required grant (or VGF) exceeds the limit of 40 % set up by law for PPP contract structures

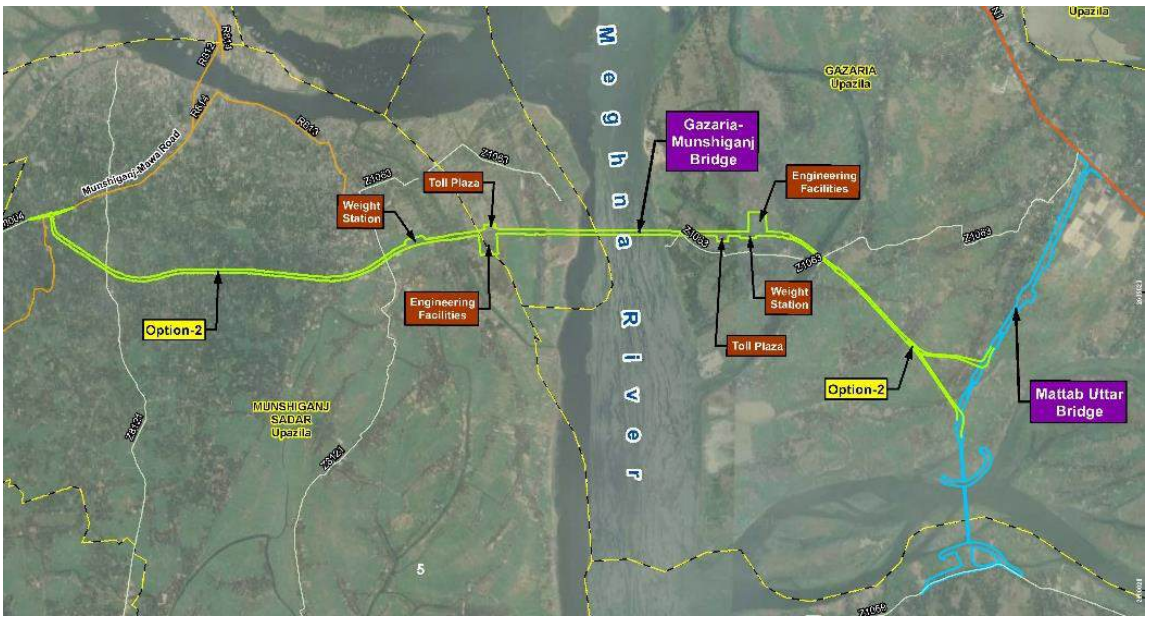


Figure 31. General view of the FS under analysis alternative option.

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Annexure 01 – Economic and Financial Model Calculation Sheets

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Economic Analysis

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CBA

FINAL FEASIBILITY STUDY REPORT FOR CONSTRUCTION OF BRIDGE OVER THE RIVER MEGHNA ON GAZARIA-MUNSHIGANJ ROAD		2025 Year 1	2026 Year 2	2027 Year 3	2028 Year 4	2029 Year 5
SOCIO ECONOMIC BENEFITS (Cr BDT)	**NPV**					
Change in Consumer Surplus	**7,211.66**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Existing traffic	**3,315.14**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
User passenger time savings	3,269.65	0.00	0.00	0.00	0.00	0.00
User freight time savings	62.86	0.00	0.00	0.00	0.00	0.00
Vehicle Operating Costs (VOC) savings	-17.37	0.00	0.00	0.00	0.00	0.00
Diverted traffic	**3,387.61**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
User passenger time savings	2,760.71	0.00	0.00	0.00	0.00	0.00
User freight time savings	7.23	0.00	0.00	0.00	0.00	0.00
Vehicle Operating Costs (VOC) savings	619.67	0.00	0.00	0.00	0.00	0.00
Generated traffic	**508.91**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
User time costs savings	503.89	0.00	0.00	0.00	0.00	0.00
User freight time savings	3.15	0.00	0.00	0.00	0.00	0.00
Additional Vehicle Operating Costs (VOC)	1.87	0.00	0.00	0.00	0.00	0.00
Variation in Externalities	**-926.78**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Accidents	-648.95	0.00	0.00	0.00	0.00	0.00
Emissions	-239.25	0.00	0.00	0.00	0.00	0.00
Air polution	-131.92	0.00	0.00	0.00	0.00	0.00
Climate change	-107.33	0.00	0.00	0.00	0.00	0.00
Well to tank	-38.58	0.00	0.00	0.00	0.00	0.00
TOTAL ECONOMIC BENEFITS (Cr BDT)	**6,284.89**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
SOCIO ECONOMIC COSTS (Cr BDT)						
Project initial investments	**-3,065.34**	**-64.07**	**-134.55**	**-1,121.25**	**-897.00**	**-1,121.25**
Residual value	**44.22**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Renovation works	**-346.62**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Change in Producer Surplus:	**1,244.23**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Producers costs savings for the system	1,166.63	0.00	0.00	0.00	0.00	0.00
Existing traffic	214.27	0.00	0.00	0.00	0.00	0.00
Diverted traffic	952.36	0.00	0.00	0.00	0.00	0.00
Toll revenues (generated traffic)	103.67	0.00	0.00	0.00	0.00	0.00
Vehicle Op costs (generated traffic)	-26.07	0.00	0.00	0.00	0.00	0.00
TOTAL ECONOMIC COSTS (Cr BDT)	**-2,123.51**	**-64.07**	**-134.55**	**-1,121.25**	**-897.00**	**-1,121.25**
NET BENEFITS (Cr BDT)	**4,161.38**	**-64.07**	**-134.55**	**-1,121.25**	**-897.00**	**-1,121.25**

IRR (%)	**18.17%**
NPV (Cr BDT)	**4,161.38**
Pay Back	**2,044**
Benefit / Cost	**2.96**

CBA

FINAL FEASIBILITY STUDY REPORT FOR CONSTRUCTION OF BRIDGE OVER THE RIVER MEGHNA ON GAZARIA-MUNSHIGANJ ROAD		2030 Year 6	2031 Year 7	2032 Year 8	2033 Year 9	2034 Year 10
SOCIO ECONOMIC BENEFITS (Cr BDT)	**NPV**					
Change in Consumer Surplus	**7,211.66**	**0.00**	**224.39**	**360.59**	**525.30**	**721.96**
Existing traffic	**3,315.14**	**0.00**	**139.74**	**170.26**	**205.28**	**245.24**
User passenger time savings	3,269.65	0.00	139.23	169.34	203.88	243.27
User freight time savings	62.86	0.00	2.41	2.98	3.65	4.40
Vehicle Operating Costs (VOC) savings	-17.37	0.00	-1.89	-2.06	-2.24	-2.44
Diverted traffic	**3,387.61**	**0.00**	**77.83**	**174.48**	**292.44**	**434.19**
User passenger time savings	2,760.71	0.00	60.58	136.54	229.98	342.96
User freight time savings	7.23	0.00	0.07	0.14	0.24	0.39
Vehicle Operating Costs (VOC) savings	619.67	0.00	17.18	37.79	62.22	90.85
Generated traffic	**508.91**	**0.00**	**6.82**	**15.86**	**27.58**	**42.53**
User time costs savings	503.89	0.00	6.71	15.63	27.20	41.97
User freight time savings	3.15	0.00	0.03	0.08	0.14	0.22
Additional Vehicle Operating Costs (VOC)	1.87	0.00	0.07	0.15	0.24	0.34
Variation in Externalities	**-926.78**	**0.00**	**-47.92**	**-90.78**	**-136.94**	**-186.61**
Accidents	-648.95	0.00	-33.96	-64.81	-97.88	-133.31
Emissions	-239.25	0.00	-12.02	-22.33	-33.57	-45.81
Air polution	-131.92	0.00	-6.65	-12.27	-18.40	-25.08
Climate change	-107.33	0.00	-5.37	-10.06	-15.17	-20.73
Well to tank	-38.58	0.00	-1.95	-3.65	-5.49	-7.50
TOTAL ECONOMIC BENEFITS (Cr BDT)	**6,284.89**	**0.00**	**176.47**	**269.80**	**388.36**	**535.35**
SOCIO ECONOMIC COSTS (Cr BDT)						
Project initial investments	**-3,065.34**	**-1,121.25**	**0.00**	**0.00**	**0.00**	**0.00**
Residual value	**44.22**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Renovation works	**-346.62**	**0.00**	**-47.28**	**-47.28**	**-112.15**	**-47.28**
Change in Producer Surplus:	**1,244.23**	**0.00**	**47.26**	**85.58**	**130.24**	**181.85**
Producers costs savings for the system	1,166.63	0.00	43.45	77.67	117.92	164.83
Existing traffic	214.27	0.00	17.00	19.50	22.18	25.05
Diverted traffic	952.36	0.00	26.44	58.17	95.74	139.78
Toll revenues (generated traffic)	103.67	0.00	4.41	9.23	14.50	20.24
Vehicle Op costs (generated traffic)	-26.07	0.00	-0.60	-1.32	-2.19	-3.22
TOTAL ECONOMIC COSTS (Cr BDT)	**-2,123.51**	**-1,121.25**	**-0.02**	**38.30**	**18.08**	**134.57**
NET BENEFITS (Cr BDT)	**4,161.38**	**-1,121.25**	**176.45**	**308.10**	**406.45**	**669.91**

IRR (%)	**18.17%**
NPV (Cr BDT)	**4,161.38**
Pay Back	**2,044**
Benefit / Cost	**2.96**

CBA

FINAL FEASIBILITY STUDY REPORT FOR CONSTRUCTION OF BRIDGE OVER THE RIVER MEGHNA ON GAZARIA-MUNSHIGANJ ROAD		2035 Year 11	2036 Year 12	2037 Year 13	2038 Year 14	2039 Year 15
SOCIO ECONOMIC BENEFITS (Cr BDT)	**NPV**					
Change in Consumer Surplus	**7,211.66**	**821.90**	**932.38**	**1,054.21**	**1,188.22**	**1,335.32**
Existing traffic	**3,315.14**	**290.58**	**341.77**	**399.29**	**463.67**	**535.44**
User passenger time savings	3,269.65	287.96	338.38	395.04	458.43	529.08
User freight time savings	62.86	5.27	6.25	7.35	8.59	9.97
Vehicle Operating Costs (VOC) savings	-17.37	-2.64	-2.86	-3.10	-3.35	-3.61
Diverted traffic	**3,387.61**	**482.25**	**534.13**	**590.04**	**650.20**	**714.84**
User passenger time savings	2,760.71	382.49	425.26	471.46	521.28	574.94
User freight time savings	7.23	0.49	0.60	0.73	0.88	1.05
Vehicle Operating Costs (VOC) savings	619.67	99.28	108.27	117.85	128.04	138.85
Generated traffic	**508.91**	**49.07**	**56.48**	**64.88**	**74.36**	**85.04**
User time costs savings	503.89	48.45	55.80	64.12	73.52	84.11
User freight time savings	3.15	0.26	0.31	0.36	0.43	0.50
Additional Vehicle Operating Costs (VOC)	1.87	0.35	0.37	0.39	0.41	0.44
Variation in Externalities	**-926.78**	**-194.40**	**-202.50**	**-210.91**	**-219.61**	**-228.61**
Accidents	-648.95	-138.47	-143.81	-149.34	-155.06	-160.94
Emissions	-239.25	-48.08	-50.46	-52.95	-55.53	-58.23
Air polution	-131.92	-26.34	-27.66	-29.05	-30.49	-32.00
Climate change	-107.33	-21.74	-22.80	-23.90	-25.04	-26.23
Well to tank	-38.58	-7.85	-8.23	-8.62	-9.02	-9.44
TOTAL ECONOMIC BENEFITS (Cr BDT)	**6,284.89**	**627.50**	**729.88**	**843.30**	**968.61**	**1,106.71**
SOCIO ECONOMIC COSTS (Cr BDT)						
Project initial investments	**-3,065.34**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Residual value	**44.22**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Renovation works	**-346.62**	**-47.28**	**-112.15**	**-47.28**	**-47.28**	**-112.15**
Change in Producer Surplus:	**1,244.23**	**198.49**	**216.22**	**235.07**	**255.09**	**276.32**
Producers costs savings for the system	1,166.63	180.85	197.95	216.16	235.53	256.11
Existing traffic	214.27	28.12	31.41	34.91	38.64	42.61
Diverted traffic	952.36	152.73	166.54	181.25	196.89	213.50
Toll revenues (generated traffic)	103.67	21.20	22.21	23.26	24.35	25.49
Vehicle Op costs (generated traffic)	-26.07	-3.56	-3.93	-4.34	-4.79	-5.28
TOTAL ECONOMIC COSTS (Cr BDT)	**-2,123.51**	**151.21**	**104.07**	**187.79**	**207.81**	**164.17**
NET BENEFITS (Cr BDT)	**4,161.38**	**778.70**	**833.94**	**1,031.09**	**1,176.42**	**1,270.88**

IRR (%)	**18.17%**
NPV (Cr BDT)	**4,161.38**
Pay Back	**2,044**
Benefit / Cost	**2.96**

CBA

FINAL FEASIBILITY STUDY REPORT FOR CONSTRUCTION OF BRIDGE OVER THE RIVER MEGHNA ON GAZARIA-MUNSHIGANJ ROAD		2040 Year 16	2041 Year 17	2042 Year 18	2043 Year 19	2044 Year 20
SOCIO ECONOMIC BENEFITS (Cr BDT)	**NPV**					
Change in Consumer Surplus	**7,211.66**	**1,496.44**	**1,672.55**	**1,864.68**	**2,073.89**	**2,312.97**
Existing traffic	**3,315.14**	**615.17**	**703.44**	**800.88**	**908.11**	**1,035.14**
User passenger time savings	3,269.65	607.55	694.41	790.26	895.75	1,020.64
User freight time savings	62.86	11.51	13.22	15.11	17.19	19.67
Vehicle Operating Costs (VOC) savings	-17.37	-3.89	-4.19	-4.50	-4.83	-5.17
Diverted traffic	**3,387.61**	**784.20**	**858.53**	**938.08**	**1,023.13**	**1,115.57**
User passenger time savings	2,760.71	632.65	694.63	761.12	832.35	910.21
User freight time savings	7.23	1.24	1.46	1.70	1.98	2.30
Vehicle Operating Costs (VOC) savings	619.67	150.31	162.44	175.26	188.80	203.07
Generated traffic	**508.91**	**97.07**	**110.58**	**125.72**	**142.65**	**162.26**
User time costs savings	503.89	96.04	109.43	124.44	141.24	160.68
User freight time savings	3.15	0.57	0.66	0.76	0.88	1.00
Additional Vehicle Operating Costs (VOC)	1.87	0.46	0.48	0.51	0.54	0.57
Variation in Externalities	**-926.78**	**-237.91**	**-247.49**	**-257.35**	**-267.50**	**-277.99**
Accidents	-648.95	-167.00	-173.23	-179.63	-186.18	-192.93
Emissions	-239.25	-61.03	-63.93	-66.94	-70.06	-73.30
Air polution	-131.92	-33.57	-35.21	-36.91	-38.66	-40.51
Climate change	-107.33	-27.46	-28.73	-30.04	-31.39	-32.80
Well to tank	-38.58	-9.87	-10.32	-10.78	-11.26	-11.75
TOTAL ECONOMIC BENEFITS (Cr BDT)	**6,284.89**	**1,258.54**	**1,425.06**	**1,607.32**	**1,806.40**	**2,034.98**
SOCIO ECONOMIC COSTS (Cr BDT)						
Project initial investments	**-3,065.34**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Residual value	**44.22**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Renovation works	**-346.62**	**-74.53**	**-47.28**	**-112.15**	**-47.28**	**-47.28**
Change in Producer Surplus:	**1,244.23**	**298.79**	**322.55**	**347.64**	**374.09**	**402.29**
Producers costs savings for the system	1,166.63	277.94	301.05	325.50	351.33	378.93
Existing traffic	214.27	46.84	51.33	56.10	61.15	66.86
Diverted traffic	952.36	231.10	249.72	269.40	290.18	312.07
Toll revenues (generated traffic)	103.67	26.68	27.91	29.19	30.51	31.88
Vehicle Op costs (generated traffic)	-26.07	-5.82	-6.41	-7.05	-7.75	-8.52
TOTAL ECONOMIC COSTS (Cr BDT)	**-2,123.51**	**224.26**	**275.27**	**235.49**	**326.80**	**355.00**
NET BENEFITS (Cr BDT)	**4,161.38**	**1,482.79**	**1,700.33**	**1,842.81**	**2,133.20**	**2,389.98**

IRR (%)	**18.17%**
NPV (Cr BDT)	**4,161.38**
Pay Back	**2,044**
Benefit / Cost	**2.96**

CBA

FINAL FEASIBILITY STUDY REPORT FOR CONSTRUCTION OF BRIDGE OVER THE RIVER MEGHNA ON GAZARIA-MUNSHIGANJ ROAD		2045 Year 21	2046 Year 22	2047 Year 23	2048 Year 24	2049 Year 25
SOCIO ECONOMIC BENEFITS (Cr BDT)	**NPV**					
Change in Consumer Surplus	**7,211.66**	**2,560.70**	**2,832.66**	**3,130.93**	**3,457.78**	**3,815.61**
Existing traffic	**3,315.14**	**1,164.79**	**1,309.25**	**1,469.97**	**1,648.50**	**1,846.52**
User passenger time savings	3,269.65	1,148.14	1,290.16	1,448.14	1,623.60	1,818.19
User freight time savings	62.86	22.19	25.01	28.15	31.64	35.53
Vehicle Operating Costs (VOC) savings	-17.37	-5.54	-5.92	-6.33	-6.75	-7.19
Diverted traffic	**3,387.61**	**1,212.51**	**1,316.25**	**1,427.19**	**1,545.70**	**1,672.17**
User passenger time savings	2,760.71	991.78	1,079.35	1,173.27	1,273.88	1,381.58
User freight time savings	7.23	2.64	3.02	3.44	3.92	4.45
Vehicle Operating Costs (VOC) savings	619.67	218.09	233.89	250.48	267.89	286.15
Generated traffic	**508.91**	**183.41**	**207.15**	**233.77**	**263.58**	**296.92**
User time costs savings	503.89	181.66	205.21	231.62	261.19	294.26
User freight time savings	3.15	1.14	1.30	1.48	1.67	1.89
Additional Vehicle Operating Costs (VOC)	1.87	0.60	0.64	0.68	0.72	0.76
Variation in Externalities	**-926.78**	**-288.67**	**-299.63**	**-310.87**	**-322.37**	**-334.13**
Accidents	-648.95	-199.79	-206.81	-213.97	-221.28	-228.73
Emissions	-239.25	-76.62	-80.05	-83.59	-87.23	-90.98
Air polution	-131.92	-42.39	-44.34	-46.36	-48.44	-50.59
Climate change	-107.33	-34.23	-35.71	-37.23	-38.79	-40.39
Well to tank	-38.58	-12.26	-12.78	-13.31	-13.86	-14.42
TOTAL ECONOMIC BENEFITS (Cr BDT)	**6,284.89**	**2,272.03**	**2,533.02**	**2,820.06**	**3,135.41**	**3,481.49**
SOCIO ECONOMIC COSTS (Cr BDT)						
Project initial investments	**-3,065.34**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Residual value	**44.22**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Renovation works	**-346.62**	**-371.43**	**-47.28**	**-47.28**	**-112.15**	**-47.28**
Change in Producer Surplus:	**1,244.23**	**431.61**	**462.51**	**495.05**	**529.28**	**565.26**
Producers costs savings for the system	1,166.63	407.67	438.02	470.05	503.81	539.36
Existing traffic	214.27	72.55	78.66	85.23	92.28	99.85
Diverted traffic	952.36	335.12	359.36	384.82	411.53	439.52
Toll revenues (generated traffic)	103.67	33.29	34.74	36.24	37.77	39.35
Vehicle Op costs (generated traffic)	-26.07	-9.35	-10.25	-11.24	-12.30	-13.46
TOTAL ECONOMIC COSTS (Cr BDT)	**-2,123.51**	**60.18**	**415.22**	**447.76**	**417.13**	**517.97**
NET BENEFITS (Cr BDT)	**4,161.38**	**2,332.21**	**2,948.25**	**3,267.83**	**3,552.54**	**3,999.46**

IRR (%)	**18.17%**
NPV (Cr BDT)	**4,161.38**
Pay Back	**2,044**
Benefit / Cost	**2.96**

CBA

FINAL FEASIBILITY STUDY REPORT FOR CONSTRUCTION OF BRIDGE OVER THE RIVER MEGHNA ON GAZARIA-MUNSHIGANJ ROAD		2050 Year 26	2051 Year 27	2052 Year 28	2053 Year 29	2054 Year 30
SOCIO ECONOMIC BENEFITS (Cr BDT)	**NPV**					
Change in Consumer Surplus	**7,211.66**	**4,207.01**	**4,629.05**	**5,088.99**	**5,589.74**	**6,134.41**
Existing traffic	**3,315.14**	**2,065.85**	**2,308.39**	**2,576.21**	**2,871.52**	**3,196.64**
User passenger time savings	3,269.65	2,033.66	2,271.92	2,534.97	2,824.98	3,144.23
User freight time savings	62.86	39.83	44.60	49.88	55.71	62.13
Vehicle Operating Costs (VOC) savings	-17.37	-7.65	-8.14	-8.64	-9.17	-9.72
Diverted traffic	**3,387.61**	**1,807.04**	**1,950.73**	**2,103.69**	**2,266.41**	**2,439.36**
User passenger time savings	2,760.71	1,496.74	1,619.77	1,751.11	1,891.18	2,040.46
User freight time savings	7.23	5.04	5.70	6.42	7.23	8.12
Vehicle Operating Costs (VOC) savings	619.67	305.26	325.26	346.16	368.00	390.78
Generated traffic	**508.91**	**334.13**	**369.93**	**409.08**	**451.82**	**498.41**
User time costs savings	503.89	331.19	366.70	405.53	447.92	494.14
User freight time savings	3.15	2.14	2.38	2.66	2.96	3.28
Additional Vehicle Operating Costs (VOC)	1.87	0.81	0.85	0.89	0.94	0.99
Variation in Externalities	**-926.78**	**-346.13**	**-355.28**	**-364.43**	**-373.56**	**-382.66**
Accidents	-648.95	-236.32	-242.38	-248.45	-254.50	-260.53
Emissions	-239.25	-94.83	-97.49	-100.15	-102.81	-105.46
Air polution	-131.92	-52.80	-54.27	-55.75	-57.22	-58.69
Climate change	-107.33	-42.03	-43.22	-44.40	-45.59	-46.77
Well to tank	-38.58	-14.99	-15.41	-15.83	-16.25	-16.67
TOTAL ECONOMIC BENEFITS (Cr BDT)	**6,284.89**	**3,860.88**	**4,273.77**	**4,724.56**	**5,216.19**	**5,751.75**
SOCIO ECONOMIC COSTS (Cr BDT)						
Project initial investments	**-3,065.34**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Residual value	**44.22**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Renovation works	**-346.62**	**-74.53**	**-112.15**	**-47.28**	**-47.28**	**-112.15**
Change in Producer Surplus:	**1,244.23**	**603.04**	**642.38**	**683.64**	**726.88**	**772.16**
Producers costs savings for the system	1,166.63	576.78	616.11	657.43	700.81	746.32
Existing traffic	214.27	107.96	116.64	125.93	135.86	146.47
Diverted traffic	952.36	468.82	499.47	531.51	564.96	599.85
Toll revenues (generated traffic)	103.67	40.97	42.10	43.23	44.36	45.48
Vehicle Op costs (generated traffic)	-26.07	-14.71	-15.83	-17.03	-18.30	-19.64
TOTAL ECONOMIC COSTS (Cr BDT)	**-2,123.51**	**528.50**	**530.23**	**636.35**	**679.59**	**660.01**
NET BENEFITS (Cr BDT)	**4,161.38**	**4,389.38**	**4,804.00**	**5,360.92**	**5,895.78**	**6,411.76**

IRR (%)	**18.17%**
NPV (Cr BDT)	**4,161.38**
Pay Back	**2,044**
Benefit / Cost	**2.96**

CBA

FINAL FEASIBILITY STUDY REPORT FOR CONSTRUCTION OF BRIDGE OVER THE RIVER MEGHNA ON GAZARIA-MUNSHIGANJ ROAD		2055 Year 31	2056 Year 32	2057 Year 33	2058 Year 34	2059 Year 35	2060 Year 36
SOCIO ECONOMIC BENEFITS (Cr BDT)	**NPV**						
Change in Consumer Surplus	**7,211.66**	**6,726.27**	**7,368.78**	**8,065.62**	**8,820.64**	**9,637.91**	**10,521.72**
Existing traffic	**3,315.14**	**3,554.08**	**3,946.46**	**4,376.59**	**4,847.44**	**5,362.13**	**5,923.97**
User passenger time savings	3,269.65	3,495.17	3,880.38	4,302.60	4,764.74	5,269.87	5,821.23
User freight time savings	62.86	69.20	76.97	85.51	94.86	105.09	116.27
Vehicle Operating Costs (VOC) savings	-17.37	-10.29	-10.89	-11.51	-12.16	-12.83	-13.53
Diverted traffic	**3,387.61**	**2,623.05**	**2,818.03**	**3,024.84**	**3,244.07**	**3,476.30**	**3,722.17**
User passenger time savings	2,760.71	2,199.42	2,368.57	2,548.42	2,739.53	2,942.46	3,157.79
User freight time savings	7.23	9.09	10.17	11.35	12.64	14.06	15.60
Vehicle Operating Costs (VOC) savings	619.67	414.54	439.29	465.07	491.89	519.78	548.77
Generated traffic	**508.91**	**549.14**	**604.29**	**664.19**	**729.14**	**799.48**	**875.58**
User time costs savings	503.89	544.46	599.17	658.58	723.01	792.80	868.28
User freight time savings	3.15	3.64	4.03	4.46	4.92	5.42	5.97
Additional Vehicle Operating Costs (VOC)	1.87	1.04	1.09	1.15	1.21	1.27	1.33
Variation in Externalities	**-926.78**	**-391.73**	**-400.76**	**-409.74**	**-418.65**	**-427.50**	**-436.27**
Accidents	-648.95	-266.54	-272.52	-278.46	-284.37	-290.22	-296.02
Emissions	-239.25	-108.10	-110.74	-113.35	-115.96	-118.54	-121.11
Air polution	-131.92	-60.15	-61.61	-63.07	-64.51	-65.94	-67.37
Climate change	-107.33	-47.95	-49.12	-50.29	-51.45	-52.60	-53.74
Well to tank	-38.58	-17.09	-17.50	-17.92	-18.33	-18.74	-19.14
TOTAL ECONOMIC BENEFITS (Cr BDT)	**6,284.89**	**6,334.54**	**6,968.02**	**7,655.88**	**8,401.99**	**9,210.41**	**10,085.45**
SOCIO ECONOMIC COSTS (Cr BDT)							
Project initial investments	**-3,065.34**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Residual value	**44.22**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2,334.83**
Renovation works	**-346.62**	**-306.56**	**-47.28**	**-112.15**	**-47.28**	**-47.28**	**-139.40**
Change in Producer Surplus:	**1,244.23**	**819.55**	**869.13**	**920.95**	**975.10**	**1,031.65**	**1,090.68**
Producers costs savings for the system	1,166.63	794.03	844.00	896.33	951.08	1,008.34	1,068.19
Existing traffic	214.27	157.79	169.87	182.74	196.45	211.04	226.56
Diverted traffic	952.36	636.23	674.13	713.59	754.63	797.30	841.63
Toll revenues (generated traffic)	103.67	46.60	47.71	48.81	49.91	50.99	52.07
Vehicle Op costs (generated traffic)	-26.07	-21.07	-22.59	-24.19	-25.89	-27.68	-29.58
TOTAL ECONOMIC COSTS (Cr BDT)	**-2,123.51**	**512.99**	**821.84**	**808.80**	**927.82**	**984.37**	**3,286.11**
NET BENEFITS (Cr BDT)	**4,161.38**	**6,847.53**	**7,789.87**	**8,464.69**	**9,329.81**	**10,194.78**	**13,371.56**

IRR (%)	**18.17%**
NPV (Cr BDT)	**4,161.38**
Pay Back	**2,044**
Benefit / Cost	**2.96**

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Financial Analysis-Project and Government Cash Flows

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FINAL FEASIBILITY STUDY REPORT FOR CONSTRUCTION OF BRIDGE OVER THE RIVER MEGHNA ON GAZARIA-MUNSHIGANJ ROAD

			2025 Year 1	2026 Year 2	2027 Year 3	2028 Year 4	2029 Year 5
Construction period	6 years		1	1	1	1	1
Operation period	30 years		0	0	0	0	0
Term of analysis	36 years		1	1	1	1	1
Price indexation	5.00%		1.00	1.05	1.10	1.16	1.22

CASH FLOWS (Cr BDT)			2025 Year 1	2026 Year 2	2027 Year 3	2028 Year 4	2029 Year 5
Operating revenues			**0**	**0**	**0**	**0**	**0**
Toll revenues			0	0	0	0	0
Other commercial revenues			0	0	0	0	0
Operation & Maintenance expenses		**16,387**	**0**	**0**	**0**	**0**	**0**
Maintenance & Overhaul			0	0	0	0	0
Operation			0	0	0	0	0
Net Cash Flows due to Operations		**1,454.2**	**0**	**0**	**0**	**0**	**0**
Cash Flows due to Investments			**-446**	**-363**	**-3,153**	**-2,707**	**-3,581**
Initial CAPEX		14,070	-446	-363	-3,153	-2,707	-3,581
Other CAPEX		0	0	0	0	0	0
Residual Value of Investments		-458	0	0	0	0	0
Project cash flows	**2.49%**	**-8,190.8**	**-446**	**-363**	**-3,153**	**-2,707**	**-3,581**

CASH FLOWS (Cr BDT)			2025 Year 1	2026 Year 2	2027 Year 3	2028 Year 4	2029 Year 5
Outflows			**-446**	**-363**	**-3,153**	**-2,707**	**-3,581**
Project Development (Initial CAPEX)		-8,060	-224	-353	-3,087	-2,593	-3,403
Financing Fees		-551	-222	-10	-66	-114	-178
Operating expenses		-1,369	0	0	0	0	0
Loan Repayments							
Interest		-1,149	0	0	0	0	0
Principal Repayments		-1,478	0	0	0	0	0
Inflows			**382**	**267**	**2,352**	**2,066**	**2,780**
Borrowings		6,646	382	267	2,352	2,066	2,780
Operating revenues		2,667	0	0	0	0	0
Future Developments		0	0	0	0	0	0
GoB net cash flows (FIRR / FNPV)	**2.09%**	**-3,293.4**	**-64**	**-96**	**-802**	**-641**	**-802**

FINAL FEASIBILITY STUDY REPORT FOR CONSTRUCTION OF BRIDGE OVER THE RIVER MEGHNA ON GAZARIA-MUNSHIGANJ ROAD

	2030 Year 6	2031 Year 7	2032 Year 8	2033 Year 9	2034 Year 10	2035 Year 11	2036 Year 12
Construction period	1	0	0	0	0	0	0
Operation period	0	1	1	1	1	1	1
Term of analysis	1	1	1	1	1	1	1
Price indexation	1.28	1.34	1.41	1.48	1.55	1.63	1.71

CASH FLOWS (Cr BDT)	2030 Year 6	2031 Year 7	2032 Year 8	2033 Year 9	2034 Year 10	2035 Year 11	2036 Year 12
Operating revenues	**0**	**138**	**193**	**260**	**339**	**381**	**427**
Toll revenues	0	138	193	260	339	381	427
Other commercial revenues	0	0	0	0	0	0	0
Operation & Maintenance expenses	**0**	**-140**	**-147**	**-349**	**-162**	**-170**	**-404**
Maintenance & Overhaul	0	-129	-135	-337	-149	-157	-391
Operation	0	-11	-11	-12	-12	-13	-13
Net Cash Flows due to Operations	**0**	**-2**	**47**	**-89**	**177**	**212**	**23**
Cash Flows due to Investments	**-3,819**	**0**	**0**	**0**	**0**	**0**	**0**
Initial CAPEX	-3,819	0	0	0	0	0	0
Other CAPEX	0	0	0	0	0	0	0
Residual Value of Investments	0	0	0	0	0	0	0
Project cash flows	**-3,819**	**-2**	**47**	**-89**	**177**	**212**	**23**

CASH FLOWS (Cr BDT)	2030 Year 6	2031 Year 7	2032 Year 8	2033 Year 9	2034 Year 10	2035 Year 11	2036 Year 12
Outflows	**-3,819**	**-876**	**-870**	**-1,060**	**-860**	**-855**	**-1,077**
Project Development (Initial CAPEX)	-3,574	0	0	0	0	0	0
Financing Fees	-246	0	0	0	0	0	0
Operating expenses	0	-140	-147	-349	-162	-170	-404
Loan Repayments							
Interest	0	-374	-361	-349	-336	-323	-311
Principal Repayments	0	-362	-362	-362	-362	-362	-362
Inflows	**3,018**	**138**	**193**	**260**	**339**	**381**	**427**
Borrowings	3,018	0	0	0	0	0	0
Operating revenues	0	138	193	260	339	381	427
Future Developments	0	0	0	0	0	0	0
GoB net cash flows (FIRR / FNPV)	**-802**	**-738**	**-677**	**-800**	**-521**	**-474**	**-650**

FINAL FEASIBILITY STUDY REPORT FOR CONSTRUCTION OF BRIDGE OVER THE RIVER MEGHNA ON GAZARIA-MUNSHIGANJ ROAD

	2037 Year 13	2038 Year 14	2039 Year 15	2040 Year 16	2041 Year 17	2042 Year 18	2043 Year 19
Construction period	0	0	0	0	0	0	0
Operation period	1	1	1	1	1	1	1
Term of analysis	1	1	1	1	1	1	1
Price indexation	1.80	1.89	1.98	2.08	2.18	2.29	2.41

CASH FLOWS (Cr BDT)	2037 Year 13	2038 Year 14	2039 Year 15	2040 Year 16	2041 Year 17	2042 Year 18	2043 Year 19
Operating revenues	**477**	**531**	**589**	**652**	**719**	**792**	**870**
Toll revenues	477	531	589	652	719	792	870
Other commercial revenues	0	0	0	0	0	0	0
Operation & Maintenance expenses	**-187**	**-196**	**-468**	**-367**	**-227**	**-541**	**-251**
Maintenance & Overhaul	-173	-182	-452	-350	-210	-523	-232
Operation	-14	-15	-16	-16	-17	-18	-19
Net Cash Flows due to Operations	**290**	**334**	**121**	**285**	**492**	**250**	**619**
Cash Flows due to Investments	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Initial CAPEX	0	0	0	0	0	0	0
Other CAPEX	0	0	0	0	0	0	0
Residual Value of Investments	0	0	0	0	0	0	0
Project cash flows	**290**	**334**	**121**	**285**	**492**	**250**	**619**

CASH FLOWS (Cr BDT)	2037 Year 13	2038 Year 14	2039 Year 15	2040 Year 16	2041 Year 17	2042 Year 18	2043 Year 19
Outflows	**-847**	**-844**	**-1,102**	**-989**	**-837**	**-1,138**	**-835**
Project Development (Initial CAPEX)	0	0	0	0	0	0	0
Financing Fees	0	0	0	0	0	0	0
Operating expenses	-187	-196	-468	-367	-227	-541	-251
Loan Repayments							
Interest	-298	-285	-273	-260	-247	-235	-222
Principal Repayments	-362	-362	-362	-362	-362	-362	-362
Inflows	**477**	**531**	**589**	**652**	**719**	**792**	**870**
Borrowings	0	0	0	0	0	0	0
Operating revenues	477	531	589	652	719	792	870
Future Developments	0	0	0	0	0	0	0
GoB net cash flows (FIRR / FNPV)	**-370**	**-313**	**-514**	**-337**	**-118**	**-346**	**35**

FINAL FEASIBILITY STUDY REPORT FOR CONSTRUCTION OF BRIDGE OVER THE RIVER MEGHNA ON GAZARIA-MUNSHIGANJ ROAD

	2044 Year 20	2045 Year 21	2046 Year 22	2047 Year 23	2048 Year 24	2049 Year 25	2050 Year 26
Construction period	0	0	0	0	0	0	0
Operation period	1	1	1	1	1	1	1
Term of analysis	1	1	1	1	1	1	1
Price indexation	2.53	2.65	2.79	2.93	3.07	3.23	3.39

CASH FLOWS (Cr BDT)	2044 Year 20	2045 Year 21	2046 Year 22	2047 Year 23	2048 Year 24	2049 Year 25	2050 Year 26
Operating revenues	**957**	**1,048**	**1,145**	**1,251**	**1,366**	**1,489**	**1,623**
Toll revenues	957	1,048	1,145	1,251	1,366	1,489	1,623
Other commercial revenues	0	0	0	0	0	0	0
Operation & Maintenance expenses	**-263**	**-1,467**	**-290**	**-305**	**-725**	**-336**	**-597**
Maintenance & Overhaul	-243	-1,446	-268	-282	-701	-310	-571
Operation	-20	-21	-22	-23	-24	-25	-27
Net Cash Flows due to Operations	**694**	**-420**	**855**	**946**	**640**	**1,153**	**1,025**
Cash Flows due to Investments	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Initial CAPEX	0	0	0	0	0	0	0
Other CAPEX	0	0	0	0	0	0	0
Residual Value of Investments	0	0	0	0	0	0	0
Project cash flows	**694**	**-420**	**855**	**946**	**640**	**1,153**	**1,025**

CASH FLOWS (Cr BDT)	2044 Year 20	2045 Year 21	2046 Year 22	2047 Year 23	2048 Year 24	2049 Year 25	2050 Year 26
Outflows	**-834**	**-2,026**	**-836**	**-838**	**-1,246**	**-844**	**-1,093**
Project Development (Initial CAPEX)	0	0	0	0	0	0	0
Financing Fees	0	0	0	0	0	0	0
Operating expenses	-263	-1,467	-290	-305	-725	-336	-597
Loan Repayments							
Interest	-209	-197	-184	-171	-159	-146	-133
Principal Repayments	-362	-362	-362	-362	-362	-362	-362
Inflows	**957**	**1,048**	**1,145**	**1,251**	**1,366**	**1,489**	**1,623**
Borrowings	0	0	0	0	0	0	0
Operating revenues	957	1,048	1,145	1,251	1,366	1,489	1,623
Future Developments	0	0	0	0	0	0	0
GoB net cash flows (FIRR / FNPV)	**123**	**-978**	**309**	**413**	**119**	**645**	**530**

FINAL FEASIBILITY STUDY REPORT FOR CONSTRUCTION OF BRIDGE OVER THE RIVER MEGHNA ON GAZARIA-MUNSHIGANJ ROAD

	2051 Year 27	2052 Year 28	2053 Year 29	2054 Year 30	2055 Year 31	2056 Year 32	2057 Year 33
Construction period	0	0	0	0	0	0	0
Operation period	1	1	1	1	1	1	1
Term of analysis	1	1	1	1	1	1	1
Price indexation	3.56	3.73	3.92	4.12	4.32	4.54	4.76

CASH FLOWS (Cr BDT)	2051 Year 27	2052 Year 28	2053 Year 29	2054 Year 30	2055 Year 31	2056 Year 32	2057 Year 33
Operating revenues	**1,765**	**1,918**	**2,082**	**2,259**	**2,449**	**2,653**	**2,871**
Toll revenues	1,765	1,918	2,082	2,259	2,449	2,653	2,871
Other commercial revenues	0	0	0	0	0	0	0
Operation & Maintenance expenses	**-840**	**-389**	**-408**	**-972**	**-1,819**	**-473**	**-1,125**
Maintenance & Overhaul	-812	-359	-377	-940	-1,785	-437	-1,088
Operation	-28	-29	-31	-32	-34	-36	-37
Net Cash Flows due to Operations	**925**	**1,529**	**1,674**	**1,287**	**630**	**2,180**	**1,746**
Cash Flows due to Investments	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Initial CAPEX	0	0	0	0	0	0	0
Other CAPEX	0	0	0	0	0	0	0
Residual Value of Investments	0	0	0	0	0	0	0
Project cash flows	**925**	**1,529**	**1,674**	**1,287**	**630**	**2,180**	**1,746**

CASH FLOWS (Cr BDT)	2051 Year 27	2052 Year 28	2053 Year 29	2054 Year 30	2055 Year 31	2056 Year 32	2057 Year 33
Outflows	**-1,322**	**-859**	**-865**	**-1,417**	**-2,251**	**-892**	**-1,532**
Project Development (Initial CAPEX)	0	0	0	0	0	0	0
Financing Fees	0	0	0	0	0	0	0
Operating expenses	-840	-389	-408	-972	-1,819	-473	-1,125
Loan Repayments							
Interest	-121	-108	-95	-83	-70	-57	-44
Principal Repayments	-362	-362	-362	-362	-362	-362	-362
Inflows	**1,765**	**1,918**	**2,082**	**2,259**	**2,449**	**2,653**	**2,871**
Borrowings	0	0	0	0	0	0	0
Operating revenues	1,765	1,918	2,082	2,259	2,449	2,653	2,871
Future Developments	0	0	0	0	0	0	0
GoB net cash flows (FIRR / FNPV)	**442**	**1,059**	**1,217**	**842**	**198**	**1,761**	**1,339**

FINAL FEASIBILITY STUDY REPORT FOR CONSTRUCTION OF BRIDGE OVER THE RIVER MEGHNA ON GAZARIA-MUNSHIGANJ ROAD

	2058 Year 34	2059 Year 35	2060 Year 36
Construction period	0	0	0
Operation period	1	1	1
Term of analysis	1	1	1
Price indexation	5.00	5.25	5.52

CASH FLOWS (Cr BDT)	2058 Year 34	2059 Year 35	2060 Year 36
Operating revenues	**3,105**	**3,356**	**3,624**
Toll revenues	3,105	3,356	3,624
Other commercial revenues	0	0	0
Operation & Maintenance expenses	**-521**	**-547**	**-1,702**
Maintenance & Overhaul	-482	-506	-1,658
Operation	-39	-41	-43
Net Cash Flows due to Operations	**2,584**	**2,809**	**1,922**
Cash Flows due to Investments	**0**	**0**	**458**
Initial CAPEX	0	0	0
Other CAPEX	0	0	0
Residual Value of Investments	0	0	458
Project cash flows	**2,584**	**2,809**	**2,380**

CASH FLOWS (Cr BDT)	2058 Year 34	2059 Year 35	2060 Year 36
Outflows	**-915**	**-928**	**-1,613**
Project Development (Initial CAPEX)	0	0	458
Financing Fees	0	0	0
Operating expenses	-521	-547	-1,702
Loan Repayments			
Interest	-32	-19	-6
Principal Repayments	-362	-362	-362
Inflows	**3,105**	**3,356**	**3,624**
Borrowings	0	0	0
Operating revenues	3,105	3,356	3,624
Future Developments	0	0	0
GoB net cash flows (FIRR / FNPV)	**2,190**	**2,427**	**2,011**

Annexure 02 – GDP Impact Justification

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The GDP impact calculation has been carried out following international methodology for economic impact estimation studies and as implemented in previous international projects. It has been estimated as a sum of the three impacts: direct, indirect and induced, as follows:

GDP IMPACT CALCULATION		Million BDT
GDP economic impact. Direct Impact		44,520
Personnel expenses. Construction	22%	31,683
Personnel expenses. Operation	65%	1,069
EBITDA. Construction & Maintenance	8%	11,521
EBITDA. Operation	15%	247
GDP economic impact. Indirect Impact		101,137
Suppliers. Construction	70%	100,808
Suppliers. Operation	20%	329
GDP economic impact. Induced Impact		106,327
Bridge activity		32,752
Induced activity of the bridge		65,739

- Right-hand column is the addition of all the economic projections generated, in constant BDT (not considering inflation)
- Direct impact is the impact generated by the project itself and is similar to the Gross Added Value, which means the addition of personnel expenses and EBITDA both in the implementation phase and in the operation phase.
- Indirect impact is the impact generated by the suppliers of the project, also in both the implementation phase and the operation phase.
- Induced impact is the impact generated by all the personnel expenses with the money spent in any other activity in the region / country. It has been calculated as the induced impact of the bridge activity, based on the personnel expenses of the bridge itself (in construction and in operation), and the induced impact of the activity of the bridge, based on the personnel expenses of the indirect impact multiplied by the 65% estimated of personnel expenses of any service activity.

In summary, it is the sum of the effects generated by the bridge, either by its construction or by its operation, both directly and those produced by each of the activities derived from the bridge itself:

Total impact on GDP (million BDT 2022)	251,984
Direct impact	44,520
Indirect impact	101,137
Induced impact	106,327
GDP Bangladesh (million USD 2022)	453,852
GDP Bangladesh (million BDT 2022)	49,923,720
Project impact on GDP	0.50%