People's Republic of Bangladesh
Bangladesh Railway

Preparatory Survey for Construction of Dual Gauge Double Line between Joydebpur-Ishurdi Section Project

Final Report

(Advanced Release Version)

November 2024

Japan International Cooperation Agency (JICA)

Oriental Consultants Global Co., Ltd.
Chodai Co., Ltd.
Japan International Consultants for Transportation Co., Ltd.

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Executive Summary

1. Introduction

1.1 Background and Objective of the Study

The "Project for Construction of Dual Gauge Double Line between Joydebpur - Ishurdi Section" (hereafter called “the Project”) aims to enhance railway transportation capacity by double-tracking the main line between Joydebpur and Ishurdi, which connects the east and west sides of the country.

The executing agency, the Bangladesh Railway (hereafter called “BR”), has already conducted a Feasibility Study (hereafter called the “Prior F/S”) of the Project in 2019. However, since several years have passed after the Prior F/S, it is necessary to review the project cost, available technologies, construction methods, materials, equipment, etc.in the preparatory survey. In addition, JICA Study Team (hereafter called “JST”) will gather additional information to consider avoidance, minimization, mitigation, and compensation for environmental and social impacts.

1.2 Outline of the Study

The outline of the Study is described as follows.

Table 1 Outline of the Study (Project)

Items	Contents
Study Name	Preparatory Survey for Construction of Dual Gauge Double Line Between Joydebpur - Ishurdi Section Project (hereafter called “the Study”)
Project Objectives	By implementing the double-tracking between Joydebpur Station near Dhaka and Ishurdi Station in the western part of the country, the project aims to enhance railway transportation capacity and promote economic development through improved connectivity within the country and with neighboring countries.
Project Outline	Railroad double-tracking from Joydebpur station to Ishurdi station Doubling of the line: approx. 170 km: civil works (including the construction of approx. 200 bridges, 3 new station and renovation/reconstruction of 20 out of 24 existing stations), track works, signaling and communication facilities (international competitive bidding) Consulting services: detailed design, bidding assistance, construction supervision, environmental and social consideration procedures, monitoring assistance, etc.
Survey Area	Gazipur District, Tangail District (Dhaka Division) Sirajganj District, Pabna District, Natore District (Rajshahi Division)
Executing Agency	Bangladesh Railway (BR)
Other related Government Agencies and Institutions	Ministry of Railways (MOR)
Study Period	June 2022 – November 2024

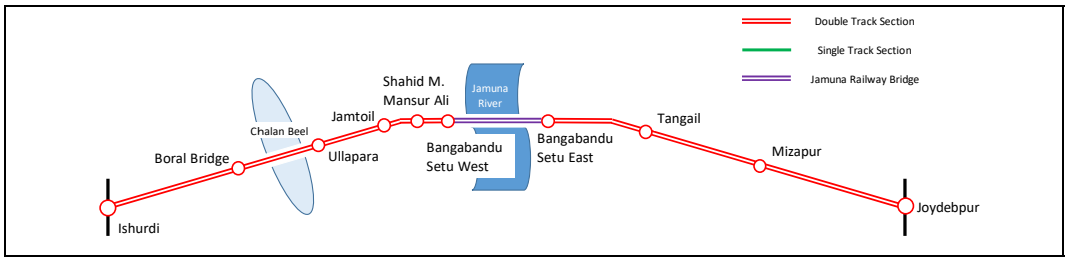
Source: JST

2. Consideration of Alternative Plans

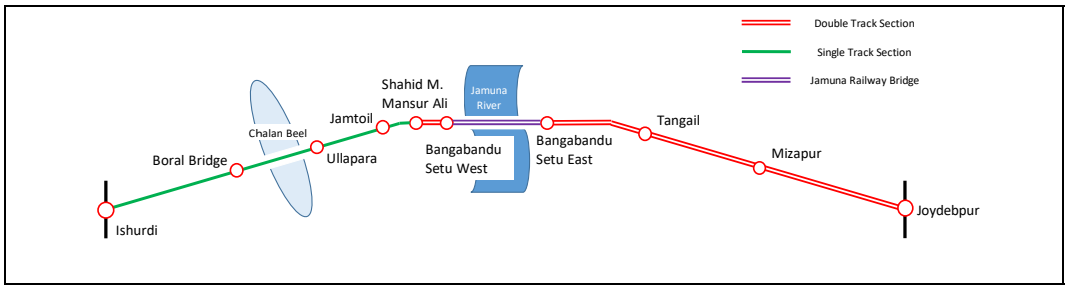
2.1 Outline of Alternatives

Alternative plans to improve the line capacity of the entire line section were examined. 4 alternatives and "Without Project" to be examined are shown as follows:

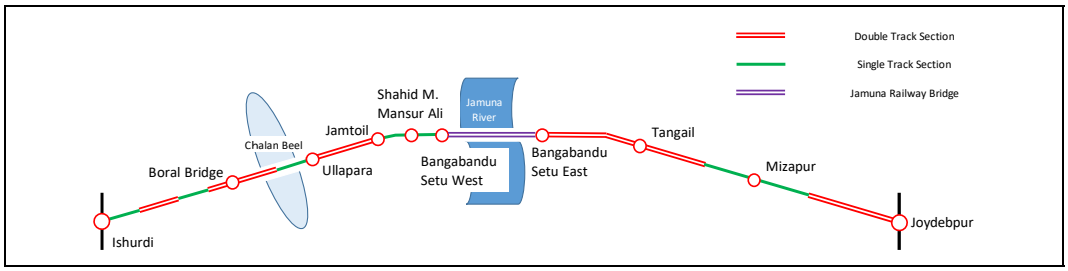
Without Project:	No Double Track section
Alternative 1:	Double Tracking in all section (Original Plan of the Prior F/S)
Alternative 2:	Double Tracking between Shahid M. Mansur Ali and Joydebpur
Alternative 3:	Partial Double Tracking
Alternative 4:	Addition of Passing Loop Station with Single-Track



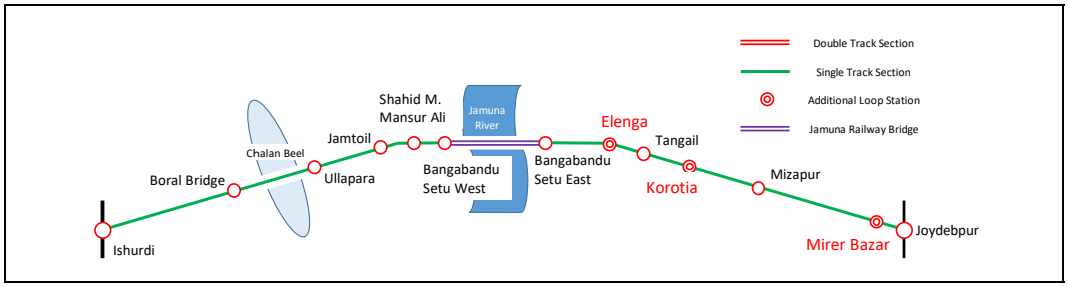
(a) Alternative 1



(b) Alternative 2



(c) Alternative 3



(d) Alternative 4

Source: JST

Figure 1 Schematic of Alternatives

2.2 Alternative Analysis

(1) Preliminary Alternative Analysis

Among the five alternatives including Without Project, the preliminary alternative analysis was carried out to confirm whether to pass the key criteria.

[Key Criteria]

(a) Line Capacity shall meet the transport demand when Jamuna Railway Bridge is completed.
(b) Travel time between Joydebpur and Ishurdi shall not be longer than the current one.
(c) The project shall be implemented outside the national parks and wildlife sanctuaries.

As a result of preliminary alternative analysis, "Without Project" and "Alternative 4" fail to meet any of key criteria and were excluded from the secondary analysis.

(2) Secondary Alternative Analysis

For the alternatives excluding "Without Project" and "Alternative 4" as the result of the preliminary alternative analysis, the result of secondary comparative analysis is shown below. Each item is scored on a 4-grade scale (A to D).

Table 2 Comparison of Alternatives

Item	Alternative 1	Alternative 2	Alternative 3	Note
Length of Double Track [1)]	164.1 km	East: 83.6 km	Total. 106.5km	
Line Capacity per day both direction [2)]	68 trains/day (A: 100)	33 trains/day (C: 50)	41 trains/day (C: 50)	25 trains/day as of 2022
Passenger Service (Duration between JYR and ISD)	4.0 to 4.5 hours (A: 100)	4.8 to 5.3 hours (C: 50)	4.6 to 5.1 hours (B: 75)	Bus: around 4.6 hours
Construction Cost [3)]	Undisclosed			
FIRR [4)]				
EIRR [4)]				
Land Acquisition[5)]	Approx.72 acres (B: 75)	Approx.50 acres (B: 75)	Approx.40 acres (B: 75)	
Resettlement [5)] (Displaced Project Affected Household: PAH)	Approx.1,600 PAHs (C: 50)	Approx.580 PAHs (A: 100)	Approx.1,040 units (B: 75)	
Environmental impact (Ecosystem) (Impact on Chalan Beel)	Impact (C: 50)	No impact (A: 100)	Partially Impact (B: 75)	
Overall Evaluation	**Score: 575 Recommendation**	Score: 475	Score: 500	

Note1: The lower row shows the 4-grade evaluation of each item.
A: Excellent (Low Cost, High Benefit, Less Impact etc.); Score: 100 B: Good; Score: 75
C: Fair (High Cost, Low Benefit, Large Impact, etc.) ; Score: 50 D: Poor (Not Feasible) ; Score: 0

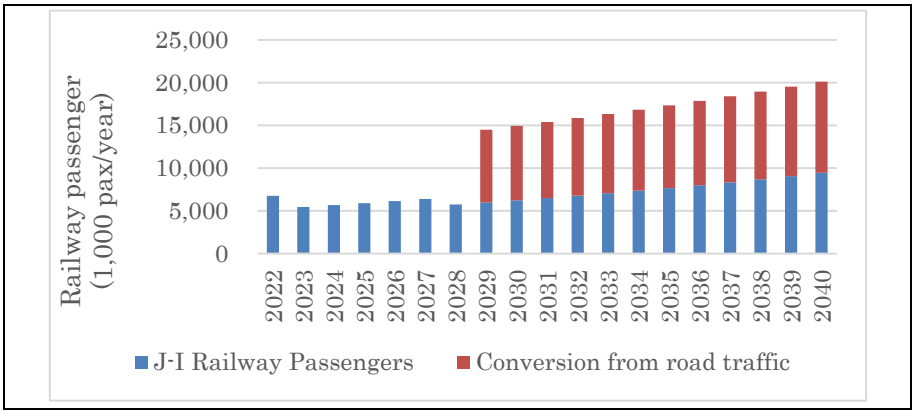
Note2: 1) Length: Distance between station centers.
2) Line Capacity: Maximum number of trains that can run between Joydebpur and Ishurdi per day
3) Undisclosed
4) Refer to Chapter 11 in the main text
5) Based on RAP survey 2022-23

Source: JST

Considering the result of comparative analysis comprehensively, Alternative 1 with the highest score is selected as a suitable alternative.

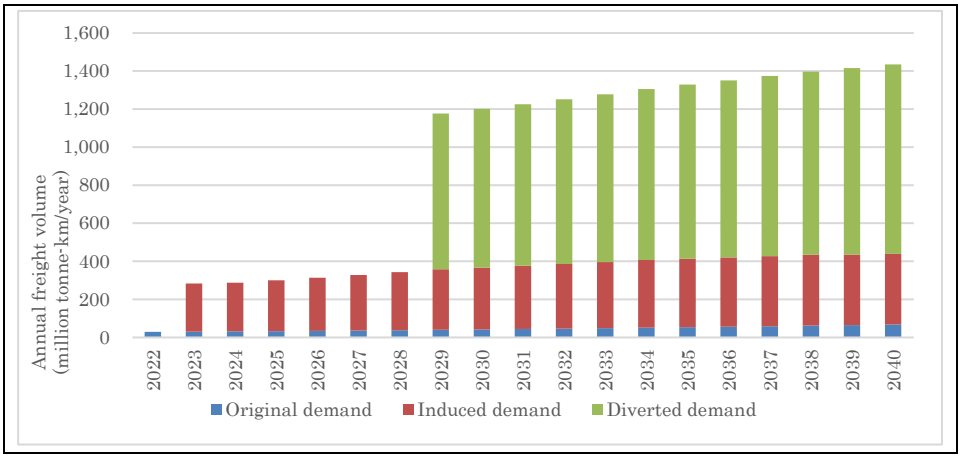
3. Transport Demand Forecast

Total number of passengers and annual freight transport volume between Joydebpur - Ishurdi Section has been forecasted below:



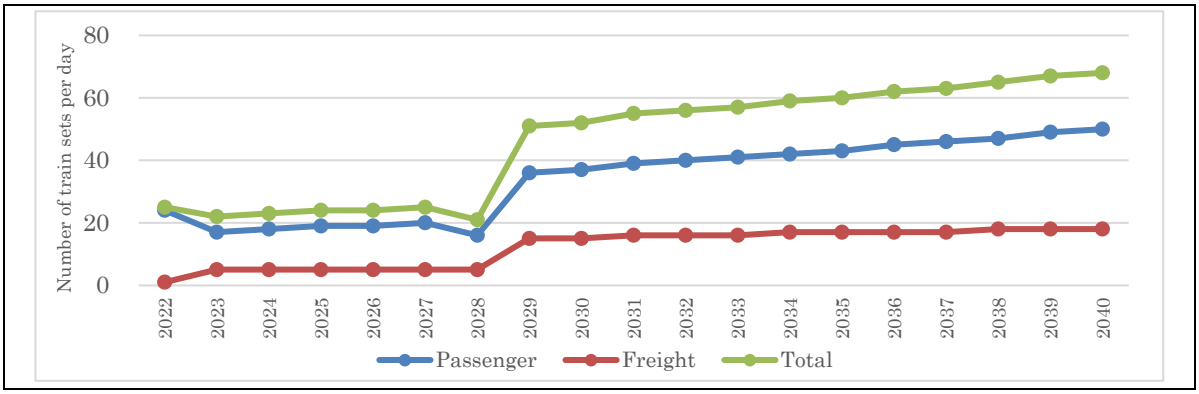
Source: JST

Figure 2 Total number of Passengers and Annual Freight Transport Volume



Source: JST

Figure 3 Annual Freight Transport Volume



Note: The number of train sets is rounded up and shown as an integer.
Source: JST

Figure 4 The Number of Train Sets

Based on the demand forecast for passenger and freight transport explained above, the estimated number of train sets between the Joydebpur-Ishurdi section is demonstrated as follow:

4. Conceptual Design

4.1 Design Parameter

Main technical railway standard and design parameters of railway track are shown below:

Table 3 Main Technical Railway Standard

Item	Standards
Number of main lines	Double tracks
Gauge	DG consisting of BG (1676 mm) and MG (1000 mm)
Design running speed	120km/h for BG passenger train, 100km/h for MG passenger train, 80km/h for BG and MG freight train
Distance between Tracks	Main lines: 6m*, station lines: 5.3m, major bridges: 12m or less**
Minimum curve radius	500 m to match curves of existing track
Ruling gradient	0.5% (1 in 200), not steeper than 0.25% (1 in 400) in existing station yards. 0.04% per degree of curvature.
Electrification/ Non-electrification	Non-electrification considering electrification in the future
Effective length of receiving-departure track	750m
Axle load	BG: 25t, MG: 15t

*: Distance between the existing and new track, including on the minor bridges and box culverts
**: Distance will be finalized on the detailed design stage.

Source: JST based the Prior F/S

4.2 Route and Alignment

The proposed alignment of new double track lies on the north side, i.e., to the left of the existing track while travelling from Ishurdi to Joydebpur. Distance between the existing and new track will be at 6 m . At the minor bridges and box culvert, this distance is proposed to be at 6 to12 m to facilitate construction of these bridges on the new track without much interference with the existing track.

4.3 Bridge Works

The structural types and number of new bridges shall be planned as shown in the table below:

Table 4 Structural Types and Number of New Bridges (Minor Bridges)

Category	Structural Types	Number of Bridges	Remarks
Minor Bridges	Steel Semi-Through Girder	2	1 span (span length = 15 m)
	RC Box Culvert	135	1 or 2 or 3 cells (span lengths = 1, 3, 4, 4.5, 5, 6 m)
Total		**137**	Bridge No.34 has been closed

Source: JST

Table 5 Structural Types and Number of New Bridges (Major Bridges)

Category	Structural Types	Number of Bridges	Remarks
Major Bridges	Steel Semi-Through Girder	66	1 to 8 spans (span lengths = 15, 20, 25, 30, 35 m)
	RC Box Culvert	0	-----
Total		**66**	

Source: JST

JST recommend the ballastless track with synthetic sleepers on deck bridges in order to reduce construction cost by reducing the weight of the superstructure, lowering the rail level and so on.

4.4 Earthworks

Regarding circular landslip, considering that the existing embankment is stable without any problems, it seems that there will be no problem even if the embankment is widened. However, it is necessary to pay attention to the consolidation settlement directly under the new embankment.

4.5 Station Plan

The station plan is shown below:

Table 6 Station Plan

New Station (3 Station)	Elenga, Karotia, Mirer Bazar
Renovation (13 Station)	Mouchak, Mirzapur, Mohera , Korotia, and Tangail , Shahid M. Mansur Ali, Jamtoil, Ullapara, Lahirimohanpur, Chatmoharr, Mooladuli, Majhgram, Ishurdi Bypass, Ishurdi Junction
Reconstruction (7 Station)	Dilpashar, Baral Bridge, Salop, Saratnagar, Bhangura, Guakhara, Gafurabad

Source: JST based on the Prior F/S

4.6 Signal and Telecommunication

Improvement work of signaling system and level crossing equipment corresponding to the double track between Joydebpur and Ishurdi, and CTC conversion work of the section are planned.
Level crossings are classified into Special, A, B, C, and D in descending order of importance according to road traffic volume, train speed and geographical conditions such slope, and crossing security devices are installed according to these classifications.

4.7 Power Supply

Proposed new power supply system mainly consists of high voltage power receiving & distribution equipment and emergency generator for signaling & telecommunication equipment for block station and general electrical & mechanical equipment for station & building.

4.8 Train Operation Plan

The estimated number of train sets between the Joydebpur-Ishurdi section is demonstrated in Figure 4.

4.9 Maintenance Plan

It is estimated that 888 staffs need to be added to the Maintenance and Operation field. And, the increase in human resource cost is 382,475.81 thousand BDT.

5. Applicability of Innovative Technologies

JST introduced 8 innovative technologies to BR throughout the series of 3 seminars. Among of those technologies, BR has selected the following innovative technologies to be considered for adoption in the Project.

- **RRR Embankment**: Will be applied for embankments in densely populated urban areas.
- **Direct Rail Fastener**: Will be applied for track on steel bridge sections.
- **Synthetic Sleeper (FFU)**: Will be applied for track sections with turn-outs, crossings, and steel bridges.
- **Weathering Steel for Bridges**: Will be applied for steel bridge design.
- **Head Hardened Rail (HHR)**: Will be applied for track sections with sharp curves (R<600m) and turn-outs.

Cost increase due to the application of those innovative technologies is incorporated in the cost estimation in the Study, although the impact is minimal while the Life Cycle Cost (LCC) will be decreased in exchange for the capital cost increase.

6. Project Cost Estimation

Undisclosed

Undisclosed

Undisclosed

7. Project Implementation Plan

Undisclosed

Undisclosed

8. Project Evaluation

Undisclosed

9. Operation and Management System

Undisclosed

10. Environmental and social considerations

The main issues for environmental and social considerations are as follows

10.1 Noise impact along the alignment due to increased number of running train

The increased number of running trains from the current average of 1.08 trains per hour to 2.83 trains per hour will increase the noise level by approximately 4 dB. Therefore, detailed noise prediction shall be implemented at the detailed design stage, and further mitigation measures shall be considered if the noise level exceeds the standard.

10.2 Ecosystem survey in the Chalan Beel

In the ecosystem survey, endangered species were identified for mammals and fish. 21 endangered species of fish were identified in partiular, including two critical endangered species (CR). Therefore, preliminary surveys shall be conducted before and during construction, and if their habitats or nesting sites are identified, further mitigation measures shall be conducted, such as suspending or prohibited construction and seeking instructions from Department of Environment (DoE).

10.3 Affected trees

Approximately 80,000 trees will be affected by the Project, including 12 trees designated as endangered species. The 12 trees shall be transplanted to preserve them. Additionally, 3 times as many trees as the number of logged trees shall be planted along the alignment, in the station sites etc. as a mitigation measure. Under the responsibility of BR, a monitoring for 2 years after planting shall be implemented to encourage their native growth.

10.4 Greenhouse gas reduction

A modal shift of passenger and freight transportation will be promoted by the double-tracking railways, which enhances to reduce of over 276,000 t-CO_2 in 2040, contributing to climate change mitigation.

11. Resettlement Action Plan

11.1 Impact of the Project

The Project requires to acquire 72.12 acres of private land. The total numbers of Project Affected Households (PAH) and Project Affected People (PAP) are 2,991 PAHs and 12,150 PAPs, respectively. 32.9% of PAHs are non-title holders, and 1,601 PAHs and 6,753 PAPs require resettlement. There are no ethnic minorities or other minority groups among the affected population.

11.2 Compensation and Assistance Policy

PAPs are entitled to compensation and assistance based on the project impact. Although compensation for land is only for title holders, non-title holders are eligible to receive compensation for structure, crops, trees, etc. owned by them. The basic items of compensation and assistance are summarized as follows.

- Compensation at replacement cost for the loss of land, crops/trees
- Compensation at replacement cost for structures and other immovable property
- Assistance for loss of business income/wage income
- Assistance for relocation of structures, and Common Property Resources (CPRs)
- Assistance for income and livelihood restoration
- Additional support for vulnerable groups

11.3 Stakeholder Meeting

Stakeholder meetings (SHMs) for EIA and RAP were jointly held at the scoping stage and DFR stage. In each stage, SHMs were held at 11 locations in 5 districts. In the SHMs, no objections were expressed by the participants. Separately, a total of 30 focal group discussions (FGDs) were organized, and the comments from FGDs were reflected in the Environmental Management Plan (EMP) and the Entitlement Matrix.

Preparatory Survey for Construction of Dual Gauge Double Line Between Joydebpur-Ishurdi Section Project

Final Report

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List of Stations

Sl. No.	Station Name	Code	Existing Km	Design Km	Class of Station*	Note
1	Ishurdi Junction	ISD	204.80	204.800	B	-
2	Ishurdi Bypass	ISDB	208.58	-	B	-
3	Majhgram	MZRA	211.00	210.983	B	-
4	Mooladuli	MODI	216.70	216.629	B	-
5	Gafurabad	GFB	224.11	224.273	D	-
6	Chatmohar	CMO	229.77	229.977	B	-
7	Guakhara	GAK	235.00	235.121	D	-
8	Bhangura	BOO	239.26	239.424	B	-
9	Baral Bridge	BRBE	241.00	241.132	D	-
10	Saratnagar	SNG	243.50	243.640	B	Improved to B class
11	Dilpashar	DIS	248.37	248.413	D	-
12	Lahirimohanpur	LMR	254.00	254.139	B	-
13	Ullapara	ULP	262.08	262.145	B	-
14	Salop	SOV	267.34	267.446	D	-
15	Jamtoil	JOI	274.50	274.457	B	-
16	Shahid M. Mansur Ali	SMA	281.00	280.759	B	Improved to B class in another project
17	Bangabandhu Setu West	BBW	285.41	285.283	B	-
18	Bangabandhu Setu East	BBE	294.60	294.560	B	-
19	Elenga	-	-	306.015	B	New crossing station
20	Tangail	TAGL	315.50	315.460	B	-
21	Karotia	-	-	323.100	B	New crossing station
22	Mohera	MHRA	331.24	331.194	B	-
23	Mirzapur	MZRP	341.40	341.334	B	-
24	Hi Tech City	-	-	350.800	B	Opened in 2018 instead of Kaliakoir station
25	Mouchak	MOCK	362.20	362.111	B	-
26	Mirer Bazar	-	-	370.073	B	New crossing station
27	Joydebpur	JYR	378.20	378.123	B	-

*: 'B' Class station has station yard, 'D' Class station has no station yard.

Abbreviations and Terminology

Abbreviation	Terminology
ADB	Asian Development Bank
AIDS	Acquired Immunodeficiency Syndrome
ARIPA	Acquisition and Requisition of Immovable Property Act
ATACS	Advanced Train Administration and Communications System
ATC	Automatic Train Control
ATP	Automatic Train Protection
ATS	Automatic Transfer Switch
ATS-P	Automatic Train Stop P-Type
ATS-S	Automatic Train Stop S-Type
AVR	Automatic Voltage Regulator
B/C	Benefit over Cost
BDT	Bangladeshi Taka
BG	Broad Gauge (1,676m gauge)
BIWTA	Bangladesh Inland Water Transport Authority
BMMS	Bangladesh Maternal Mortality and Health Care Survey
BNBC	Bangladesh National Building Code
BRWWM	Bangladesh Railway Way and Works Manual
BOD	Biochemical Oxygen demand
BOQ	Bill of Quantities
BR	Bangladesh Railway
BWDB	Bangladesh Water Development Board
CBI	Computer Based Interlocking Devices
CCL	Cash Compensation under Law
CEDAW	Convention of the Elimination of All Forms of Discrimination against Women
CMP	Current Market Price
CMS	Cast Manganese-Steel (crossing)
COD	Chemical oxygen demand
COVID-19	Coronavirus Disease 2019
CP	Counterpart
CP	Construction Phase
CPR	Common Property Resources
CSC	Construction Supervision Consultant
CSL	Clear Standing Length
CSS	Census and Socio-economic Survey
CTC	Centralized Traffic Control (system)
D/D	Detailed Design

Abbreviation	Terminology
DB	Design Build
DC	Deputy Commissioner
DF/R	Draft Final Report
DG	Dual Gauge (Broad Gauge and Meter Gauge on 1 track)
DG	Director General
DNP	Defect Notification Period
DO	Demand Oxygen
DPP	Development Project Proforma/Proposal
DRGA	Debt Relief Grant Aid
DoE	Department of Environment
E/S	Engineering Services
ECC	Environmental Clearance Certificate
ECR	Environment Conservation Rules
EG	Emergency Generator
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
EQS	Environmental Quality Standards
ESC	Environmental Social Considerations
ETCS	European Train Control System
EU	European Union
F/F	Fact Finding mission
F/R	Final Report
F/S	Feasibility Study
FFU	Fiber-reinforced Foamed Urethane
FGD	Focus Group Discussions
FIDIC	Fédération Internationale Des Ingénieurs-Conseils
FIRR	Financial Internal Rate of Return
GAP	Gender Action Plan
GHG	Green House Gas
GHPW	On-site Gas Heat Pressure Welding Machine
GLCNMO	Global Land Cover by National Mapping Organizations
GOB	Government of Bangladesh
HHR	Head Hardened Rail
HIES	Household Income and Expenditure Survey
HIV	Human Immunodeficiency Viruses
HSR	High Speed Railway
HWL	High Water Level

Abbreviation	Terminology
ICB	International Competitive Bidding
IEC	International Electrotechnical Commission
IEE	Initial Environmental Examination
IFC	International Finance Corporation
INGO	International Non-Governmental Organization
IOL	Inventory Of Loss
ISCGM	International Steering Committee for Global Mapping
ISO	International Organization for Standardization
IT/R	Interim Report
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
JIDLP	Joydebpur and Ishurdi Double Line Project
JIS	Japan Industrial Standard
JNR	Japanese National Railways
JST	JICA Study Team
LAP	Land Acquisition Plan
LARAP	Land Acquisition and Resettlement Action Plan
LC	Least Concerned
LC	Level Crossing
LCC	Life Cycle Cost
LTC	Load Tap Changer
LoC	Line of Credit
M/F	Mal per Female
MDB	Multilateral Development Bank
MDI	Diphenyl Methane Diisocyanate
MLIT	Ministry of Land Infrastructure and Transportation, Japan
MG	Meter Gauge (1,000mm gauge)
MOF	Ministry of Finance
MOPA	Ministry of Public Administration
MOR	Ministry of Railways
MOR	Ministry of Railways
N&V	Noise & Vibration
N/A	Not Applicable
NEMAP	National Environmental Management Action Plan
NOC	Non-Objection Certificate
NOx	Nitrogen Oxides
NT	Near Threatened
O&M	Operation and Maintenance

Abbreviation	Terminology
OD	Origin and Destination
OFC	Optical Fiber Cable
OP	Operational Policies
OP	Operation Phase
PAHs	Project Affected Households
PAPs	Project Affected Peoples
PBS	Polli Biddut Samaity
PC	Pre-stressed Concrete
PD	Project Director
PIU	Project Implementation Unit
pH	potential of Hydrogen
PSC	Pre-Stressed Concrete
PVAC	Property Valuation Advisory Committee
RAP	Resettlement Action Plan
RC	Reinforced Concrete
RC	Replacement Cost
RCIP	Regional Cooperation and Integration Project
ROW	Right Of Way
RRR	Reinforced Railroad with Rigid Facing Method Embankment
RTA	Railway Training Academy
RTRI	Railway Technical Research Institute
SBD	Standard Bidding Documents
SEJ	Switch Expansion Joints
SHM	Stakeholders Meeting
SoR	Schedule of Rate
SOx	Sulfur Oxides
SPM	Suspended Particle Matter
SPT	Standard Penetration Test
STD	Sexually Transmitted Diseases
T-N	Total Nitrogen
T-P	Total Phosphorus
T/A	Technical Assistance
TAPP	Technical Assistance Project Proposal
TC	Track Circuit
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TOR	Terms of Reference
TPRP	Tree Plantation and Replacement Programme

Abbreviation	Terminology
TSS	Total Suspended Solids
TTC	Travel Time Cost
ToC	Table of Contents
UIC	International Union of Railways (Union Internationale des Chemins de Fer)
UN	United Nations
USP	Under Sleeper Pad
VOC	Vehicle Operation Cost
VU	Vulnerable
WB	World Bank
WHO	World Health Organization
WS	Wayside Signal

Chapter 1 Introduction

1.1 Background

According to the Master Plan of Railways of the People's Republic of Bangladesh 2019 (hereafter referred to as the "BR Master Plan"), the country's railways have not been able to meet the growing transportation demand due to the bottlenecks of low transportation capacity. Besides, according to the 8th Five-Year Plan (FY2020/21-FY2024/25), the country's transportation demand is growing at about 8% per year due to strong economic growth in the country and neighboring countries. The government plans to strengthen transportation capacity through the construction of a double-track railway.

The "Project for Construction of Dual Gauge Double Line between Joydebpur - Ishurdi Section" (hereafter called "the Project") aims to enhance railway transportation capacity by double-tracking the main line between Joydebpur and Ishurdi, which connects the east and west sides of the country. Currently, all sections of between Joydebpur-Ishurdi are single tracks, and the Jamuna Multipurpose Bridge, completed in 1998, is located almost in the middle. This bridge is with a single track and has a train load limit and speed limit, which is a bottleneck in responding to the increasing demand for rail transport. Therefore, in the BR Master Plan, construction of a railway bridge to replace the existing bridge was positioned as a top priority project along with the double-tracking of the between Joydebpur-Ishurdi section. After that, the Japan ODA loan project "Jamuna Railway Bridge Construction Project" has started in 2020, and it is expected that the bottleneck of railway transportation will be eliminated when the construction is scheduled to be completed in 2024. In addition to the development effect of the Jamuna Railway Bridge Construction Project, the Project aims to strengthen the transportation capacity of the whole section between Joydebpur-Ishurdi by double-tracking the section connecting the east and west sides of the bridge.

* Double Track Project from the Akhaura - Laksam, financed by ADB.

Source JST

Figure 1.1 Image of Double-Tracking Railway After Completion

When the Project is implemented, the entire section from Darshana station on the Indian border to Dhaka, the country's capital, will be double-tracked. The Project will enhance logistics capacity between the western part of the country and Dhaka, thereby improving connectivity within the country

and with neighboring countries, and is expected to promote the economic development in the entire region, including the local economy.

The executing agency, the Bangladesh Railways (hereafter called "BR"), has already conducted a Feasibility Study (hereafter called the "Prior F/S") of the project in 2019. However, since several years have passed after the study, it is necessary to review the project cost, available technologies, construction methods, materials, equipment, etc.in the Study. In addition, JICA Study Team (hereafter called "JST") will gather additional information to consider avoidance, minimization, mitigation, and compensation for environmental and social impacts.

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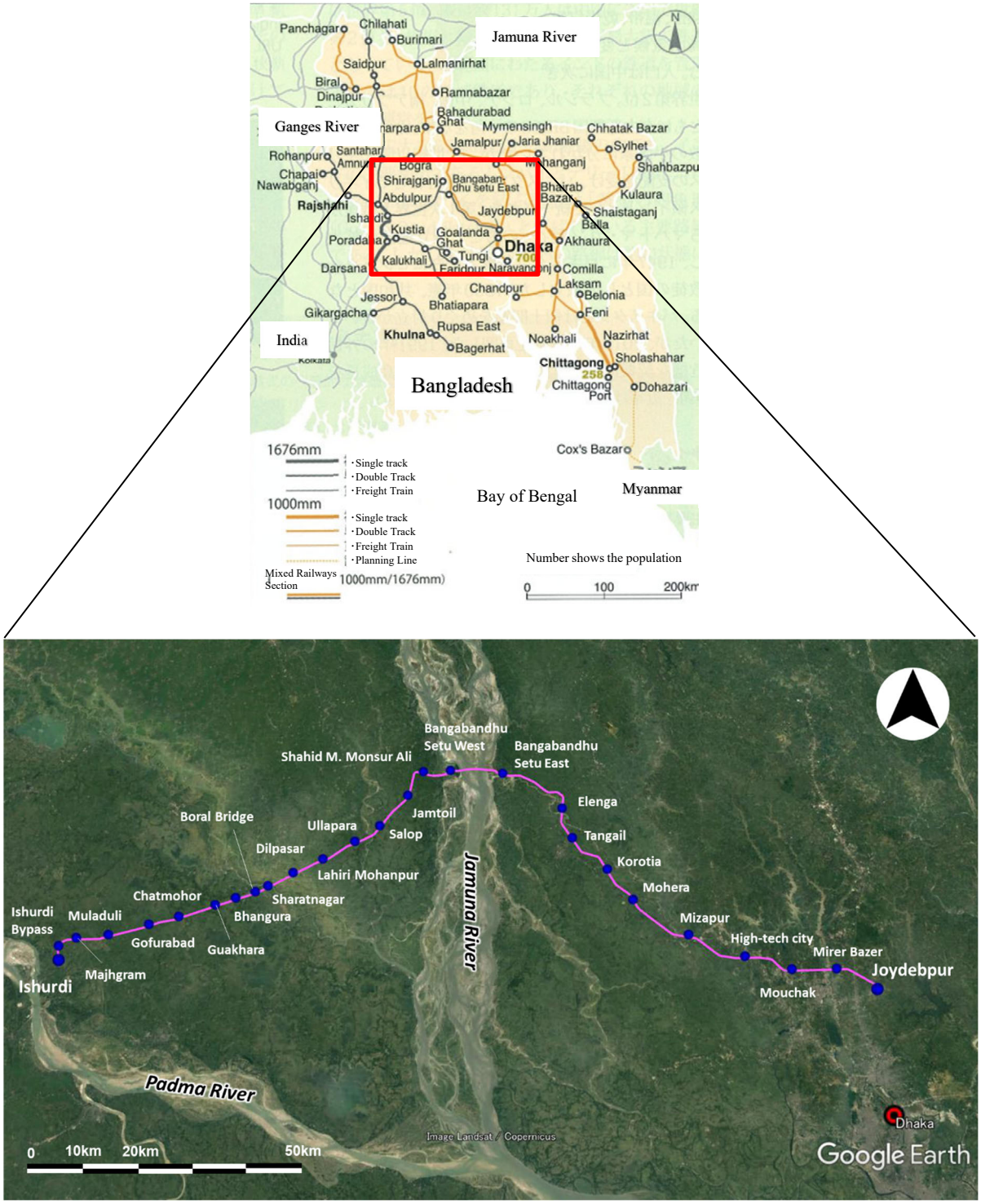
Project Objectives	By implementing the double-tracking between Joydebpur Station near Dhaka and Ishurdi Station in the western part of the country, the project aims to enhance railway transportation capacity and promote economic development through improved connectivity within the country and with neighboring countries.
Project Outline	Railroad double-tracking from Joydebpur station to Ishurdi station Doubling of the line: approx. 170 km: civil works (including the construction of approx. 200 bridges and renewal of 20 out of 24 existing stations), track works, signaling and communication facilities (international competitive bidding) Consulting services: detailed design, bidding assistance, construction supervision, environmental and social consideration procedures, monitoring assistance, etc.
Survey Area	Gazipur District, Tangail District (Dhaka Division) Sirajganj District, Pabna District, Natore District (Rajshahi Division)
Executing Agency	Bangladesh Railway (BR)
Other related Government Agencies and Institutions	Ministry of Railways (MOR)
Study Period	June 2022 - November 2024

Source: JST



Source (1): "Railways of the World", Association for Overseas Technical Cooperation on Railways, Diamond Bic (upper)
Source (2): JST based on the Google Earth (lower)

Figure 1.2 Map of Routes covered in the Study

1.3 Prior Studies and Existing Projects

The following studies and projects have been conducted prior to the Study, and the information obtained from these previous studies and projects should be utilized to the maximum extent possible to ensure that the study is conducted efficiently and without duplication.

Table 1.2 List of Prior Studies and Existing Projects

№	Prior Studies and Existing Projects
1	Yen loan "Jamuna Railway Bridge Construction Project" (First phase approved in 2016, second phase approved in 2020)
2	Supplemental Study Final Report on the Jamuna Railway Dedicated Bridge Construction Project, Bangladesh." (JICA, November 2015)
3	Feasibility Study for Construction of Double Line between Joydebpur and Ishurdi Section of Bangladesh Railway (June 2015 and February 2019 revised) (hereafter "the Prior F/S")
4	Resettlement Plan (January 2019)
5	Environmental Impact Assessment Study of Construction of Double Line Between Joydebpur and Ishurdi Section of Bangladesh Railway (March 2020)
6	Ex-post evaluation report of the yen loan "Dhaka-Chittagong Railway Network Development Project", JICA, 2019
7	Bangladesh: Jamuna Bridge Railway Link Project," Asian Development Bank, November 2005.
8	Bangladesh: Railway Sector Investment Program," Asian Development Bank, November 2019, etc.
9	Feasibility Study of Construction of Dual Gauge Railway Line from Bogura to Shahid M. Mansur Ali Station, Sirajganj of Bangladesh Railway (Interim Report, May 2022)

Source: JST

1.4 Overview of BR

1.4.1 Basic Information on BR

The basic information on BR is as follows.

Table 1.3 Basic Information on BR (2019-2020)

Items	Figures
Current No. of Station	489
Number of Passenger Trains Daily	328
Total Passengers Carried (million)	63.99
Average lead of a Passenger (Km.)	155.62
Number of Freight Train Daily	26
Annual Total Tons carried (million)	3.18
Average lead of Ton of Freight (Km.)	315.56
Annual Total Operating Revenue (million Taka)	14,065.79
Annual Total Operating Expense (million Taka)	30,506.52
Annual Net Operating Income (million Taka)	(-)16,440.73
Operating Ratio (%)	283.25
Number of Employees	26,449

Source: BR (Information Book 2020)

1.4.2 Previous Master Plan and Revised Master Plan

The previous Railway Master Plan (Master Plan, 2010-2030) was prepared in 2006, based on 2005 and earlier data, which means that the assumptions and situation were now over 15 years old. Based on the current situation, the assumptions and data upon which the previous Master Plan was developed have changed. In addition, updating the previous Master Plan, including uprising needs such as gauge conversion and modeling of capacity and operations, is necessary. Therefore, BR decided to update the previous Master Plan and a revised version, the BR Master Plan including the information on (2017 to 2045) was created to play an important and dominant role in an integrated transport system by emphasizing its strength.

The BR Master Plan includes the projects' financial aspects and identifies which projects are best implemented as the GoB loans, ODA loans, or PPP scheme. Then, the BR Master Plan composes of 30 years and is divided into six phases every five years. The table below shows the expenditure for each phase of the BR Master Plan over five years if all projects are implemented as planned.

Table 1.4 The BR Master Plan's Cost by Phase

Phases	Period	Total no. of Project	GOB	FA	FA/PPP	FA/GOB	Total Cost
Phase 1 Project	2016-2020	83	6,673	77,673	9,030	54,457	147,833
Phase 2 Project	2021-2025	67	11,412	72,812	3,439	32,017	119,680
Phase 3 Project	2026-2030	37	8,054	-	1,600	84,507	94,161
Phase 4 Project	2031-2035	23	726	-	-	96,159	96,885
Phase 5 Project	2036-2040	1	125	9,448	-	73,076	82,649
Phase 6 Project	2041-2045	6	125	1,534	-	10,795	12,454
Total for all Phases		**217**	**27,115**	**161,467**	**14,069**	**351,011**	**553,662**

Note: GOB: Government of Bangladesh
FA: Foreign Assistance
PPP: Private Public Partnership

Source: The Master Plan of Railways of the People's Republic of Bangladesh 2019

1.4.3 The Strategy to be Achieved from the BR Master Plan

The six strategies below are to be achieved mentioned in the BR Master Plan.

(1) Gauge Conversion

- Regional railway Integration
- Improved operating performance

(2) Line Improvements

- Electric traction

- S&T enhancements; PW rehabilitation improvement; Additional mainline tracks
- Greater capacity; improved operating performance

(3) New Rail Line

- Extend railway reach
- Increased passenger and freight traffic

(4) Rolling Stock Improvements

- Rehabilitated and new rolling stock
- New and improved maintenance capacity

(5) Updated PW Maintenance

- Mechanized track maintenance

(6) Development and Standardization (D&S) Unit

- Increased standardization and more utilization of Bangladeshi suppliers
- Resulting in greater efficiency and reduced costs

The BR Master Plan has an extensive long-term vision spaning over 30 years, so it is to be reviewed and updated every five years to ensure that the project is headed in the right direction. The Project, "Project for Construction of Dual Gauge Double Line Between Joydebpur-Ishurdi Section", will contribute to the achievement of Strategy (1), (2), and (6).

In the BR Master Plan, BR Vision statement objectives referred to the ranking system by the importance of projects (e.g., traffic forecast, project cost) by giving them a score. The ranking is given by phase, and the Jamuna Railway Bridge project is ranked #1 and the Project is ranked #3 in terms of priority in the ranking among the projects positioned as Phase 1 (2018-2020) when the BR Master Plan was prepared (83 projects in total). (Table 1.5 shows the ranked project in Phase 1, which indicates the high importance of the Project.

The 7th Five-Year Plan (FY2010-FY2021), the Bangladesh government's top development plan, also aims to establish effective railway linkages between the east and west zones of the country, which is divided by the Jamuna River, and participate in global and regional transport connectivity initiatives that help develop the land route links between South Asia and East Asia through Bangladesh. The Eighth Five-Year Plan has been currently prepared based on the Seventh Plan and addresses gaps in progress.

When we consider the above, the Project is essential to Bangladesh because the Joydebpur-Ishurdi line is one of the main lines connecting East and West corridors.

Table 1.5 Project Ranking in Phase1 from the BR Master Plan

No.	Project Name	Project Ranking in Phase	Project Cost (BDT crore)	Project Score
1	Bangabandhu Railway Bridge Constriction	1	9,740	29
2	Construction of new locomotive workshop at Naryanganj	2	1,155	27
3	Conversion of existing MG track to DG track between Akhaura-Sylhet	3	8,619	26
4	Construction of double line between Joydebpur and Ishwardi section of BR	3	7,698	26
5	Construction of Dual Gauge Rail Line Parallel to the Existing metre Gauge Rail Line in Joydebpur-Mymensingh-Jamalpur Section	3	7,255	26
83	Contingent Projects- Phase1	17	1,436	-

Source: The Master Plan of Railways of the People's Republic of Bangladesh 2019

1.5 Achievements and Prospects of Support by Other Donors such as International Organizations

In 2021-2022, 40 railway projects (35 Investment projects & 5 Technical Assistance (TA) projects) are ongoing in Bangladesh. The number of projects by donors is summarized as follows.

Table 1.6 Institutions Financing Bangladesh Railway Projects

Donner Information	Number of Project
Government of Bangladesh (GOB) fund	15
ADB fund	10
India Line of Credit (LOC) fund	6
China fund	3
Fund by tender	2
India Government fund	1
Korea Economic Development Cooperation Fund (EDCF) fund	1
Japanese Debt Relief Grant Assistance (DRGA) fund	1
JICA fund	1

Source: The Master Plan of Railways of the People's Republic of Bangladesh 2019

Out of the project mentioned above, the projects below are considered high-priority projects by BR.

Table 1.7 Important Ongoing Bangladesh Railway Projects

(as of August 2023)

Project Name	Donors
Padma Bridge Rail Link	Chinese G to G
Dohazari-Cox's Bazar via Ramu to Ghundum	ADB
Bangabandhu Sheikh Mujib Rail Bridge over Jamuna River	JICA
Double Tracking of the Akhaura-Laksam Lines	ADB & EIB
Khulna-Mongla Rail Link	Indian LOC
3 rd & 4th Line between Dhaka-Tongi and 2nd Line between Tongi-Joydebpur	Indian LOC
Darshana-Khulna Broad Gauge Double Line	Indian LOC
Bogra-Shahid M. Monsur Ali Dual Gauge Single Line	Indian LOC
Procurement of Meter Gauge and Broad Gauge Passenger Carriages	ADB
Procurement of 20 Nos. Meter Gauge Diesel Electric Locomotives and 150 Nos. Meter Gauge Passenger Carriages	EDCF
Procurement of Locomotives, Relief Cranes and Locomotive Simulator	ADB
Rehabilitation of 100 nos. Meter Gauge Passenger Carriages	GoB

Source: The Master Plan of Railways of the People's Republic of Bangladesh 2019

ADB and the Indian government have actively financed the BR projects to increase the line capacity of the main corridors, which matches the strategy of the BR Master Plan. In addition, the Jamuna Railway Bridge Project financed by JICA is a key project to connect the west and east sides separated by the Jamuna River, which is one of the serious bottlenecks to increase the line capacity along the corridor. To make the most use of the impacts of other funded projects, the line capacity enhancement of the next section, the Joydebpur and Ishurdi section, is crucial.

Chapter 2 Outline of the Prior F/S

2.1 General

(1) Introduction

The Joydebpur – Ishurdi section is the backbone of the cross-border transaction from India and is connected to the seaports, such as Chattogram or Cox's Bazar. This corridor is a part of the proposed Trans-Asia Railway network, The Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC), South Asia Subregional Economic Cooperation (SASEC), South Asian Association for Regional Cooperation (SAARC), and Bangladesh, China, India and Myanmar Economic Corridor (BCIM). The relevant corridor or route of each plan or strategy is described in Table 2.1.

Table 2.1 Relevant Plans on Joydebpur – Ishurdi Section

Plan	Corridors or Routes related to the Study
BIMSTEC	Kolkata Port - Banapole – **Jessore – Dhaka** – Agartala
SASEC (Corridor 2)	Kolkata- Ranaghat – **Gede (Darshana)– Tangail – Dhaka** – Cumilla - Chattogram (Chittagong) - Cox's Bazar
SAARC (Corridor 4)	Kathmandu – Kakarhitta – Panitanki – Phulbari - **Banlabandha – Dhaka** – Chittagong – Cox's Bazar
BCIM	Kunming – Dali – Baoshan – Mandalay – Imphal – Silchar – Sylhet – **Dhaka – Jessore** - Kolkata

Note: The sections in **bold** include the Joydebpur – Ishurdi section in their planned corridors.

Source: ADB, INSIGHTSIAS (https://www.insightsonindia.com/2019/04/29/bangladesh-china-india-myanmar-bcim-economic-corridor/)

The Joydebpur - Ishurdi section is around 174 km long which is currently a single-track dual-gauge (DG) line. This railway project is to construct a second line of 162.023 km, which runs along the north side of the existing Joydebpur - Ishurdi railway.

(2) History of the Project

The following is a summary of the history of the Project through the Prior F/S. The Prior F/S conducted in FY 2019 is a supplemental study conducted to reflect changes that occurred during the approval process of the F/S conducted in FY 2015 and the DPP prepared at that time. The Study reviews this FY 2019 F/S (Prior F/S)) and the DPP.

Table 2.2 History of the Project

Month, Year	Actions
December 2014	• The first project DPP was prepared and approved by Planning Committee
March 2015	• The Feasibility Study was completed for construction of double line between Joydebpur and Ishurdi Section of Bangladesh Railway by the Consulting Firm.
October 2016	• Cabinet Committee of Economic Affairs (CCEA) had approved in principle for implementation of the project under China G to G funding through Direct Procurement Method (DPM).
November 2018	• Based on negotiated contract price and updated cost of other items, DPP was approved by 'Executive Committee of the National Economic Council (ECNEC)'.
January 2019	• As the scope of work and construction cost of DPP deviates from the original Feasibility Study Report, BR has formed the following 5-member committee.

Source: The Prior F/S

2.2 Review of the Prior F/S

The results of the Prior F/S review on demand forecast, economic and financial analysis and operation and maintenance are shown below. The geological survey results are described in "Chapter 5 Natural Condition".

2.2.1 Demand Forecast

Trend lines or preconditions of demand forecast in the Prior F/S are shown below.

(1) General

- The opening year of the double-tracked railway of the Joydebpur – Ishurdi section is 2025.
- Annually rate of growth is 5% and initially to lengthen trains to 22 carriages and then introduce new trains.
- The travel time for a single track is assumed to average 50 km/h, while the travel time for a doubled track is 75 km/h. Mail Express or Local trains speed is 25% lower than other trains.
- The rail traffic on this new rail route is restricted by track (facility) capacity
- Double tracking will increase the line capacity from the present capacity of 28 trains to 74 trains a day.

(2) Freight

- The trend in freight transport volume was a decrease from 3.5 million tons per year in 2004-5 to 2 million tons in 2012-13, and revenue from freight transport also decreased from BDT 1.26 billion to BDT 96 million. Subsequently, the company revised its transportation rates in October 2012, and in 2013-14, the volume of cargo transported recovered to 2.5 million tons per year and revenues to BDT 1.42 billion BDT.

- The Prior F/S uses the 2013-14 results as a benchmark in forecasting cargo demand and assumes that cargo transport will continue to grow as capacity is increased through maintenance and other measures[1].

(3) Passenger

- The fare setting of the passenger rail is 0.80 taka per passenger-km, while the current bus fare is 1.45 per passenger-km, as set by the Ministry of Communications.
- Fare revision was not conducted between 1992 and 2012, while it was increased by an average of 30% for lower classes and 50% for upper classes.
- Trains are always assumed to be 80% full.

2.2.2 Economic and Financial Analysis

(1) Preconditions

Project-specific assumptions set in the Prior F/S are summarized below.

1) Scenario

- Without-Project case
  - Subproject 3, Jamuna Rail Bridge, will construct simultaneously with the Project in 2025.
- With-Project case
  - The Project opens in the year 2025.
  - The Ishurdi-Joydebpur line section is double-track with dual-gauge.

2) Basic Conditions

- Growth Rate: 5% per year
- Conversion Factor: 0.8
- Discount Rate: 12%
- Construction Period: 5 years (2018 – 2022)
- CAPEX: Infrastructure improvement and additional rolling stocks
  - Financial cost: BDT 141,267 million
- OPEX: operation and maintenance cost of railway infrastructures

(2) Economic Benefits

In the Prior F/S, economic benefits were categorized into passenger and freight transport, as shown in the following table. Since the calculated economic benefits correspond to the benefits in the manual, the same economic benefits are updated in this study.

[1] According to the Prior F/S, interviews with major shippers of containers and bulk products were conducted in 2012.

Table 2.3 Economic Benefits Calculated in the Prior F/S

Passenger Transport	Freight Transport
Vehicle Operation Cost (VOC) Savings of Buses	VOC Savings of Trucks
Savings in road accidents reduction costs	Savings of road maintenance caused by trucks
Travel Time Cost (TTC) Savings (all passengers)	Savings in road accidents reduction costs
Savings due to modal shift	Savings in GHG emissions

Source: The Prior F/S

(3) Results of the Prior F/S

The results calculated in the Prior F/S are summarized as follows.

Table 2.4 Economic and Financial Analysis A Calculated in the Prior F/S

Economic Analysis	Financial Analysis
NPV at 15% = BDT 497,414.69 Lakh BDT	NPV at 15% = BDT 47,230.21 Lakh BDT
NPV at 20% = BDT -19,636.57 Lakh BDT	NPV at 18% = BDT -152,494.91 Lakh BDT
B/C at 15% = 1.55	B/C at 15% = 1.06
B/C at 20% = 0.97	B/C at 18% = 0.79
EIRR = 19.8 %	FIRR = 15.7 %

Source: The Prior F/S

It was concluded in the Prior F/S that both EIRR and FIRR are more than the discount factor of 15%, and the cost-benefit ratios are more than one. Therefore, the project is defined as viable both economically and financially.

2.2.3 Operation and Management

(1) Numbers of Trains and Composition of the Passenger Train

According to the Prior F/S, 32 passenger trains were operating in the section. And average 10.2 coaches are used for each train. After 2019, more train services to the northbound are added.

The compositions confirmed by the survey team in the field survey ranged from 10 to 17 cars (excluding locomotives). JST cannot confirm the latest number of coaches used in this section. It needs to be studied further in a future survey on the E/S stage.

As of July 2022, 32 to 37 passenger and two freight trains are operating in the section. The total operating slots are 44. The numbers of passenger trains are organized table below.

Table 2.5 Day wise Number of Trains operated between Joydebpur - Ishurdi Section

Train / Operation Number	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Ekota Express / 705,706	2	2	2	2	2	2	2
Lalmoni Express / 751.752	2	2	2	2	2	0	2
Drutajan Express / 757, 758	2	2	2	2	2	2	2
Rangpur Express / 771	0	1	1	1	1	1	1
Rangpur Express /772	1	1	1	1	1	1	0
Maitree Express / 3107	0	1	0	0	0	1	0
Maitree Express / 3108	0	1	0	0	0	0	1
Maitree Express / 3109	0	0	1	0	0	1	0
Maitree Express / 3110	0	0	0	1	0	0	1
Sundarban express / 725, 726	2	2	2	0	2	2	2
Silkcity Express / 753, 754	0	2	2	2	2	2	2
Padma Express / 759, 760	2	2	0	2	2	2	2
Chitra Express / 763, 764	2	0	2	2	2	2	2
Neelsagar Express / 765	1	0	1	1	1	1	1
Neelsagar Express / 766	0	1	1	1	1	1	1
Dhumketu Express / 769	1	1	1	1	0	1	1
Dhumketu Express / 770	1	1	1	0	1	1	1
Sirajganj Express / 775, 776	2	2	2	2	2	2	0
Jamalpur Express / 799, 800	0	2	2	2	2	2	2
Rajshahi Express / 5, 6	2	2	2	2	2	2	2
Local / 5, 551	2	2	2	2	2	2	2
Tangail Commuter	2	2	2	2	2	2	2
Banalata Express / 791, 792	2	2	2	2	2	0	2
Panchargarh Express / 793, 794	2	2	2	2	2	2	2
Benapole Express / 795, 796	2	2	2	0	2	2	2
Kurigram Express / 797, 798	2	2	2	0	2	2	2
Total no. of trains in the section	32	37	37	32	37	36	37

Source: JST

BR holds the two train sets for every train slot to cater to incoming and outgoing train operations. As of 2017, 532 coaches are required for the passenger service in the section. Twenty-six train slots require 532 coaches, which means 20.4 coaches are required for one train slot.

Train composition for between Joydebpur to Ishurdi section is organized in the table below.

Table 2.6 Train Composition of the Passenger Trains between Joydebpur-Ishurdi Section

Name of Trains	Train No	Composition (coaches)	Coaches secured (coaches)
Sundarban Ex.	726	13	26
Sundarban Ex.	725	13	26
Chitra Ex.	764	8	16
Chitra Ex.	763	8	16
Maitree Ex.	3107/3110	6	12
Maitree Ex.	3108/3109	6	12
Nilsagar Ex.	765	12	24
Nilsagar Ex.	766	12	24
Silk city	753	9	18
Silk city	754	9	18
Padma Ex.	759	9	18
Padma Ex.	760	9	18
Dhumketu Ex.	769	9	18
Dhumketu Ex.	770	9	18
Ekota Ex.	705	12	24
Ekota Ex.	706	12	24
Drutojan Ex.	757	12	24
Drutojan Ex.	758	12	24
Lalmoni Express	751	12	24
Lalmoni Express	752	12	24
Rangpur Ex.	771	11	22
Rangpur Ex.	772	11	22
Sirajgonj Ex.	776	12	24
Sirajgonj Ex.	775	12	24
Rajshahi Ex.	5	8	16
Rajshahi Ex.	6	8	16

Source: JST

Chapter 3 Consideration of Alternative Plans

3.1 Introduction

Traffic between Joydebpur and Ishurdi section is increasing along with the economic growth of Bangladesh, and trains exceeding the line capacity of this section are being operated. In addition, the Jamuna Railway Bridge with double-track, which is located roughly in the middle of this section, is scheduled to be opened in 2024, but the expansion of the line capacity is limited with much of the remaining section being single-track. It is necessary to improve the line capacity of the remaining single-track section to meet the increased traffic demand.

The Environmental Impact Assessment report[2] of Construction of Double Line Between Joydebpur and Ishurdi Section of Bangladesh Railway in March 2020 (hereinafter referred to as "EIA report of JIDLP 2020") prepared by BR has examined alternatives, on the premise that all lines will be double-tracked, regarding the installation position of the additional track are being examined. This chapter examines alternatives, including the ones without double tracking the entire line, which are considered possible to improve the line capacity above mentioned.

3.2 Alternatives for Double-Tracked Side (1st Alternatives)

The EIA report of JIDLP 2020 had analyzed two alternatives, one with double track to the north and the other with double track to the south next to the existing track, based on the principle of double track construction for the entire line as shown in the following. However, considering the JICA Guidelines for Environmental and Social Considerations (April 2010) (hereinafter referred to as "JICA guidelines"), the alternatives comparison is insufficient because it does not include a zero option (without project) and does not consider the project suitability for the regional conditions including other connected lines. Therefore, a more detailed alternatives analysis is conducted in 3.3.

As the first step, two options are set in the EIA report of JIDLP 2020 as below.

- Option 1: New track constructed at north of the existing rail line
- Option 2: New track constructed at south of the existing rail line

In determining the preferred rail alignment, the BR survey team considered a range of issues related to economy, technology, safety, environmental degradation, social impacts, and community disruption.

[2] On 29th June 2020, the Department of Environment (DoE) issued the Project's Environmental Clearance Certificate (ECC). As of May 2023, the latest ECC has been issued in October 2022, and no need to revise or resubmit the report in this Feasibility study.

A comparative analysis of the two options is provided in the table below. The likelihood of negative impacts for each criterion was scored between 1 and 5, with 1 being the highest negative impact.

Table 3.1 Comparison of Alternatives between Option 1 and Option 2

Environmental and Social Indicators Affected	Opt. 1 North	Opt. 2 South
Level of environmental disturbance; noise, smoke, dust	5	4
Interference to the human settlements/structures, economic activities and direct and indirect impacts on households, and on the integrity of communities	5	2
Interference to the social structures e.g., schools, hospitals, primary health clinics, playgrounds and other public facilities	4	2
Interference to cultural infrastructures e.g., worship places and cemeteries	4	4
Compliance with the railway standards for curvature and grading	5	3
Avoiding interference to sensitive receptors and preventing increased siltation following river crossing to facilitate compliance with alignment criteria and grading	4	4
Choosing alignment to facilitate release of flood flows	5	4
Impact considering availability of BR lands	5	3
Likely impact score summation	37 (Av. score: 4.63)	26 (Av. Score: 3.25)
Option rating	1	2

Likely Environmental Impact Scale 5 = very low 4 = low 3 = Moderate 2 = Above average 1 = High

Source: EIA report of JIDLP 2020

The analysis shows that Option 1 is likely to have fewer negative impacts rather than Option 2. Important attributes of Option 1 are that BR owns most of the necessary easement, which will significantly minimize impacts related to land acquisition, resettlement and sensitive areas. Further, all 'B' Class stations (18) (excluding Ishurdi and Joydebpur) are on the south side of the existing line, and there are only three 'D' Class Stations on the north side, which do not have station yards. That means the cost for relocating stations is significantly less for Option 1. For those reasons, Option 1 would have significantly lower potential environmental and social impacts as well as a lower capital cost compared to Option 2. Therefore, Option 1 was concluded as preferred and is the subject of this EIA.

3.3 Alternatives for Double-Tracked Section (2nd Alternatives)

3.3.1 Related Project of the Project

The following projects will be expected to have a large impact on consideration of the alternatives in the viewpoint of demand and train operation plans. Summaries of the projects are shown below:

(1) Jamuna Railway Bridge Construction Project

The Jamuna Bridge, which is located almost in the middle of Joydebpur-Ishurdi Section, is currently under construction as a double-track railway bridge with a Japanese ODA loan. The existing Jamuna Multipurpose Bridge has a single track and has restrictions on speed and axle load, and has become a bottleneck for transportation. The completion of this Railway bridge will improve the line capacity of the section across the bridge, enabling more stable operation.

(2) Padma Bridge Rail Link Project

The Padma Bridge Rail Link is a new 169km-long railway link being built to connect Bangladesh's capital city Dhaka to Jashore with Chinese financial support. The rail link will pass through the Padma Bridge, a 6.1km-long multi-purpose bridge with a single track being built across the Padma River. The Padma Bridge is completed in 2022 and the entire rail link is scheduled to be completed in 2023.

Since this rail link will be a shortcut between Dhaka and the southwest Bangladesh as well as Kolkata, India, it is expected that some of current operating trains between Joydebpur - Ishurdi section will divert to this link.

(3) Line Expansion Project between Dhaka-Tongi-Joydebpur Section

BR is carrying out the 35 km of line expansion project including a 25km of 3rd and 4th track construction on Dhaka-Tongi section and a 10 km of track doubling construction on the Tongi-Joydebpur section by Indian fund.

Currently, Dhaka-Tongi section is double tracks and Tongi-Joydebpur section is a single track.

The project was launched in 2012 and is supposed to be completed by 2023. However, the construction has been delayed, especially between Dhaka and Tongi, because it overlaps with highway construction just above the rail track.

(4) New Line Construction Project between Bogura to Shahid M. Mansur Ali station

This line is a new DG line with a single track of approximately 75 km, branching off from Shahid M. Mansur Ali station on the Joydebpur-Ishurdi Railway and headed for Bogura. This line will play an important role in connecting the capital Dhaka with Bogura and Rangpur (Rangpur Division).

After completing this line, the trains currently running on the Joydebpur-Ishurdi section bound for Bogura and Rangpur will pass through this line from Shahid M. Mansur Ali Station (currently four trains per day).

Indian consultants are conducting F/S, D/D, T/A (Tender Assistance), and C/S (Construction Supervision) for this line with funds from the Export-Import Bank of India. As of April 2023, the F/S and D/D are ongoing, and the D/D is scheduled to be completed in June 2023, after which the bidding for the contractor will be held immediately.

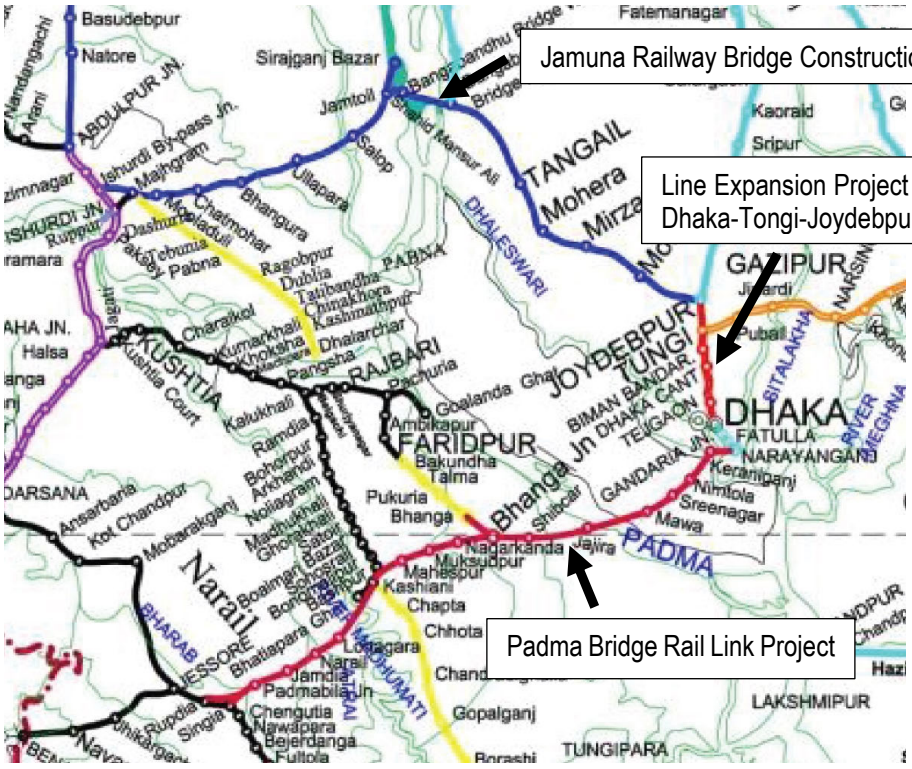
The location of this line is shown in Figure 3.1.

(5) Track Doubling and Conversion existing MG Line to DG Line (Santahar to Lalmonirhat)

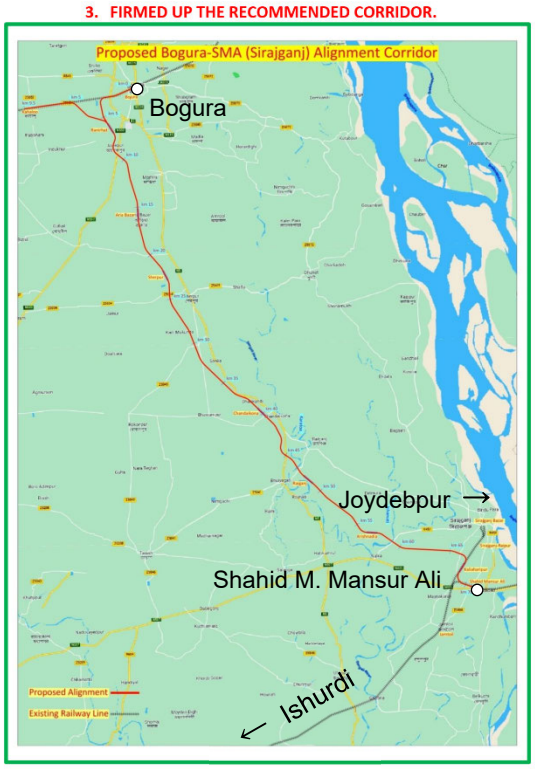
The line between Santahar and Lalmonirhat, where the above new line connects at Bogura, is currently a single MG line, but there are plans to double-track the DG from the perspective of expanding the BG network. If the above new line and this project are realized, DG trains will be able to operate between the capital city of Dhaka, and it is expected that the transport capacity of passengers and freight will be increased.

F/S and D/D for this project are scheduled to be implemented by ADB funds, and the consulting service started in February 2023.

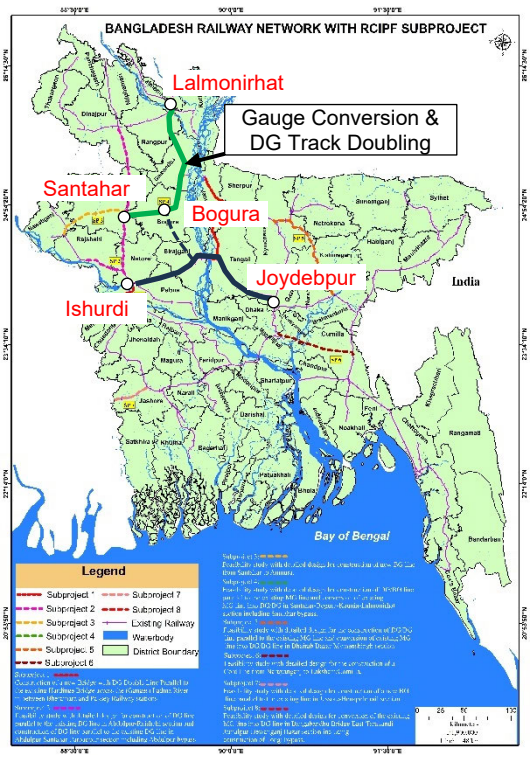
The location of this line is shown in Figure 3.1.



Jamuna Railway Bridge Construction Project, Line Expansion Project between Dhaka-Tongi-Joydebpur Section and Padma Bridge Rail Link Project



New Line between Shahid M.Mansur Ali and Bogura to be funded by Export-Import Bank of India



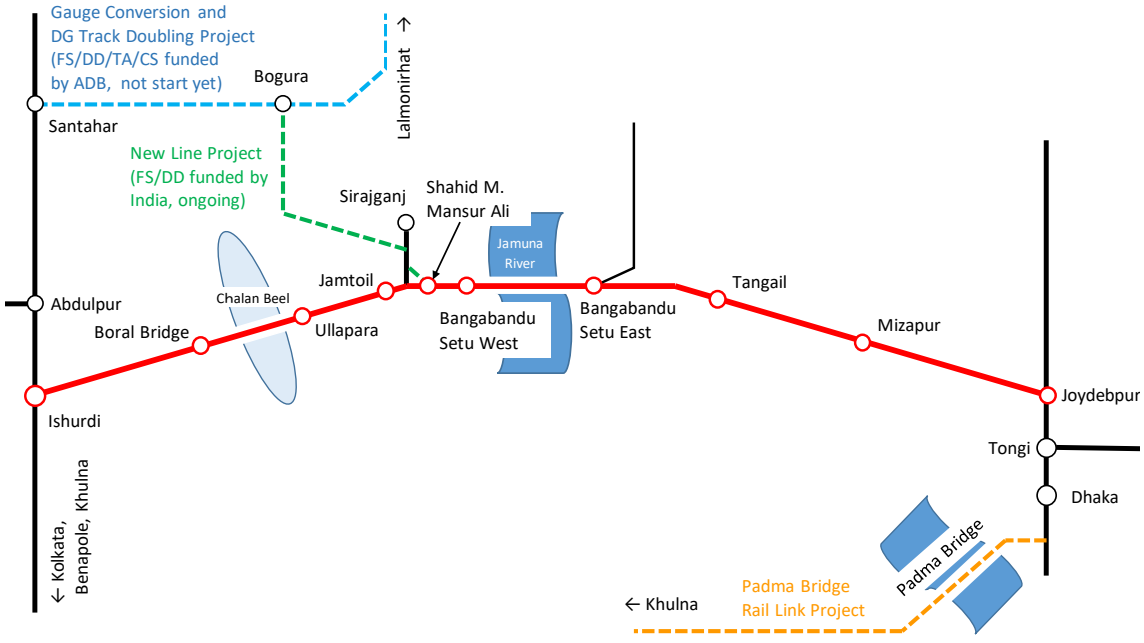
Gauge Conversion & DG Track Doubling (Santahar to Lalmonirhat) funded by the ADB

Source: BR and ADB

Figure 3.1 Location of Related Projects

3.3.2 Current Situation of the Section between Joydebpur and Ishurdi

The train punctuality rate between Joydebpur and Ishurdi section ranges from 20% to 65% in 2019, which is well below the average of in western Bangladesh. Although the line capacity in this section is about 25 trains per day, in reality 37 trains per day are currently in operation, which is far exceeding the line capacity. For this reason, it is thought that the delays that occur during operation cannot be absorbed and spread to the entire line section due to a single track in this section. Currently, the biggest bottleneck in the line capacity is the Jamuna Bridge section, but this bottleneck is expected to be eliminated with the opening of a new double-track railway bridge (scheduled in 2024). However, since a single track remains in other sections except for the Jamuna Bridge, the line capacity of the entire line will not be increased. Therefore, it is not expected that the train punctuality rate or the number of trains to be increased. In the entire section, the average distance between stations where trains can pass each other is 8.1 km (maximum 14.7 km) in the western section (Ishurdi side), while the eastern section (Joydebpur side) is 16.7 km (maximum 20.9 km). Since the line capacity is based on the distance between stations, it can be said that the east side section lowers the line capacity of the entire line section. In addition, in relation to the Project, a new line branching off from Shahid M. Mansur Ali Station on the west side of Jamuna Bridge is being planned (The detailed design is scheduled to be completed in June 2023). It is conceivable that some trains on the western section will pass through this route and a part of traffic of the western side will divert to this route.



Source: JST

Figure 3.2 Schematic of Joydebpur - Ishurdi section and related projects

3.3.3 Outline of Alternatives

Based on situation above-mentioned, alternative plans to improve the line capacity of the entire line section will be examined.

4 alternatives and "Without Project" to be examined are shown as follows:

Without Project:	No Double Track section
Alternative 1:	Double Tracking in all section (Original Plan of the Prior F/S)
Alternative 2:	Double Tracking between Shahid M. Mansur Ali and Joydebpur
Alternative 3:	Partial Double Tracking
Alternative 4:	Addition of Passing Loop Station with Single-Track

Contents of each alternative are below:

- Without Project: No Double Track section

  The Project is not implemented. Line capacity of Without Project (same as the current condition) is shown below:

Table 3.2 Line Capacity of Without Project

(Unit: Trains per day)

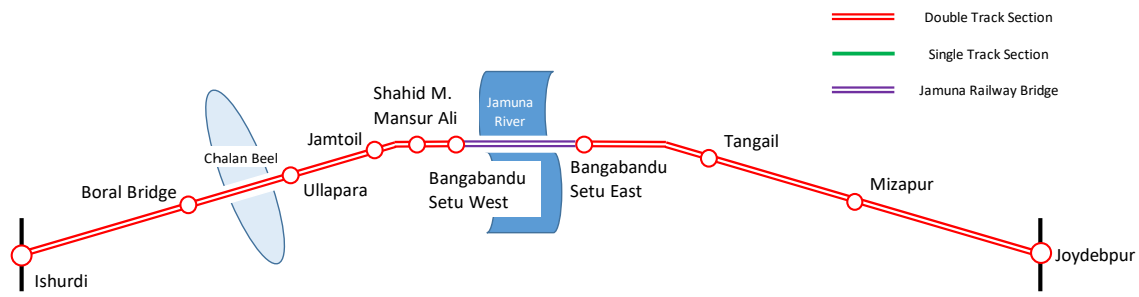
Section	Capacity	Section	Capacity
(West Area)		(East Area)	
Ishurdi - Majhgram	61	BBE - Tangail	25
Majhgram - Mooladuli	66	**Tangail - Mohera**	32
Mooladuli - Chatmohar	36	Mohera - Mirzapur	45
Chatmohar - Bhangura	48	Mirzapur - High-Tech City	36
Bhangura - Lahirimohanpur	33	High-Tech City - Mouchak	57
Lahirimohanpur - Ullapara	54	Mouchak - Joydebpur	32
Ullapara - Jamtoil	39		
Jamtoil - BBW	43		

Note: Bold is the line capacity bottleneck of alternative.
Calculation of line capacity is referred on Chapter 6.10.

Source: JST

- Alternative 1: Double Tracking in all section

  This alternative is the original plan of the Prior F/S. The line capacity with this Alternative is 68 trains/day. Schematic of Alternative 1 and Line Capacity is shown below:



Source: JST

Figure 3.3 Schematic of Alternative 1

Table 3.3 Line Capacity of Alternative 1

(Unit: Trains per day)

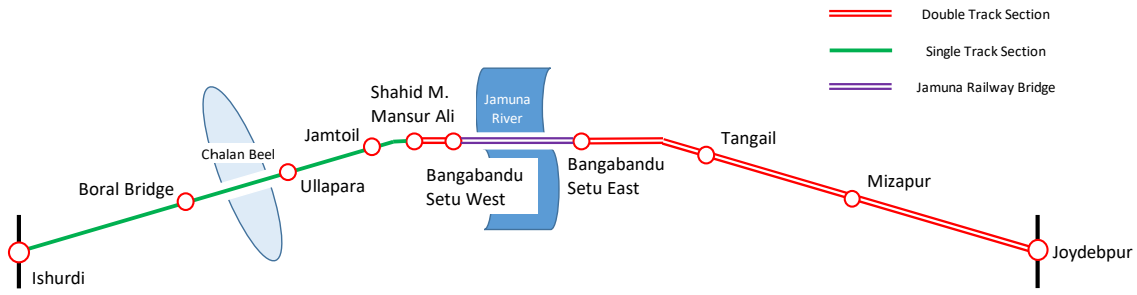
Section	Capacity	Section	Capacity
(West Area)		(East Area)	
Ishurdi-Majhgram	122	**BBE - Elenga**	**68**
Majhgram - Mooladuli	132	Elenga - Tangail	114
Mooladuli - Chatmohar	72	Tangail - Karotia	108
Chatmohar - Bhangura	96	Karotia - Mohera	100
Bhangura - Saratnagar	156	Mohera - Mirzapur	90
Saratnagar - Lahirimohanpur	86	Mirzapur - High-tech City	72
Lahirimohanpur - Ullapara	108	High-Tech City - Mouchak	114
Ullapara - Jamtoil	78	Mouchak - Mirer Bazar	108
Jamtoil - BBW	86	Mirer Bazar - Joydebpur	108

Note: **Bold section** is the line capacity bottleneck of alternative.
Calculation of line capacity is referred on Chapter 6.10.

Source: JST

- Alternative 2: Double Tracking between Shahid M. Mansur Ali and Joydebpur

  This alternative is to double-track the section between Shahid M. Mansur Ali (SMA)station and Joydebpur station, excluding the section between Bangabandhu Setu West (BBW) station and Bangabandhu Setu East (BBE) station. In this Alternative, the single track between Ishurdi station and Shahid M. Mansur Ali station remains because the new line between Shahid M. Mansur Ali station and Bogura station and the improvement project of the existing line beyond Bogura are expected to diversify the traffic on the west section. The line capacity with this alternative will be 33 trains/day. Schematic and Line Capacity of Alternative 2 are shown below:



Source: JST

Figure 3.4 Schematic of Alternative 2

Table 3.4 Line Capacity of Alternative 2

(Unit: Trains per day)

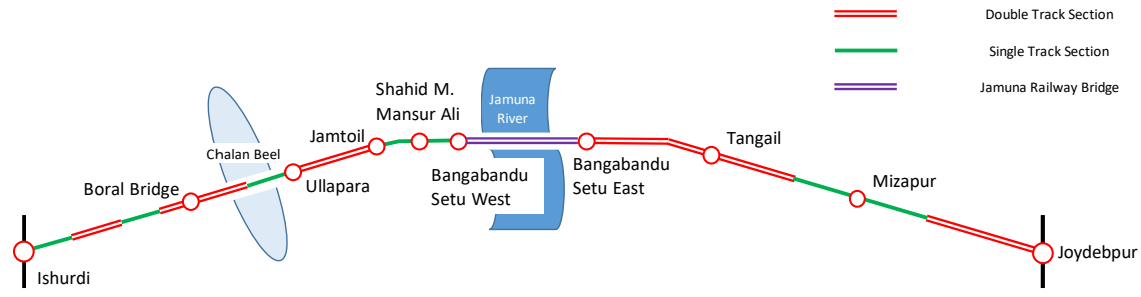
Section	Capacity	Section	Capacity
(West Area)		(East Area)	
Ishurdi - Majhgram	61	BBE - Elenga	68
Majhgram - Mooladuli	66	Elenga - Tangail	114
Mooladuli - Chatmohar	36	Tangail - Karotia	108
Chatmohar - Bhangura	48	Karotia - Mohera	100
Bhangura - Lahirimohanpur	**33**	Mohera - Mirzapur	86
Lahirimohanpur - Ullapara	54	Mirzapur - High-Tech City	72
Ullapara - Jamtoil	39	High-Tech City - Mouchak	108
Jamtoil - SMA	61	Mouchak - Joydebpur	60
SMA - BBW	144		

Note: **Bold section** is the line capacity bottleneck of this alternative.
Calculation of line capacity is referred on Chapter 6.10.

Source: JST

- Alternative 3: Partial Double Tracking

This alternative is to partially double-track the sections where distances between stations are long. It is possible to reduce construction costs and shorten the construction period by avoiding construction on long bridges and in urban areas. However a complicated train operation plan is required and a significant increase in line capacity cannot be expected due to the issue of the current signaling system. In addition, it is desirable to double track some sections between stations, not solo a section, in order to increase flexibility in operation planning. The line capacity depends on the total length of double traced sections. It is necessary to double track a total of 106.5km in order to increase the line capacity over 40 trains/ day, which is necessary based on the demand forecast. In that case, technically, the line capacity will be 41 trains/ day with this altenarive. Schematic and Line Capacity of Alternative 3 are shown below:



Source: JST

Figure 3.5 Schematic of Alternative 3

Table 3.5 Line Capacity of Alternative 3

(Unit: Trains per day)

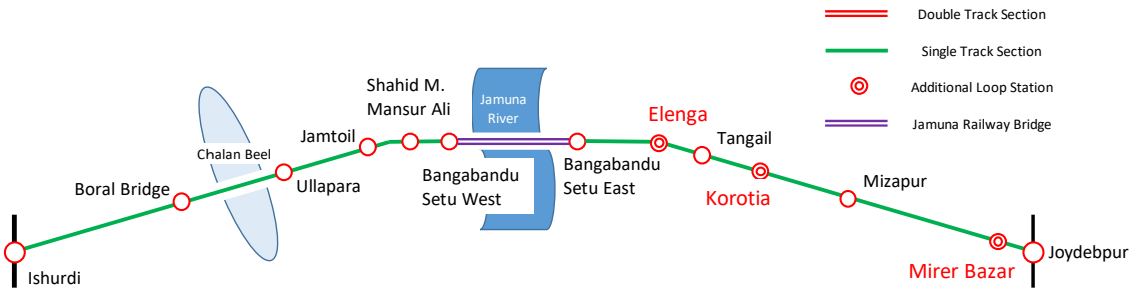
Section	Capacity	Section	Capacity
(West Area)		(East Area)	
Ishurdi - Majhgram	61	BBE- Tangail	50
Majhgram - Mooladuli	66	Tangail - Mohera	64
Mooladuli - Chatmohar	72	Mohera - Mirzapur	43
Chatmohar - Bhangura	45	Mirzapur - High-Tech City	72
Bhangura - Saratnagar	78	High-Tech City - Mouchak	54
Saratnagar - Lahirimohanpur	43	Mouchak - Joydebpur	60
Lahirimohanpur - Ullapara	50		
Ullapara - Jamtoil	74		
Jamtoil - BBW	**41**		
SMA - BBW	144		

Note: **Bold section** is the line capacity bottleneck of this alternative.
Underlined sections are double-tracked.
Calculation of line capacity is referred on Chapter 6.10.

Source: JST

- Alternative 4: Addition of Passing Loop Stations with Single-Track

This Alternative aims to increase line capacity by increasing the number of stations, for trains passing each other, in sections with long distances between stations, especially in the eastern section. Therefore, the line capacity can be said to depend on the total number of stations. According to the BR regulations, station staff must be assigned in each station to operate turnouts regardless of whether they handle passengers and freight or not . Hence, increasing the number of stations means hiring additional personnel. In addition, as the number of train increases in this alternative, the frequency and time of waiting with oncoming trains increases as well. That causes a slow-down in the average scheduled speed of trains. It can be expected as preferred to add 3 stations in the eastern section because of the long distances between stations. In this case, the line capacity will be 33 trains/day. Schematic and Line Capacity of Alternative 4 are shown below:



Source: JST

Figure 3.6 Schematic of Alternative 4

Table 3.6 Line Capacity of Alternative 4

(Unit: Trains per day)

Section	Capacity	Section	Capacity
(West Area)		(East Area)	
Ishurdi - Majhgram	61	**BBE - Elenga**	**33**
Majhgram - Mooladuli	66	Elenga - Tangail	57
Mooladuli - Chatmohar	36	Tangail - Karotia	54
Chatmohar - Bhangura	45	Karotia - Mohera	50
Bhangura - Saratnagar	78	Mohera - Mirzapur	43
Saratnagar - Lahirimohanpur	43	Mirzapur - High-Tech City	36
Lahirimohanpur - Ullapara	50	High-Tech City - Mouchak	54
Ullapara - Jamtoil	37	Mouchak - Mirer Bazar	50
Jamtoil - BBW	41	Mirer Bazar - Joydebpur	50
SMA - BBW	144		

Note: Bold section is the line capacity bottleneck of this alternative.
Calculation of line capacity is referred on Chapter 6.10.

Source: JST

3.3.4 Comparison Study among Alternatives

(1) Comparison Study among Alternatives

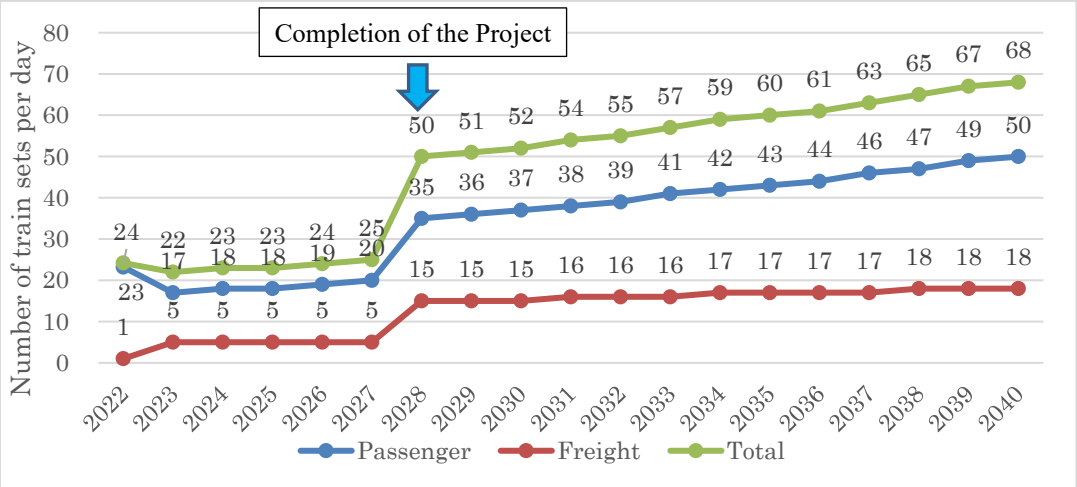
Some key points to consider when selecting alternatives are shown below:

1) Demand Forecasting Perspective

The result of demand forecasting (the number of trains passing the Jamuna Bridge section) is shown below. As mentioned above, as of 2022, there are 37 trains in operation per day between Joydebpur and Ishurdi. In 2023, since the Padma Bridge Rail Link will open and some trains for Khulna in southern Bangladesh and Kolkata (India) will be able to run this route, temporarily the number of trains running the section between Joydebpur and Ishurdi will be reduced. After that, since the Jamuna bridge section (between BBE and BBW) is one of the biggest bottlenecks in the section between Joydebpur and Ishurdi, restrictions on train operation (speed, train weight, etc.) at the Jamuna bridge section will be resolved by opening the Jamuna Railway Bridge, and the number of trains will be able to increase to some extent.

When the Project is completed in 2028, the number of trains will increase significantly, and around 2040, the traffic demand (the number of trains) is expected to reach 68 trains/day which is the capacity of the double-tracking of the entire section. In the selection of alternatives, one of the important factors is setting the number of trains that the Project aims to operate.

Demand Forecasting (the Number of Trains) are shown below:



Note: Refer to Chapter 4.5.3
Source: JST

Figure 3.7 Demand Forecasting (the Number of Trains)

2) Travel Time

Double-tracking not only increases the number of trains, but also shortens the time required for the entire route by eliminating waiting time for oncoming trains. If travel time is shortened, the demand for rail traffic can convert from road traffic, so the effect of shortening travel time is also an important factor in selecting alternatives.

3) Economic and Financial Analysis

Alternative 1 is a double-tracking of the entire section, and the construction cost is the highest among the alternatives. However, it is important that the implementation of the Project will contributes to the regional development along the Joydebpur - Ishurdi Corridor and eventually to the western part of Bangladesh.

4) Land Acquisition and Resettlement

Since the Project involves the construction of additional tracks parallel to the existing tracks, the existing ROW (Right of Way) will be used for construction. However, there will be places where new land acquisition will be required in order that embankment width will be expanded by about 6m, and the station premises will also be expanded. Scale of land acquisition and resettlement is also a factor of selecting alternative.

(2) Alternative Analysis

1) Preliminary Alternative Analysis

Among the five alternatives including Without Project, the preliminary alternative analysis was carried out to confirm whether to pass the key criteria.

[Key Criteria]

(a) Line Capacity shall meet the transport demand when Jamuna Railway Bridge is completed.
(b) Travel time between Joydebpur and Ishurdi shall not be longer than the current one.
(c) The project shall be implemented outside the national parks and wildlife sanctuaries.

For key criteria (a), although currently, 37 trains are operated per day, transport demand when Jamuna Railway Bridge is completed will be slightly decreased (29 trains per day) because of opening of another important development project (Padma Bridge Link Rail). Among the five alternatives, Without Project fails to meet the key criteria (a).

For key criteria (b), since the current number of trains operating between Joydebpur and Ishurdi with a single track far exceeds the track capacity as above-mentioned, trains are unable to ensure on-time operation and are taking around 6 hours to run, whereas the scheduled operating time is 4 to 4.5 hours. Travel time will be shortened under Alternative 1-3 and there will be no change in case of Without Project (i.e. passing the key criteria (b)), while Alternative 4 fails to meet the key criteria (b).

For key criteria (c), all the alternatives pass the condition.

As a result of preliminary alternative analysis, "Without Project" and "Alternative 4" fail to meet any of key criteria and were excluded from the secondary analysis.

2) Secondary Alternative Analysis

For the alternatives excluding "Without Project" and "Alternative 4" as the result of the preliminary alternative analysis, comparative analysis is carried out based on following item.

- Number of Train and Travel Time

  The primary objective of the Project is to strengthen the transportation capacity between Joydebpur and Ishurdi section to increase the line capacity, to operate the number of trains to meet demand, and shorten the travel time. Therefore, the effect of shortening the number of trains and travel time is an indicator of the evaluation of the alternatives.

  Since Alternatives 2 and 3 leave the single-track section, it is difficult to significantly increase the number of trains to meet the demand growth. In addition, the travel time will be shortened rather than the current one, but it will be same or longer than the current bus travel time (around 4.6 hours), hence a significant shift away from bus demand is not expected .

- Economic and Financial Analysis (FIRR, EIRR)

Undisclosed

Undisclosed

- Land Acquisition and Resettlement

  The western section of the Jamuna Bridge opened in 1915 during the British colonial period and has a wide ROW. On the other hand, the eastern section, which was constructed in the 2000s, has only a minimal ROW. Therefore, the double-tracking of the eastern section requires more land acquisition compared to the double-tracking of the western section. On the other hand, the number of affected households is higher in western section majority of which are informal settlements.

- Environmental impact (Ecosystem)

  In Alternative 1, almost all sections of the Chalan Beel[3] will be double-tracked, but in alternative 3 only a part of the line will be double-tracked. It is note that, most of the Chalan Beel land near the railway become cultivated land retreating flood water in dry season. Civil structure, especially embankment and bridge substructures, will be constructed on dry season.

[3] A lake-like wetland with static water in a flood plain. Chalan Beel is a permanent water body (wetland) located west of the Jamuna River and crosses intermittently 13 km of the Project alignment and is important for a range of activities including fishing, livestock keeping and agriculture.

In addition, since the bridge on the new track side will be installed at the same position and span as the existing bridge, it will not have a significant impact on the water flow during the rainy season.

Since Alternative 2 will not be double-tracked on this section, this has little environmental impact.

3) Selection of Suitable Alternative

Each item is scored on a 4-grade scale (A to D). Comparison of Alternatives 1 to 3 is shown below:

Table 3.7 Comparison of Alternatives

Item	Alternative 1	Alternative 2	Alternative 3	Note
Length of Double Track [1)]	164.1 km	East: 83.6 km	Total. 106.5km	
Line Capacity per day both direction [2)]	68 trains/day (A: 100)	33 trains/day (C: 50)	41 trains/day (C: 50)	25 trains/day as of 2022
Passenger Service (Duration between JYR and ISD)	4.0 to 4.5 hours (A: 100)	4.8 to 5.3hours (C: 50)	4.6 to 5.1 hours (B: 75)	Bus: around 4.6 hours
Construction Cost [3)]	Undisclosed			
FIRR [4)]				
EIRR [4)]				
Land Acquisition[5)]	Approx.60 acres (B: 75)	Approx.50 acres (B: 75)	Approx.40 acres (B: 75)	
Resettlement [5)] (Displaced Project Affected Household: PAH)	Approx.1,600 PAHs (C: 50)	Approx.580 PAHs (A: 100)	Approx.1,040 units (B: 75)	
Environmental impact (Ecosystem) (Impact on Chalan Beel)	Impact (C: 50)	No impact (A: 100)	Partially Impact (B: 75)	
Overall Evaluation	**Score: 575 Recommendation**	Score: 475	Score: 500	

Note1: The lower row shows the 4-grade evaluation of each item.
A: Excellent (Low Cost, High Benefit, Less Impact etc.); Score: 100
B: Good; Score: 75
C: Fair (High Cost, Low Benefit, Large Impact, etc.) ; Score: 50
D: Poor (Not Feasible) ; Score: 0

Note2: 1) Length: Distance between station centers.
2) Line Capacity: Maximum number of trains that can run between Joydebpur and Ishurdi per day
3) Undisclosed
4) Refer to Chapter 11
5) Based on RAP survey 2022-23

Source: JST

Considering the result of comparative analysis comprehensively, Alternative 1 with the highest score is selected as a suitable alternative.

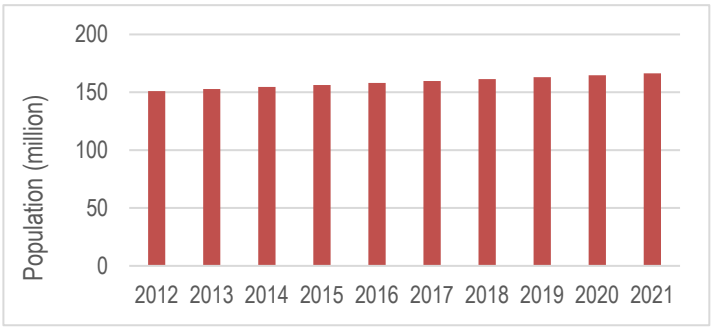
Chapter 4 Transport Demand Forecast

4.1 General Information

As the proposed Joydebpur-Ishurdi section connects both the eastern and western zone of the Bangladesh Railway (BR) network, the socio-economic parameters of Bangladesh directly affect the transport demand of this section. The socio-economic status of Bangladesh is analyzed briefly in the following sections.

(1) Population

According to the World Bank (WB) website, the population in Bangladesh in the last ten years is shown in Figure 4.1. The population in 2021 is 166 million and the growth rate in the previous ten years is about 1%.

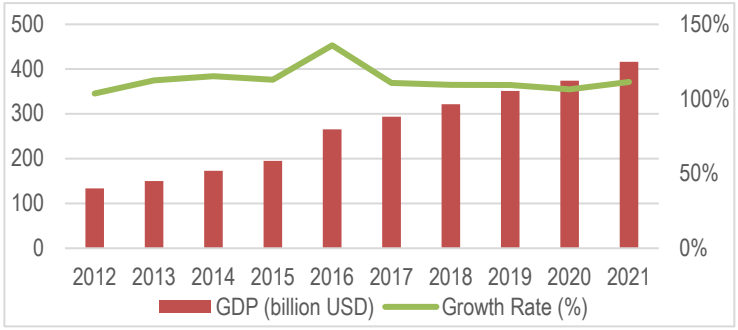


Source: The World Bank, https://data.worldbank.org/indicator/SP.POP.TOTL?locations=BD

Figure 4.1 Population, Total – Bangladesh (2012 – 2021)

(2) GDP

According to the World Bank website, the GDP and its growth rate in Bangladesh with the current value are shown in Figure 4.2. The GDP in 2021 is 416 billion USD and the average GDP growth rate during the last ten years is 13%, the highest is 36% in 2016, and the lowest is 4% in 2012.



Source: The World Bank national accounts data and OECD National Accounts data files, https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=BD

Figure 4.2 GDP (in USD) – Bangladesh (2012 – 2021)

4.2 Existing Reports and Data

(1) Relevant Reports

The existing reports below are utilized in the transport demand forecast of the Study.

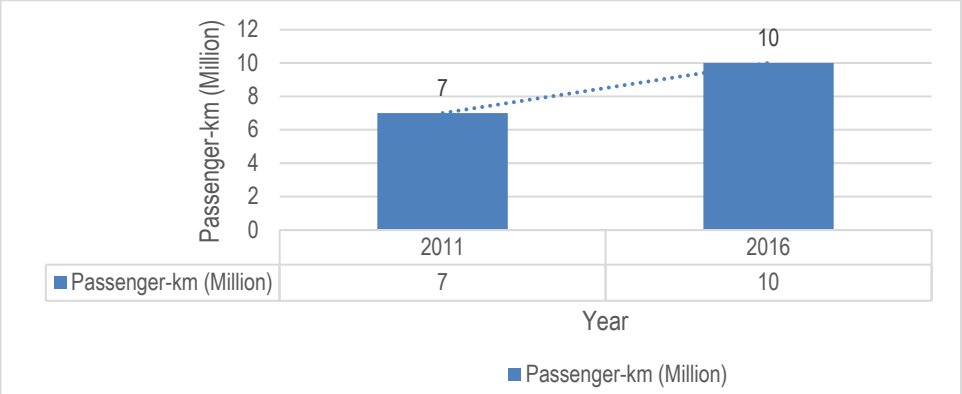
Table 4.1 Existing Reports Relevant to the Study

No.	Reference Name	Issued Year
1	Consulting Services for Detailed Design, Bid Assistance, and Construction Supervision of the Bangabandhu Sheikh Mujib Railway Bridge Construction Project (hereafter referred to as the "Jamuna Bridge F/S")	2018
2	Feasibility Study for Construction of Double Line between Joydebpur and Ishurdi Section of Bangladesh Railway (the Prior F/S)	2019
3	The Master Plan of Railways of the People's Republic of Bangladesh 2019	2018
4	Timetable Book 2021	2021
5	Information Book 2020	2020
6	Investigation of Traffic Flow Characteristics Parameters in Major National Highway of Bangladesh, Ph.D. Dissertation by Mohammad Ahad Ullah, Curtin University, Australia	2017
7	Project TOR of "Transport Connectivity Improvement Preparatory Facility"	2021

Source: JST

(2) Existing Data

The figure below shows that the BR passenger-km increased from 7 billion to 10 billion between 2011 and 2016 in Bangladesh. The passenger-km traveled data by the railway transportation system of Bangladesh was also cross-referenced[4].



Source: Bangladesh Railway Data. Link: data.worldbank.org/indicator/IS.RRS.PASG.KM

Figure 4.3 Bangladesh Railway (BR) Passenger-km (Million) from 2011 to 2016

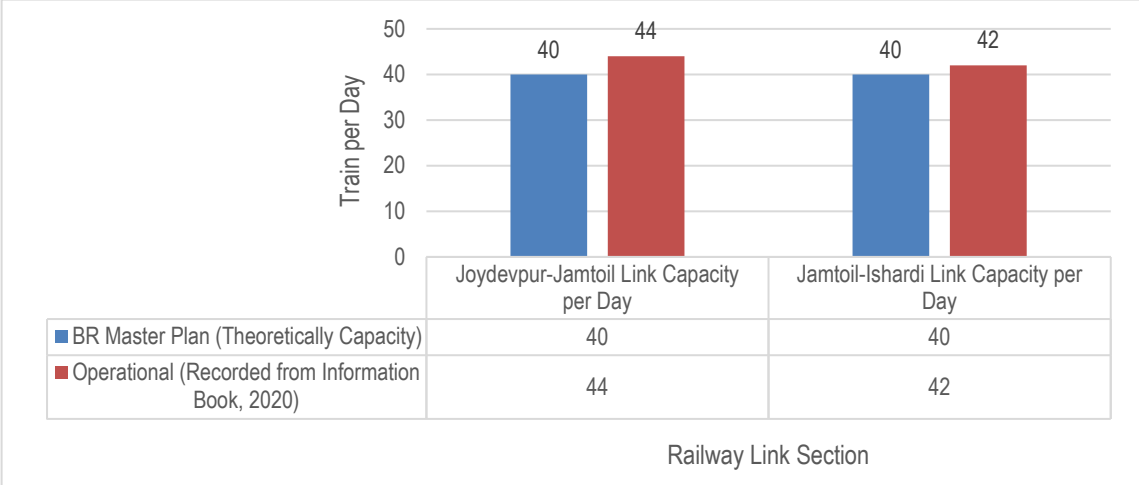
According to the BR Master Plan[5], the assumed capacity of the Joydebpur to Jamtoil[6] and Jamtoil to Ishurdi is 40 trains (20 x 2) per day in both combined directions. But 44 trains (including 2 freight

[4] The 2019/20 data from Table 18, page 50, BR Information Book 2020 (9,957,768,000 Passenger-Km by Total System between 2019-2020.

[5] Table 8-14, Formulation of the BR Master Plan. Link: http://railway.portal.gov.bd/sites/default/files/files/railway.portal.gov.bd/page/67cd2529_587a_45b9_84e0_cd12c8d8c9bd/8.%20Formulation%20of%20BR%20Masterplan.pdf

[6] The station next to Bangabandhu West station to the west

trains) in Joydebpur to Jamtoil section and 42 Trains (including 4 freight trains) in Jamtoil to Ishurdi section have been recorded in Information Book 2020[7] in both combined directions and with combined freight and non-freight trains shown in Figure 4.4.



Source: Table 8-14, Formulation of the BR Master Plan. Link: railway.gov.bd/site/page/8e5a704d-72e2-4d69-b443-21988229cbbc

Figure 4.4 Comparison between Line Capacity and Current Operation per Day

Based on the above, two facts can be concluded that both sections of the railway between Joydebpur-Ishurdi are currently saturated with train operation numbers, and passenger demand until 2016 has been increasing. In addition to these, there are several points to consider from the existing data as shown below.

- BR Information Book, 2020 has both section-wise, zone-wise, and BR organization-wise data, but a data gap is identified for the Joydebpur - Ishurdi section data, which needs to be collected from BR.
- Time Schedule Book, 2020, has the section-wise train data, which fulfills the necessary data for the Joydebpur - Ishurdi section to calculate the capacity.
- The BR Master Plan has the pipeline projects list with a classified freight list that can be combined with other transportation system data to calculate freight transport demand in the corridor.
- The feasibility study report of Jamuna Railway Bridge, which is middle of the Joydebpur–Ishurdi section, is available, so the transport demand of the Jamuna Rail Bridge can be highly utilized for the demand forecast of the Study.

4.3 Transport Data Collected from Relevant Authority

The transportation system combined carries the demand load from the regions. Therefore, actual demand in the Joydebpur-Ishurdi section in any transportation system can be calculated by assessing the current demand projected in future years with modal shifts for certain impedance factors. other transportation systems data is required to calculate the modal shift. In Joydebpur-Ishurdi section,

[7] SL No 11& 13, Table 60-2, Bangladesh Railway Information Book 2020

railway, roadway, waterway, and airway transportation systems are available. Moreover, the section connects the eastern and western zone of Bangladesh's railway system, which connects to the east-west part of the region. Due to regional connectivity, the section will also attract regional inter boundary demand. Therefore, the following data is required to forecast the demand for Joydebpur-Ishurdi section.

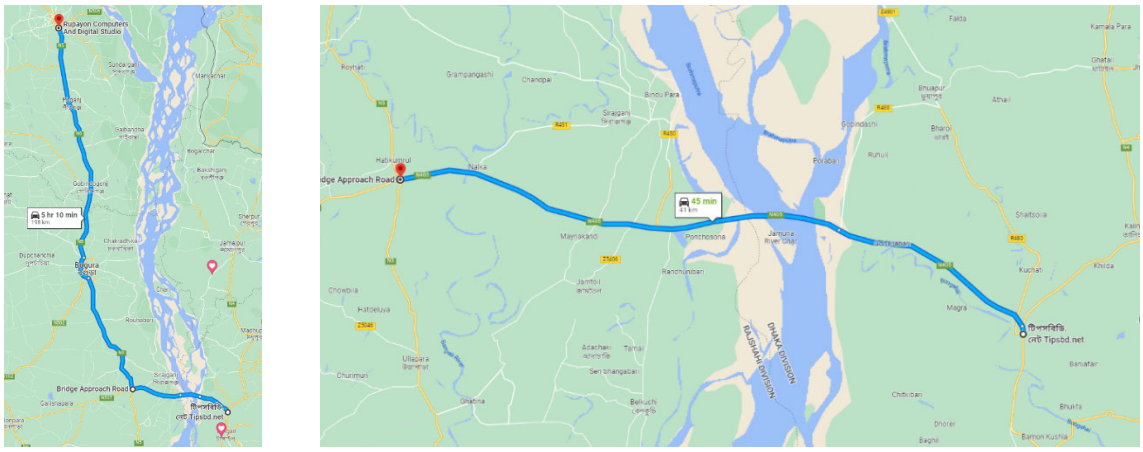
Table 4.2 Data Collected in the Study

Sector	Type	Data Requested
Railway	Passenger	• Railway daily passenger traffic data from 2014 to 2022 for each section has been requested through a letter to Bangladesh Railway (BR).
	Freight	• Roadway-categorized daily traffic flow in Jamuna Bridge over the Jamuna River has been requested through a letter to BR.
Road	Passenger	• Roadway-categorized daily traffic flow in Jamuna Bridge over the Jamuna River has been requested through a letter to BR.
	Freight	• Roadway-categorized daily traffic flow in Jamuna Bridge over the Jamuna River has been requested through a letter to BR.
Waterway	Freight	• A letter to BR has requested waterway transport through ICD/ICT planning and existing daily data.
Seaport	Freight	• Seaport daily data has been requested through a letter to BR.
Transboundary Demand	Freight	• Transboundary daily traffic has been requested through a letter to BR.
Airway	Passenger	• Airway daily traffic has been requested through a letter to BR.

Source: JST

(1) Roadway

The roadway network currently has connectivity from Joydebpur to Ishurdi. From Dhaka to Elenga, the roadway network has been upgraded to four-lanes. But after Elenga, the four-lane stops, although the bridge has four lanes. Currently, in this section from Elenga to Rangpur via Hatikamrul, shown below, the roadway is under construction to upgrade from a two-lane to a four-lane highway under the South Asia Subregional Economic Corridor (SASEC) initiative through the Roads and Highways Department (RHD), implementing agency. The 41 km long section from Elenga to Hatikamrul runs parallel with the Joydebpur-Ishurdi Railway link. Although the under-construction four-lane section from Elenga to Hatikamrul will reduce the roadway travel time, the overall impact on the Joydebpur-Ishurdi section is expected to be minimum as the long-distance traveling passengers will not be impacted by sectional roadway improvement of the corridor.



(a) Elenga-Rangpur via Hatikamrul approx. 190 km Roadway Section

(b) 41 km Elenga-Hatikamrul Roadway Section, Alternative of Railway Connectivity

Source: Prepared by JST based on Google Map

Figure 4.5 SASEC Elenga-Rangpur via Hatikamrul Roadway Improvement Project

(2) Waterway Scenarios (Sea Port and River Port)

Plans for the development of land-based container terminals near the border and seaports were also reviewed but were either too far away from this route or the construction completion date was undecided, so they were not included in the demand forecasting study for this route.

(3) Land Port

The particular ICT project's location is at the south-eastern side of Dhaka city (the far south-eastern side of Joydebpur of the railway corridor), therefore, for the particular ICT project, Joydebpur - Ishurdi corridor will not be affected. Additionally, other proposed ICTs by BIWTA have been assigned no timeline till now. Therefore, other proposed ICTs have been not included during the Joydebpur - Ishurdi corridor demand calculation.

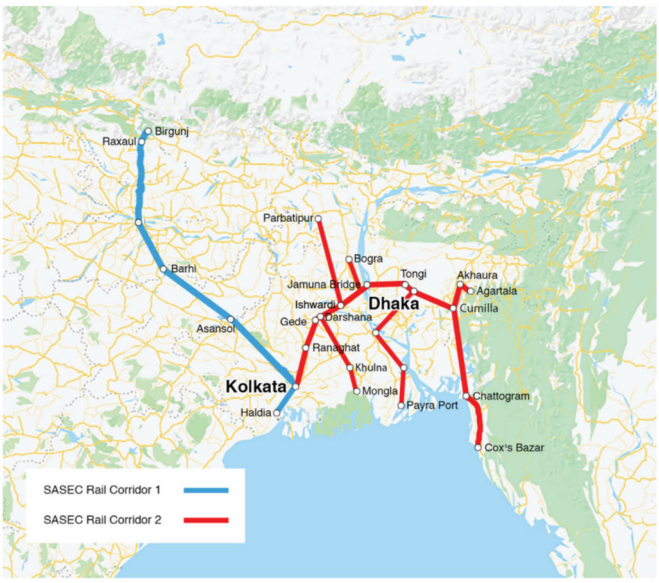
(4) Airway Scenarios

The domestic airports in Dhaka, Saidpur, and Rajshahi, and the international airport, Hazrat Shahjalal, carry both passengers and cargo, and information was collected at these airports. However, considering the unavailability of data, the income level of air route users, and the location of the airports, it was assumed that there would be almost no conversion from air routes, and thus these airports were not included in the demand forecasting study for this route.

(5) South Asia Subregional Economic Corridor (SASEC)

Joydebpur–Ishurdi section is a part of the SASEC Rail Corridor 2, "India-Bangladesh Corridor", proposed by the ADB. The Jamuna River splits the section into east and west sides so that a new double-tracked Jamuna Bridge has been constructed with support from the Japanese Government, which will be completed by 2024. After the completion, the lack of capacity of the Joydebpur–Ishurdi section will be addressed, allowing high-volume transportation along the corridor.

SASEC Rail Corridor 2 connects Kolkata, Ranaghat, Gede, Tangail, Dhaka, Cumilla, Chattogram (Chittagong), and Cox's Bazar. This means that the corridor plays a significant role in cross-border transportation and connection to the major seaports in Bangladesh, such as Chattogram, Payra Port, and Mongla. To be precise, the western half is the major route for bilateral movement of bulk traffic between India and Bangladesh (Gede-Darshana), while the eastern half is connected from Dhaka to its main port (e.g., Chattogram) and extension to Cox's Bazar. This corridor development will increase the railway capacity and handle broad-gauge freight train operations. The proposed SASEC Railway Corridors 1 and 2 are shown in Figure 4.6.



SASEC = South Asia Subregional Economic Cooperation.

Note: The boundaries, colors, denominations and any other information shown on the map do not imply, on the part of the Asian Development Bank, any judgment on the legal status of any territory, or any endorsement or acceptance of such boundaries, colors, denominations or information.

Source: South Asia Subregional Economic Cooperation Operational Plan 2016-2025 Update, ADB

Figure 4.6 Proposed SASEC Railway Corridors

(6) Ongoing and Planned Project by BR

Th BR Master Plan explained that 230 projects are proposed with various fund sources during the target period, of 30 years, including rolling stock maintenance, Mechanized Track Maintenance (MTM), the RDS gauge conversion, S&T upgrades, etc. Based on the BR Master Plan, there are some ongoing investment projects by BR, shown in Table 4.3, and this scenario setting needs to be discussed and reached an agreement with BR.

Table 4.3 Ongoing Investment Projects by BR

No.	Project Name	Completion Year	Fund Source
1	Padma Bridge Rail Link	2023	Chinese G to G
2	Dohazari-Cox's Bazar via Ramu to Ghundum	2022	ADB
3	Bangabandhu Sheikh Mujib Rail Bridge over Jamuna River	2024	JICA
4	Khulna-Mongla Rail Link	2022	ADB & EIB
5	3rd & 4th Line between Dhaka-Tongi and 2nd Line between Tongi-Joydebpur	2023	Indian LOC
6	Darshana-Khulna Broad Gauge Double Line	2022	Indian LOC

No.	Project Name	Completion Year	Fund Source
7	Bogura-Shahid M. Monsur Ali Dual Gauge Single Line	2030	Indian LOC
8	Double Track Akhaura – Laksam	2023	ADB
9	Tongi – Akhaura DG Double Tracking Project	2030	Not Finalized
10	Construction of a Rail Line from Bhanga Junction (Faridpur) to Payra Port via Barisal	2030	Not Finalized
11	Akhaura – Agartala Rail Link	2023	Indian Grant

Source: BR and various sources on the internet about the completion years

In addition, some ongoing T/A projects of BR are conducted by ADB as follows. Dhaka-Chattogram-Cox's Bazar Rail Project Preparatory Facility is a part of the SASEC corridor 2, so the increase in capacity needs to be incorporated into the demand forecast of the Study. Railway Connectivity Improvement Preparatory Facility (RCIPF) includes 11 subprojects, eight-line capacity development projects, and three sector-wise projects.

Table 4.4 Ongoing T/A Project by BR

No.	Project Name	End Year	Fund Source
1	Dhaka-Chattogram-Cox's Bazar Rail Project Preparatory Facility	2019	ADB
2	Railway Connectivity Improvement Preparatory Facility (RCIPF)	2025	ADB
3	Capacity Development of Bangladesh Railway for Implementation of Construction of Single Line Dual Gauge Railway Track from Dohazari to Cox's Bazar Via Ramu and Ramu to Gundum Near Myanmar	2023	ADB
4	Technical Assistance Project to Improve Energy Efficiency of Rolling Stock Operations of Bangladesh Railway	2024	ADB

Source: BR

According to BR's presentation material, there are some upcoming investment priority projects for BR.

Table 4.5 Upcoming Investment Priority Projects

No.	Project Name	Implementation Year in BR's M/P	Estimated Cost (million USD)
1	Construction of Joydebpur-Jamalpur Dual Gauge Double Line	2021-2025	1,308
2	Construction of Carriage, Wagon, and Locomotive Workshops, Fueling Facilities, and Depot for Broad Gauge Rolling Stock at Daripara		944.15
3	Construction of Dual Gauge Conversion between Akhaura-Sylhet	2025-2030	1,496
4	Procurement of Meter Gauge and Broad Gauge Accident Relief Cranes for Bangladesh Railway		27.5
5	Construction of Panchagar – Banglabandha Rail Line	2026-2030	440
6	Construction of Tista Bridge	2026-2030	88
7	Construction of Bhanga – Payra Port Rail Link	2016-2020	4,929
8	Conversion of Laksam-Chinki Astana-Chattogram MG double track into DG double track into Dhaka-Chattogram corridor		1,545

Source: BR

(7) Railway Connectivity Improvement Preparatory Facility (RCIPF)

Railway Connectivity Improvement Preparatory Facility (RCIPF) will be conducted by the ADB (currently T/A consultant is under selection). The project comprises nine double tracking or gauge conversion projects and three sector-wise projects. It is noted that the timing of subproject implementation will be different and accessed in the project, so whether these subprojects are included in the demand forecast scenario will be discussed between BR. The information and location of each project are shown below.

In particular, project No. 4 will influence the capacity of the Joydebpur and Ishurdi section since there is a DG single-line construction project between Bogura and Shahid M. Mansur Ali, which the Indian government will finance. On the other hand, the current line between Santahar, Bogura, and Lalmonirhat is a MG line, so the MG trains can be diverted after the construction of the Indian-funded new line. Therefore, the timing of the construction of the DG track between Santahar, Bogura, and Lalmonirhat is crucial to consider the line capacity of the west section. According to BR staff, since the RCIPF has not started yet, which means it may take another ten years to convert the line into the dual gauge, the project is not to be considered seriously in this demand forecast.

Table 4.6 11 Planned Subprojects in RCIPF

#	Project Name	Significance
1	**Construction of a new Bridge** with BG Double Line parallel to the existing Hardinge Bridge across the Ganges (Padma) River in between Bheramara and Paksey railway stations.	Corridor strengthen
2	**Feasibility study with detailed design** for construction of BG line parallels to the existing SG line in Abdulpur – Rajshahi section and construction of BG line parallel to the existing DG line in Abdulpur – Santahar – Parbatipur section including Abdulpur bypass.	Corridor strengthen
3	**Feasibility study with detailed design** for constructing a new BG line from Santahar to Amnura.	Border connection
4	**Feasibility study with detailed design** for construction of DG/BG line parallel to line existing MG line and conversion of existing MG line into DG/BG in Santahar – Bogura -Kaunia – Lalmonirhat section including Santahar bypass.	Corridor strengthening and border connection
5	**Feasibility study with detailed design** for construction of DG/BG line parallels to the existing MG line and conversion of existing MG line into DG/BG line in Bhairab Bazar Mymensingh section.	Corridor strengthening and border connection
6	**Feasibility study with detailed design** for constructing a cord line from Narayanganj to Laksham/Comilla.	Corridor strengthening and border connection
7	**Feasibility study with detailed design** for construction of a new BG line parallel to the existing line in Jessore-Benapole rail section	Corridor strengthening and border connection
8	**Feasibility study with detailed design** for converting the existing MG line into DG line in Jamuna Bridge East-Tarakandi – Jamaipur – Dewanganj Bazar section, including the construction of Tongi bypass.	Corridor strengthening and border connection
9	Assessment of future demand of rolling stocks and **feasibility study with detailed design** for relocation, redesign, rebuilding, and new construction of rolling stock maintenance installations of Bangladesh Railway.	Sector-wide issue
10	**Preparation of core and non-core business plan** for Bangladesh Railway with assessment and analysis of various traffic demands, land use the BR Master Plan, plan for optical fiber telecommunication business and increasing passengers' facilities including related infrastructure development and access control system in important stations of Bangladesh Railway to meet future needs.	Sector-wide issue

#	Project Name	Significance
11	**Analysis and assessment of sectional capacity** by introducing of Intermediate Block System and installation of ATS/ATP with existing CBI and CTC system in the main routes for enhanced capacity and need analysis for signaling training center of Bangladesh Railway.	Sector-wide issue

Source: ADB

4.4 Prior F/S Results

There are two versions of the Prior F/S; the first study was conducted in 2015 with 2014 data which was revised and updated in 2019 with 2017 data. JST studied the demand forecast of the Prior F/S with consideration of limitations and assumptions. Brief assumption details are summarized below.

(1) Assumptions and Preconditions of Freight Transport

Assumptions and necessary actions to acquire the data or sources of the freight transport demand forecast in the Study are summarized as follows.

Table 4.7 Assumptions of Demand Forecast in Freight Transport

No.	Assumptions	Necessary Actions/ Sources
1	Freight traffic will grow, according to major container shippers/logistic organizations and BR. The current lack of locomotive and staff restraining the facility and freight traffic flow through BR.	F/S assumptions requested data from other agencies.
2	West Bangla - Darshana - BR East Zone through Joydebpur - Ishurdi to proposed Dhirasram ICD for the north railway freight traffic	-
3	The 2025 benchmark of freight trains is 10 (ten) freight trains per day.	Data requested to BR to verify
4	Assumed a maximum of 45 wagons per freight train.	Data requested to BR to verify
5	Freight train rolling stock increases by 5% pa, same as passenger trains.	F/S assumptions
6	At 7000 hours/year, the average travel speed on the double track is 60 km/hr.	Data requested to BR to verify
7	A freight train's average travel distance is 450 km/day.	Requested data to BR to verify
8	The annual average freight train travel time with the project is 7100 hours/per year	F/S assumptions
9	The annual average freight train travel time without the project is 9900 hours/per year	Data requested to BR to verify
10	Average tonnage freight transport 0.44 million tonne/train/year	Data requested to BR to verify
11	Annual average freight traveling distance 451.81 km/year	Data requested to BR to verify

Source: JST based on the Prior F/S

The preconditions of this freight transport demand forecast are summarized as follows, which are the same as the ones set in the Prior F/S.

1. 2013-2014: Containers transport through Joydebpur-Ishurdi section increased by 22% and became 0.568 million tonnages, generating 42% additional freight revenue.

2. Major freight transportation of BR is a container, petroleum products, food grains (north Bengal rice grains)
3. Most Fertilizer moves through the waterway. 10-15% through railway & roadway.
4. West Bengal to Bangladesh through Darshana railway land port carries West Zone's freight to Nawapara, Jessore, Khulna, Ishurdi, Ullapara, and Serajgong Bazar for waterway or roadway modal shift.
5. Dhaka South side proposed that ICD (Inland Container Depot) will attract freight traffic through Padma rail connectivity.
6. Irregular freight trains are assumed, like one train every alternative day is half a train per day.
7. Passenger trains have priority over freight trains.
8. Average trip length 450 km.
9. The average speed on a single track is 30 km/hr and on a double track is 60 km/hr.
10. Round trip is slower due to loading and unloading.
11. Annual freight train-hour set at 7000, which includes 20% idle time.
12. Estimated NTK (net tonne-kilometer) and GTK (gross tonne-kilometer) are included with empty backhauls. The most common movements are fuel, containers, or dry bulk (e.g., food grains, etc.)

(2) Assumptions and Preconditions of Passenger Transport

Assumptions and necessary actions to acquire the data or sources of the passenger transport demand forecast in the Study are summarized as follows.

Table 4.8 Assumptions of Demand Forecast in Passenger Transport

No.	Assumptions	Necessary Actions/ Sources
1	Train passenger compartments are assumed to be 80% full at all times.	Data requested to BR to verify
2	Train track capacity (current single track) will be saturated by 2020 with an assumed 5% pa rolling stock inclusion in the BR railway system.	The Prior F/S assumptions
3	New train Introduced after 22 carriage Train capacity fills in BR railway system. In other words, each locomotive can carry 22 carriages, and an additional locomotive is added with 22-carriage when capacity is saturated.	Data requested to BR to verify
4	Assumed average passenger train speed for single track 50 km/hr and double track 70km/hr.	The Prior F/S assumptions
5	Assumed average mail train speed for single track 37.5km/hr and double track 52.5 km/hr (25% of passenger train speed)	The Prior F/S assumptions
6	Allowance: one off day for intercity train & two mail trail operations per week.	The Prior F/S assumptions
7	Forecast of train number increased indefinitely accordingly compound growth assumption of 5% pa rolling stock increase.	The Prior F/S assumptions
8	Considering restaurant cars, power cars, and baggage cars, the average passenger per intercity train is assumed to be 1120 persons with 80% occupancy.	Data requested to BR to verify

No.	Assumptions	Necessary Actions/ Sources
9	The average route length and speed are 375 km and 44 km/hr.	Data requested to BR to verify
10	By 2025 speed is assumed to be increased/improved to 50 km/hr.	The Prior F/S assumptions
11	The average mail express and local train passenger carrying number is 864 passengers/train and travels 200 km at an average speed of 27km/hr.	Data requested to BR to verify
12	On average, a passenger train travels 285.09 km/day.	Data requested to BR to verify
13	Train annual average run time with the project, 1436.54 hours/year	The Prior F/S assumptions
14	Train annual average run time without the project, 2156.25 hours/year	Data requested to BR to verify
15	Average passenger transport, 967 passenger/train/day	Data requested to BR to verify
16	Annual average passenger traveling distance, 336.227 km/passenger	Data requested to BR to verify
17	The annual average passenger traveling time with the project is 4.604 hours/per passenger	The Prior F/S assumptions
18	The annual average passenger travel time without the project is 6.906 hours/per passenger	Data requested to BR to verify

Source: JST based on the Prior F/S

The preconditions of this passenger transport demand forecast are summarized as follows, which are the same as the ones set in the Prior F/S.

1. Shovon class occupancy 82% BG West Zone and occupancy 185% MG East Zone.
2. BG carriage has 75 seats, and MG carriage has 60 seats.
3. 1992 to 2012: Fare unchanged with 0.40 BDT/passenger-km.
4. Fare Increased on October 2012: 0.53 BDT/passenger-km (30% in the lower class and 50% in the upper class).
5. The fare average of 0.80 BDT/passenger-km is needed for the breakeven point in BR Railway Operation, where the current bus fare is 1.45 BDT/passenger-km.

(3) Results of the Prior F/S

Based on the assumptions above, the demand forecast results are reproduced and shown as follows.

Table 4.9 Demand Forecast Results (Freight) of the Prior F/S

	With-Project						Without-Project						Increase Due to Project					
	Trains per day (Slots)	Annual Train-km, k [2]=[1]x450x365 /1000	Annual Train-Hour, k [3]=[1] x7100/1000	Annual net tonne, M [4]=[1]x0.44	Annual net tonne km, M [5]=[4]x451.81	Annual Gross tonne km, M [6]=[5]x1.2952	Trains per day (Slots)	Annual Train-km, k [8]=[7]x450x365 /1000	Annual Train-Hour, k [9]=[7] x9900/1000	Annual net tonne, M [10]=[7]x0.44	Annual net tonne km, M [11]=[10] x451.81	Annual Gross tonne km, M [12]=[11]x1.2952	Trains per day (Slots)	Annual Train-km, k	Annual Train-Hour, k	Annual net tonne, M	Annual net tonne km, M	Annual Gross tonne km, M
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]
2025	10.0	1643	71	4.4	1988	2575	10.0	1643	99	4.4	1988	2575	0.0	0.0	-28.0	0.00	0	0
2026	10.5	1725	75	4.6	2087	2704	10.0	1643	99	4.4	1988	2575	0.5	82.1	-24.5	0.22	99	129
2027	11.0	1807	78	4.8	2187	2832	10.0	1643	99	4.4	1988	2575	1.0	164.3	-20.9	0.44	199	257
2028	11.6	1905	82	5.1	2306	2987	10.0	1643	99	4.4	1988	2575	1.6	262.8	-16.6	0.70	318	412
2029	12.2	2004	87	5.4	2425	3141	10.0	1643	99	4.4	1988	2575	2.2	361.4	-12.4	0.97	437	566
2030	12.8	2102	91	5.6	2545	3296	10.0	1643	99	4.4	1988	2575	2.8	459.9	-8.1	1.23	557	721
2031	13.4	2201	95	5.9	2664	3450	10.0	1643	99	4.4	1988	2575	3.4	558.5	-3.9	1.50	676	875
2032	14.1	2316	100	6.2	2803	3630	10.0	1643	99	4.4	1988	2575	4.1	673.4	1.1	1.80	815	1,056
2033	14.8	2431	105	6.5	2942	3811	10.0	1643	99	4.4	1988	2575	4.8	788.4	6.1	2.11	954	1,236
2034	15.5	2546	110	6.8	3081	3991	10.0	1643	99	4.4	1988	2575	5.5	903.4	11.1	2.42	1,093	1,416
2035	16.3	2677	116	7.2	3240	4197	10.0	1643	99	4.4	1988	2575	6.3	1,034.8	16.7	2.77	1,252	1,622
2036	17.1	2809	121	7.5	3399	4403	10.0	1643	99	4.4	1988	2575	7.1	1,166.2	22.4	3.12	1,411	1,828
2037	18.0	2957	128	7.9	3578	4635	10.0	1643	99	4.4	1988	2575	8.0	1,314.0	28.8	3.52	1,590	2,060
2038	18.9	3104	134	8.3	3757	4866	10.0	1643	99	4.4	1988	2575	8.9	1,461.8	35.2	3.92	1,769	2,292
2039	19.8	3252	141	8.7	3936	5098	10.0	1643	99	4.4	1988	2575	9.8	1,609.7	41.6	4.31	1,948	2,523
2040	20.8	3416	148	9.2	4135	5356	10.0	1643	99	4.4	1988	2575	10.8	1,773.9	48.7	4.75	2,147	2,781
2041	21.8	3581	155	9.6	4334	5613	10.0	1643	99	4.4	1988	2575	11.8	1,938.2	55.8	5.19	2,346	3,038
2042	22.9	3761	163	10.1	4552	5896	10.0	1643	99	4.4	1988	2575	12.9	2,118.8	63.6	5.68	2,564	3,322
2043	24.1	3958	171	10.6	4791	6205	10.0	1643	99	4.4	1988	2575	14.1	2,315.9	72.1	6.20	2,803	3,630
2044	25.3	4156	180	11.1	5030	6514	10.0	1643	99	4.4	1988	2575	15.3	2,513.0	80.6	6.73	3,042	3,939
2045	26.5	4353	188	11.7	5268	6823	10.0	1643	99	4.4	1988	2575	16.5	2,710.1	89.2	7.26	3,280	4,248
2046	27.9	4583	198	12.3	5546	7184	10.0	1643	99	4.4	1988	2575	17.9	2,940.1	99.1	7.88	3,558	4,609
2047	29.3	4813	208	12.9	5825	7544	10.0	1643	99	4.4	1988	2575	19.3	3,170.0	109.0	8.49	3,837	4,969

Source: Recalculated by JST based on the Prior F/S

Table 4.10 Demand Forecast Results (Passenger) of the Prior F/S

	With-Project					Without-Project				Increase Due to Project				
	Train per day (Slots)	Annual Train-km, k [2]=[1]x285.09x365 /1000	Annual Train-Hour, k [3]=[1] x1436.54/1000	Annual Pax, M [4]=[1]x967x365 /10,00,000	Annual Pax-km, M [5]=[4]x336.227	Annual Pax-Hour, M [6]=[5]x4.604	Train per day (Slots)	Annual Train-km, k [8]=[7]x285.09x365 /1000	Annual Train-Hour, k [9]=[7] x2156.25/1000	Annual Pax, M [10]=[7]x967x 365 /10,00,000	Annual Pax-km, M [11]=[10]x336.227	Annual Pax-km, M [12]=[11]x6.906	Train per day (Slots) [13]=[1]-[7]	Annual Train-km, k [14]=[2]-[8]	Annual Train-Hour, k [15]=[3]-[9]	Annual Pax, M [16]=[4]-[10]	Annual Pax-km, M [17]=[5]-[11]	Annual Pax-km, M [18]=[6]-[12]
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]
2025	52	5411	74.7	18.4	6171	84.5	48	4995	103.5	16.9	5696	117	4	416	-28.8	1.4	475	-32.5
2026	62	6452	89.1	21.9	7358	100.8	48	4995	103.5	16.9	5696	117	14	1457	-14.4	4.9	1661	-16.3
2027	62	6452	89.1	21.9	7358	100.8	48	4995	103.5	16.9	5696	117	14	1457	-14.4	4.9	1661	-16.3
2028	66	6868	94.8	23.3	7832	107.3	48	4995	103.5	16.9	5696	117	18	1873	-8.7	6.4	2136	-9.8
2029	66	6868	94.8	23.3	7832	107.3	48	4995	103.5	16.9	5696	117	18	1873	-8.7	6.4	2136	-9.8
2030	70	7284	100.6	24.7	8307	113.8	48	4995	103.5	16.9	5696	117	22	2289	-2.9	7.8	2611	-3.3
2031	72	7492	103.4	25.4	8544	117.0	48	4995	103.5	16.9	5696	117	24	2497	-0.1	8.5	2848	0.0
2032	76	7908	109.2	26.8	9019	123.5	48	4995	103.5	16.9	5696	117	28	2914	5.7	9.9	3323	6.5
2033	82	8533	117.8	28.9	9731	133.3	48	4995	103.5	16.9	5696	117	34	3538	14.3	12.0	4035	16.3
2034	94	9781	135.0	33.2	11155	152.8	48	4995	103.5	16.9	5696	117	46	4787	31.5	16.2	5459	35.8
2035	94	9781	135.0	33.2	11155	152.8	48	4995	103.5	16.9	5696	117	46	4787	31.5	16.2	5459	35.8
2036	102	10614	146.5	36.0	12105	165.8	48	4995	103.5	16.9	5696	117	54	5619	43.0	19.1	6408	48.8
2037	102	10614	146.5	36.0	12105	165.8	48	4995	103.5	16.9	5696	117	54	5619	43.0	19.1	6408	48.8
2038	108	11238	155.1	38.1	12817	175.5	48	4995	103.5	16.9	5696	117	60	6243	51.6	21.2	7120	58.5
2039	112	11654	160.9	39.5	13291	182.0	48	4995	103.5	16.9	5696	117	64	6660	57.4	22.6	7595	65.0
2040	126	13111	181.0	44.5	14953	204.8	48	4995	103.5	16.9	5696	117	78	8117	77.5	27.5	9256	87.8
2041	130	13528	186.8	45.9	15427	211.3	48	4995	103.5	16.9	5696	117	82	8533	83.3	28.9	9731	94.3
2042	136	14152	195.4	48.0	16140	221.0	48	4995	103.5	16.9	5696	117	88	9157	91.9	31.1	10443	104.0
2043	142	14776	204.0	50.1	16852	230.8	48	4995	103.5	16.9	5696	117	94	9781	100.5	33.2	11155	113.8
2044	148	15401	212.6	52.2	17564	240.5	48	4995	103.5	16.9	5696	117	100	10406	109.1	35.3	11867	123.5
2045	160	16649	229.8	56.5	18988	260.0	48	4995	103.5	16.9	5696	117	112	11654	126.3	39.5	13291	143.0
2046	170	17690	244.2	60.0	20174	276.3	48	4995	103.5	16.9	5696	117	122	12695	140.7	43.1	14478	159.3
2047	172	17898	247.1	60.7	20412	279.5	48	4995	103.5	16.9	5696	117	124	12903	143.6	43.8	14715	162.5

Source: Recalculated by JST based on the Prior F/S

4.5 Updates based on the Actual Demand between Joydebpur - Ishurdi Section

4.5.1 Approach to Updating the Results

Our study mainly refers to two calculation methods below.

1) Consulting Services for Detailed Design, Bid Assistance, and Construction Supervision of the Bangabandhu Sheikh Mujib Railway Bridge Construction Project (hereafter referred to as the ”Jamuna Bridge F/S”)
2) Feasibility Study for Construction of Double Line between Joydebpur and Ishurdi Section of Bangladesh Railway (the Prior F/S)

In the Prior F/S report, as forecasted demand and supply are open-ended, both demand and supply of the study had been increased with “endless” passenger demand by 5 % and a 3 % growth rate of rolling stock transport supply which eventually crossed the feasible line capacity.

Furthermore, the Prior F/S did not consider the passenger diversion from road transport to railway transport (the demand of the Prior F/S simply increased its demand by the end of the demand forecasting year.

Therefore, the JST has taken a different approach to determine the Joydebpur-Ishurdi corridor demand by collecting corridor passenger demand and freight demand in all the transportation systems and then determining the modal shift to the railway between Joydebpur - Ishurdi section same as the approach of the Jamuna Bridge F/S. The following sections describe the transportation system’s current demand and forecasted demand for the Joydebpur - Ishurdi corridor.

4.5.2 Methodology to Update the Prior F/S

(1) Roadway Transport System

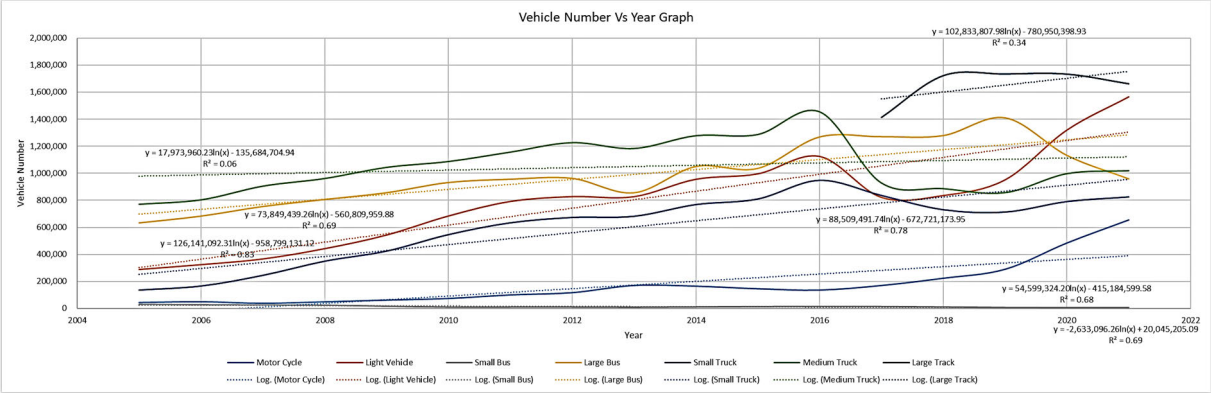
1) Predicted Road Traffic Volume

The Jamuna Bridge carries most of the passenger and freight traffic of the Joydebpur - Ishurdi corridor. The Jamuna Bridge toll captures all the traffic that crosses from one side to another side of the Jamuna River. The following figure shows the details of the traffic flow on Jamuna Bridge.

Table 4.11 Demand Forecast of Road Traffic between Joydebpur and Ishurdi

	a	b	2016	2017	2020	2025	2030	2035	2040	2045
Motor Cycle	54599324	-415184600	254,595	281,671	362,819	497,799	632,446	766,762	900,748	1,034,406
Light Vehicle	126141092	-958799131	992,121	1,054,676	1,242,153	1,553,998	1,865,074	2,175,384	2,484,933	2,793,724
Small Bus	-2633096	20045205	10,316	9,011	5,097	0	0	0	0	0
Large Bus	73849439	-560809960	1,100,869	1,137,492	1,247,251	1,429,821	1,611,940	1,793,612	1,974,838	2,155,620
Small Truck	88509492	-672721174	736,098	779,991	911,538	1,130,350	1,348,623	1,566,359	1,783,560	2,000,230
Medium Truck	17973960	-135684705	1,076,833	1,085,747	1,112,460	1,156,895	1,201,221	1,245,437	1,289,545	1,333,545
Large Truck	102833808	-780950399	1,498,742	1,549,738	1,702,575	1,956,800	2,210,398	2,463,372	2,715,725	2,967,460
Total (vehicles/year	-	-	5,669,575	5,898,325	6,583,895	7,725,664	8,869,702	10,010,925	11,149,348	12,284,984
Total (vehicle/day)	-	-	15,533	16,160	18,038	21,166	24,301	27,427	30,546	33,657

Source: Traffic Data: Toll Plaza Office of Bangladesh Bridge, Bangabandhu Bridge Authority, July 2022



Source: JST

Figure 4.7 Roadway Traffic Flow from Toll Collection Data of Jamuna Bridge

Roadway traffic flow conversion to Passenger Car Units (PCU) to determine roadway saturation status in future years for both forecasted vehicles and introduction with additional projects in the corridor. In the Study, we take option 1, PCU in the Prior F/S, which is more conservative than the PCU in the Geometric Design of RHD Road Ver. 4.

Table 4.12 Roadway Vehicle Traffic Converted to PCU

1. PCU in FS Study (ADB)												
	PCU	2016	2017	2020	2025	2028	2030	2035	2040	2045	2050	2052
Motor Cycle	0.5	127,297	140,835	181,410	248,900	289,314	316,223	383,381	450,374	517,203	583,869	610,490
Light Vehicle	1.0	992,121	1,054,676	1,242,153	1,553,998	1,740,735	1,865,074	2,175,384	2,484,933	2,793,724	3,101,761	3,224,765
Small Bus	1.4	14,443	12,615	7,136	0	0	0	0	0	0	0	0
Large Bus	2.2	2,421,913	2,502,483	2,743,952	3,145,606	3,386,122	3,546,269	3,945,946	4,344,643	4,742,363	5,139,112	5,297,541
Small Truck	1.4	1,030,537	1,091,987	1,276,154	1,582,491	1,765,930	1,888,072	2,192,902	2,496,984	2,800,321	3,102,918	3,223,750
Medium Truck	2.2	2,369,033	2,388,642	2,447,413	2,545,170	2,603,708	2,642,686	2,739,962	2,836,999	2,933,799	3,030,363	3,068,922
Large Truck	2.2	3,297,233	3,409,425	3,745,666	4,304,960	4,639,874	4,862,875	5,419,418	5,974,594	6,528,412	7,080,877	7,301,486
PCU/year	-	10,252,578	10,600,663	11,643,884	13,381,124	14,425,684	15,121,199	16,856,993	18,588,527	20,315,823	22,038,900	22,726,955
PCU/day	-	28,089	29,043	31,901	36,661	39,522	41,428	46,184	50,927	55,660	60,381	62,266
Average Annual Growth Rate (%)			3.4%	3.2%	3.0%	2.7%	2.5%	2.2%	2.0%	1.8%	1.6%	1.5%
PCU in Geometric Design of RHD Roads Ver. 4												
	PCU	2016	2017	2020	2025	2028	2030	2035	2040	2045	2050	2052
Motor Cycle	0.8	190,946	211,253	272,115	373,349	433,970	474,335	575,071	675,561	775,805	875,803	915,735
Light Vehicle	1.0	992,121	1,054,676	1,242,153	1,553,998	1,740,735	1,865,074	2,175,384	2,484,933	2,793,724	3,101,761	3,224,765
Small Bus	3.0	30,949	27,032	15,291	0	0	0	0	0	0	0	0
Large Bus	3.0	3,302,608	3,412,476	3,741,753	4,289,462	4,617,439	4,835,821	5,380,836	5,924,513	6,466,859	7,007,881	7,223,920
Small Truck	3.0	2,208,294	2,339,972	2,734,615	3,391,051	3,784,136	4,045,869	4,699,076	5,350,680	6,000,689	6,649,110	6,908,036
Medium Truck	3.0	3,230,499	3,257,240	3,337,381	3,470,686	3,550,512	3,603,663	3,736,312	3,868,636	4,000,635	4,132,313	4,184,894
Large Truck	3.0	4,496,227	4,649,215	5,107,726	5,870,400	6,327,101	6,631,193	7,390,115	8,147,174	8,902,380	9,655,741	9,956,572
PCU/year	-	14,451,645	14,951,864	16,451,034	18,948,948	20,453,893	21,455,954	23,956,794	26,451,496	28,940,091	31,422,609	32,413,922
PCU/day	-	39,594	40,964	45,071	51,915	56,038	58,783	65,635	72,470	79,288	86,089	88,805
Average Annual Growth Rate (%)			3.5%	3.2%	3.0%	2.8%	2.5%	2.2%	2.0%	1.8%	1.7%	1.6%

Source: JST

2) Relationship between Road Capacity and Traffic Volume

As the total PCU with the Prior F/S is more than the figures provided by RHD, we take the lower PCU as a conservative assumption for future year roadway corridor traffic flow. The summary with an introduction of additional projects has been done in the following table.

Table 4.13 Roadway PCU/Day in the Joydebpur - Ishurdi Corridor with Additional Roadway Project Implementation considering the PCU Values of the Prior F/S

Year	PCU/Day	Details	Remarks
2022	33726	Over 30000 PCU/Day, Saturated Condition	
2023	34677		
2024	35655	2 direction 2 lanes; Open of SASEC 2 project, 4 lanes on both sides of BB, Roadway saturated capacity 60000 PCU/day	
2028	39451		

Year	PCU/Day	Details	Remarks
2029	N/A		Opening
2030	41428		
2035	46184		
2040	50927		
2045	55660		
2050	60,381	Over 60,000 PCU/day, Over saturation condition	
2052	62,266		

Note: In this demand forecast, it is assumed that the road demand growth will stop in 2052, and the road demand after that will be flat.

Source: BBA and ADB SASEC II Project Updates, Link: https://www.adb.org/projects/40540-018/main

3) Assumptions for Conversion from Road to Railway Transport in Passenger

Next, comparing the costs of road and rail transport, rail fares are about half of the bus fares (0.80 BDT/km and 1.45 BDT/km, respectively), as shown in the table below. In order to predict the extent of modal shift, it is necessary to survey passengers' preferences, such as through a Stated Preference (SP) survey, but this could not be conducted due to time and cost constraints. Therefore, JST assumed the rate of increase in demand by referring to the price elasticity for conversion from small buses to large buses, which was set at 0.36 in the final report of a past JICA study[8] in Bangladesh. Referring to the results, the conversion rate from road traffic to rail with respect to passengers is assumed as 15% (for the Jamuna Bridge F/S, the conversion rate was set at 50%).

Table 4.14 Travel Time of the Roadway and Railway System in the Corridor

Passenger	Travel Time	Unit Cost	Source
Bus travel time	4.6 hr	1.45 BDT/km	Google Map historical average travel time Data
BR travel time (with the Project)	4.0 hr	0.80 BDT/km	The Prior F/S

Source: JST

4) Assumptions for Conversion from Road to Railway Transport in Freight

The Prior F/S assumed freight transport modal shift without concrete information. Therefore, JST had to collect arbitrary sample data and compare roadway and railway freight transport costs. The same freight transport data are given below table.

Table 4.15 Basic Data of Road Freight Transport

Origin-Destination (OD)			Sample Data Collected
Dhaka – Dinajpur			Joydebpur - Ishurdi Corridor (Extended)
Distance	331	km	Google maps
Cost	24,000	BDT	Considering 1.5 times high fuel cost from 89 BDT/L to 130 BDT/L
Load	4.5	tonne	Assume the capacity limit is 5 tons per truck
Cost	14.5	BDT/tonne/km	Cost per tonne-km

Source: JST

[8] The Kanchpur, Meghna, and Gumti 2nd Bridges Construction and Existing Bridges Rehabilitation Project (2010)

In the Study, based on information from the BR Information Book, the freight revenue unit price was set at 2.59 BDT/tonne-km based on the average over the past five years (2015-2019). Since JST could not find information on the conversion rate from road to rail transport in Bangladesh, we calculated the conversion ratio of demand by setting the price elasticity to 3.0, referring to a case study of an American freight carrier raising its rates. The conversion ratio from road transportation to rail regarding freight transportation that was commensurate with the calculated rate of change in demand was 4.5%, so this value was set as the conversion ratio for freight transportation in the Study (in the Jamuna Bridge F/S, the conversion rate was set at 15%).

(2) Railway Transport System

As of 2020, from the time-schedule book of BR, 44 trains run through the Joydebpur-Ishurdi corridor[9], which is over the capacity limit of 25 train sets per day. Among 44 trains, 10 train Origin-Destination (OD) is from Dhaka to the southwest side of Bangladesh and will be diverted to the Padma railway link from the 2023 opening. The remaining 34 Trains running through the Joydebpur - Ishurdi Railway Corridor with OD of the north or northwest side of Bangladesh will be catered by Joydebpur-Ishurdi Corridor. Among 34 trains in the northwest side OD, 2 trains are freight trains with petroleum products.

1) Passenger Transport

Based on the information in Figure 4.8, trains to the southwest will be diverted to the Padma railway link. According to the Jamuna Bridge F/S, the trains of “Dhaka-Khulna” and “Dhaka Cantonment–Kolkata” are assumed to be diverted to the south.

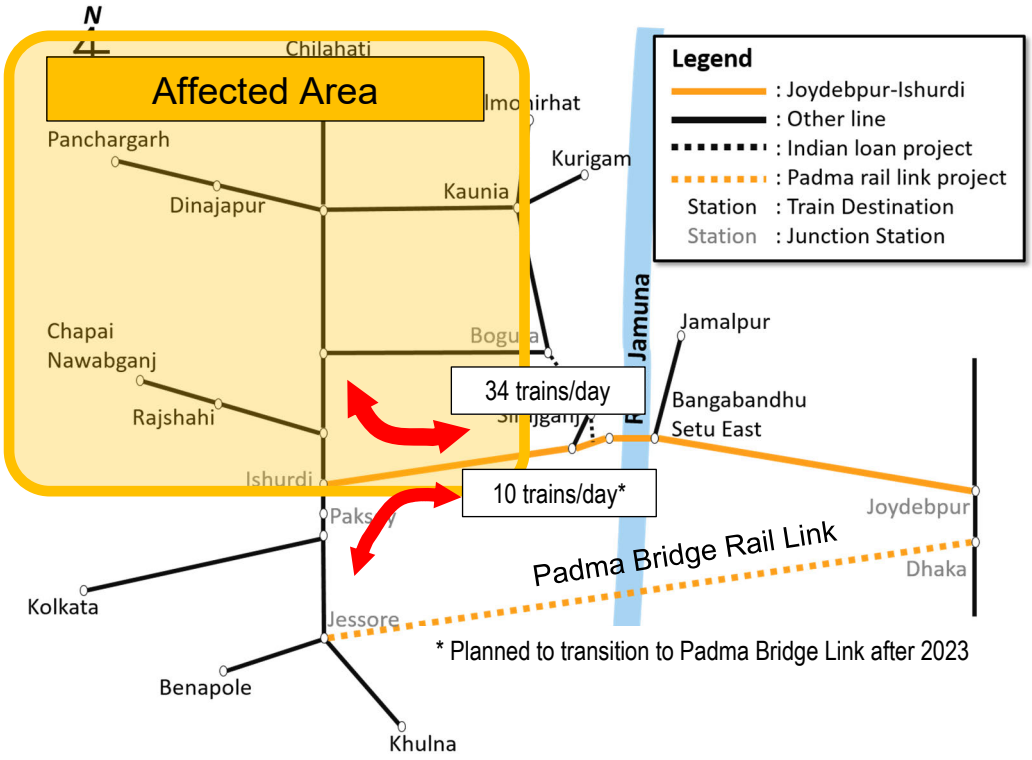
Regarding the diversion from Shahid M. Mansur Ali to Bogura, from the view of the geographical status, the trains of “Dhaka-Lalmonirhat” and “Dhaka-Rangpur” will be diverted to the north side.

2) Freight Transport

Based on the information in Figure 4.8, about one out of four train sets will be diverted to the Padma railway link, so we assumed that one-fourth of the train sets running the Joydebpur-Ishurdi corridor will be diverted to the southwest.

Regarding the train diversion to the Bogura side, it is not considered since the gauge is MG and will not be able to carry heavy wagons and containers on the corridor. The diverted traffic volume and the number of trainsets will be illustrated in Figure 4.9, Figure 4.10, Table 4.17, and Table 4.19 respectively.

[9] According to BR staff, out of 44 trains per day, there are 36 scheduled passenger train sets, 6 local commuter train sets, and 2 freight train sets.



Source: JST

Figure 4.8 Current Train Operation System and Demand Affected Area by Joydebpur - Ishurdi Railway Double Tracking

(3) Waterway Transport System

Although fertilizer accounts for 2.5% of BR's total annual freight volume between Joydebpur and Ishurdi, the transportation of fertilizer between the section is handled by waterway transport, which accounts for a small percentage of the total freight volume. Therefore, it was determined that there would be no significant impact on transportation operations after the rail upgrade. It was determined that there would be no particular impact on waterborne transportation.

(4) Airway Transport System

The airway transport system has a limited number of flights from Dhaka to Rajshahi which is unlikely to be shifted to the railway system as they are from a higher income level group. Therefore, it can be assumed that the minimal impact from the airway transport system to Joydebpur - Ishurdi Railway Corridor has been absorbed within the optimistic and pessimistic range.

(5) Transboundary Transport Demand

The Transboundary traffic has been collected from Bangladesh Land Port Authority (BSBK) which has no OD data. Due to the received data characteristics, it could not be used to facilitate the transboundary data for the Joydebpur-Ishurdi Railway corridor. Furthermore, as transboundary data is highly dependent on national-level policy and diplomatic relations and decisions, therefore, abrupt variation cannot be captured for future year demand estimation. Consequently, in this demand forecast,

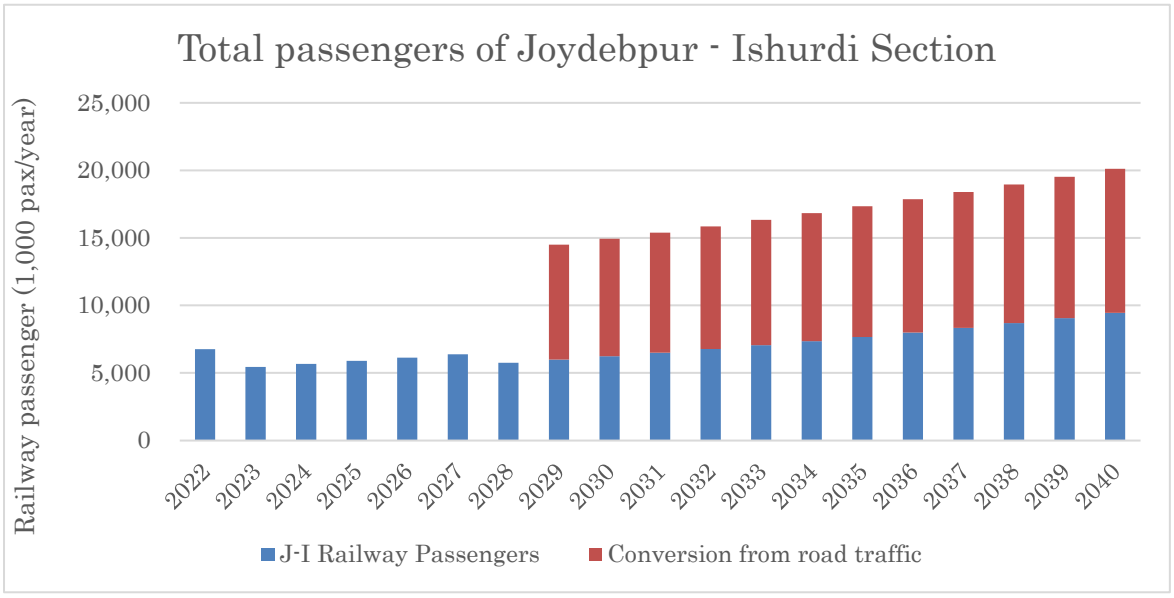
the transboundary traffic data has not been addressed (however, the international passenger train of "Dhaka Cantonment – Kolkata" is included in the railway passenger demand forecast.).

4.5.3 Results of Demand Forecast of the Study

(1) Passenger Transport

Considering the conditions in 4.5.2, with 62 passengers per carriage and varying 11-19 carriage number/train with varying 682 - 1,178 passenger/train, passenger train has been forecasted in Figure 4.9.

After the opening of the Padma railway link in 2023, some transport volume starts to be diverted to the southwest from Dhaka, and others will be also diverted from Shahid M. Mansur Ali to the north side from 2028, after the completion of the Bogura-Shahid M. Mansur Ali line, being constructed by the Indian fund.

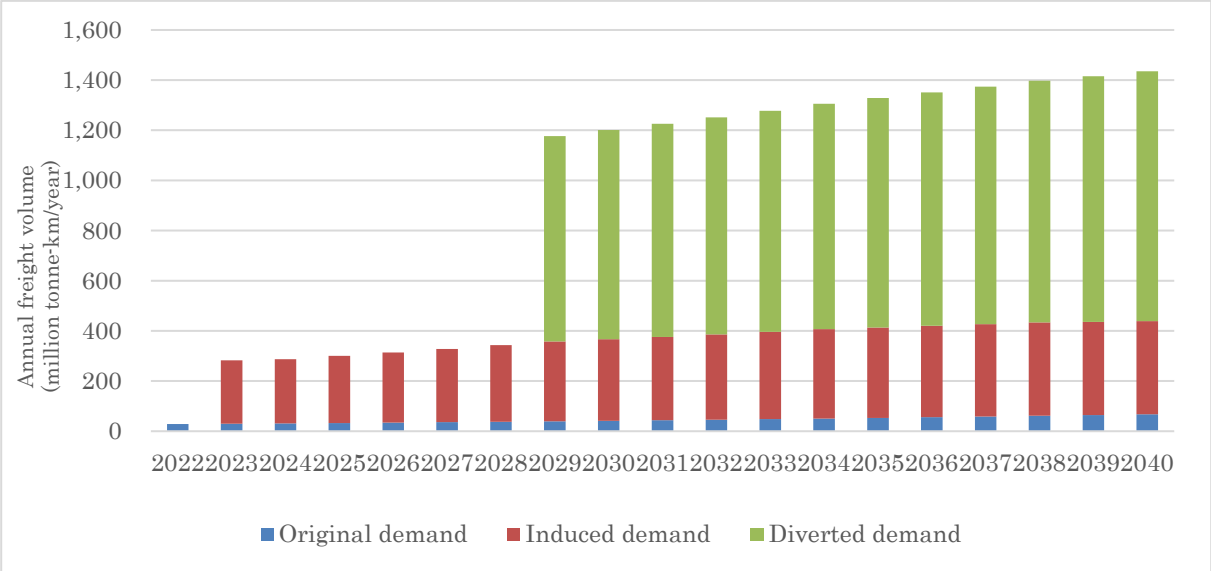


Source: JST

Figure 4.9 Total Number of Passengers in the West Section

(2) Freight Transport

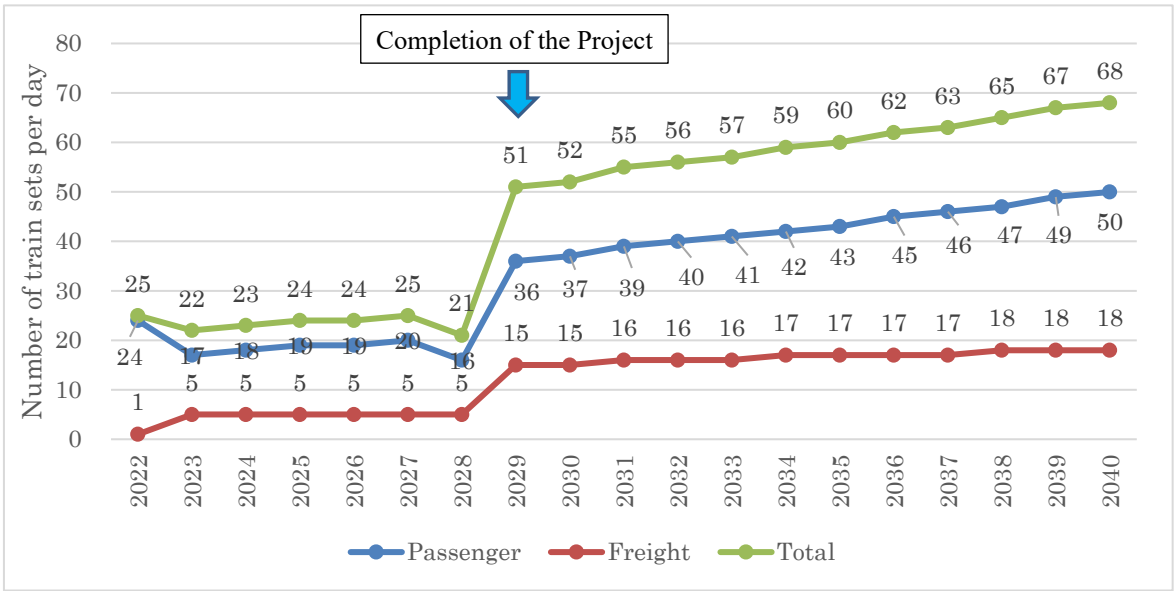
Regarding the freight train, considering 34 tonne/tank wagon, 33 tonne/BC wagon, container (TEU), and varying 25-32 wagon/train, freight train has been forecasted in the following figure. Due to the increase in the railway capacity of the western part of the country, induced freight transport will occur after 2023. Furthermore, with the opening of the improved line in 2029, JST assumed an increase in freight traffic due to the conversion from road traffic due to the increased track capacity on this section.



Source: JST

Figure 4.10 Annual Freight Transport Volume between Joydebpur - Ishurdi Section

Based on the demand forecast for passenger and freight transport explained above, the estimated number of train sets between the Joydebpur-Ishurdi section is demonstrated as follows, which will reach the line capacity limit of 68 train sets per day in 2040. Therefore, it is assumed that there is no demand growth for both passenger and freight transport after 2040 in the Study.



Note: The number of train sets is rounded up and shown as an integer.
Source: JST

Figure 4.11 The Number of Train Sets between Joydebpur - Ishurdi Section

4.5.4 Comparison between the Prior F/S and the Study

The comparison table and figure between the Prior F/S and the Study are shown as follows. As seen here, the Study dug deeper information than the Prior F/S, such as including other lines' capacity and the capacity of each relevant line.

Table 4.16 Comparison between the Prior F/S and the Study related to Demand Forecast

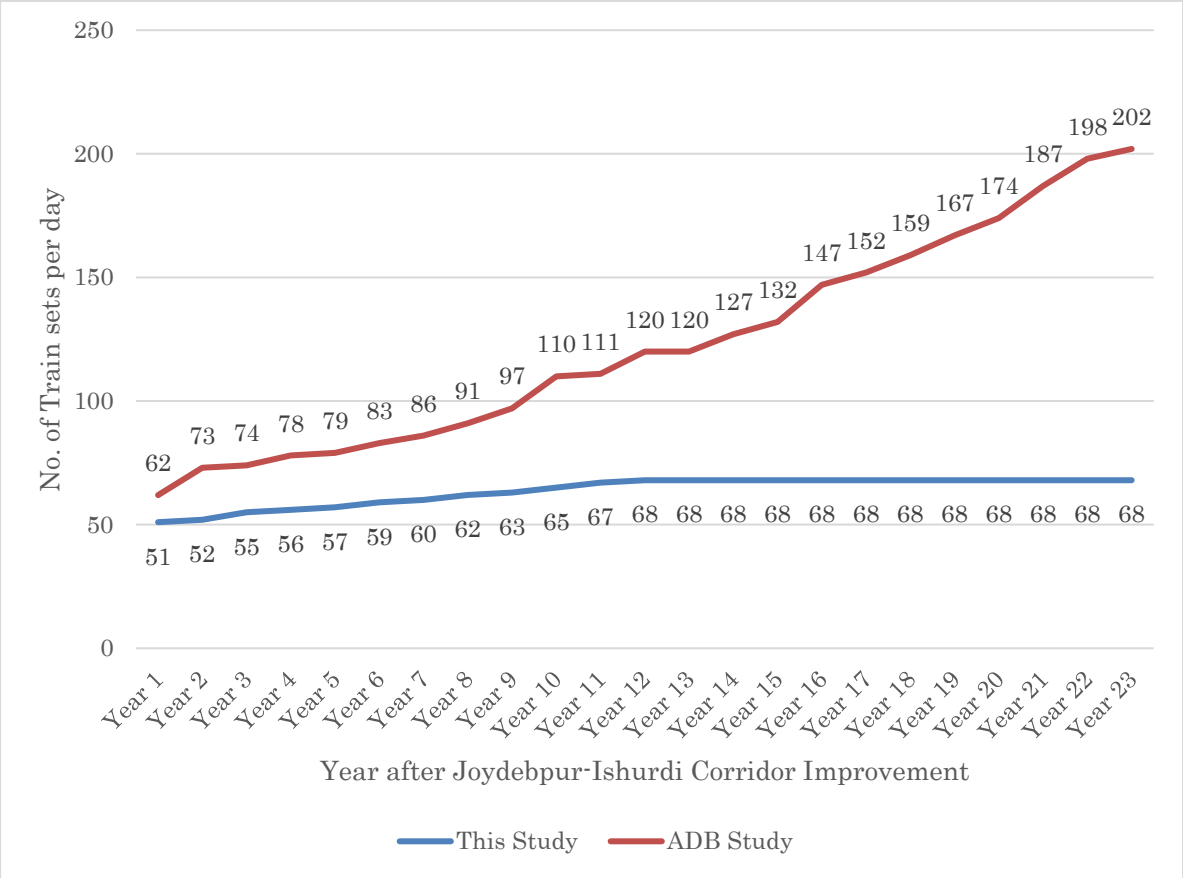
#	Topics/Issues	The Prior F/S	The Study	Remarks
1	Demand Calculation Concept	• Railway Demand Constraints by Supply	• Corridor Passenger and Freight/Goods Demand in all Available & Possible Transport Systems than modal shift to the Proposed Rail Transport System	• The Prior F/S: This may or may not be true. But claimed true without Supporting Data
2	Supply	• The train Number growth rate is driven by a Rolling Stock Increase of 3% pa	• Demand Driven Supply Calculation	• The Prior F/S: Train with track & Station infrastructures are owned by Gov. Organization, BR. Assurance or Contract or Agreement by BD gov. with BR for allocating increasing funds for a 3% pa rolling stock increase could not be found.
3	Demand	• Railway Demand is Unlimited and Constraints by Supply	• Passenger growth rate with Freight/Goods growth rate	• The Prior F/S: Demand cannot be Unlimited
4	Transportation System Considerations	• Only Railway Transportation Systems Considered	• Roadway, Railway, Waterway, and Airway Transportation Systems Considered	
5	Railway Network Considerations	• Padma Bridge Rail Link was not under consideration • Shahid M. Mansur Ali-Bogura Diverted Train was not under consideration	• Diverted Train Traffic through Padma Bridge Rail Link has been Considered • Diverted Train Traffic through the Shahid M. Mansur Ali-Bogura link has been Considered	

* Demand Driven Supply = Passenger & Freight Tonnage calculated than the appropriate number of trains assigned in the corridor

** Demand Constrained by Supply = Passenger & Freight Tonnage Demand is more than the Capacity of the Trains Operated in the corridor

Source: JST

The figure below shows the comparison of the number of train sets in the Study and the Prior F/S. As explained above, the growth is moderate and will stop after 13 years from the opening (2042) in the Study, whereas there is no ceiling for the demand growth and the final figure was 202 train sets per day after 23 years from the opening (2052) in Prior F/S.



Source: JST and the Prior F/S

Figure 4.12 The Comparison of Daily Train Sets between the Study and the Prior F/S

Table 4.17 Number of Train Sets between Joydebpur - Ishurdi Section (including the diversion to Bogura after 2028)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Passenger	24	17	18	19	19	20	16	36	37	39	40	41	42	43	45	46	47	49	50
Freight	1	5	5	5	5	5	5	15	15	16	16	16	17	17	17	17	18	18	18
Total	25	22	23	24	24	25	21	51	52	54	55	57	59	60	61	63	65	67	68
Conversion to Bogura	-	-	-	-	-	-	5	5	5	5	6	6	6	6	6	7	7	7	7

Table 4.18 Converted Number of Train Sets to the Padma Railway Link

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Passenger	-	6	6	6	6	7	7	7	7	8	9	9	9	10	10	9	11	12	12
Freight	-	2	2	2	2	2	2	5	5	5	6	6	6	6	6	6	6	6	6
Total	-	8	8	8	8	9	9	12	12	13	15	15	15	16	16	15	17	18	18

Table 4.19 Total Number of Train Sets at the West Side (both Joydebpur - Ishurdi Section and Padma Railway Link)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Passenger	24	23	24	25	26	27	23	43	45	47	49	50	51	53	55	57	58	61	62
Freight	1	7	7	7	7	7	7	20	20	22	22	22	23	23	23	23	24	24	24
Total	25	30	31	32	33	34	30	63	65	69	71	72	74	76	78	80	82	85	86

Note: The number of train sets is rounded up and shown as an integer.
The Joydebpur - Ishurdi corridor capacity is 25 train sets per day before 2027 and 68 train sets per day after 2028.

Source: JST

Chapter 5 Natural Condition

5.1 General

Natural conditions based on the existing information are described below:

5.2 Weather Information

Most of Bangladesh belongs to the tropical monsoon climate zone. There are six seasons in a year, with rainy and dry seasons and transition periods between them. It is generally divided into a hot season from April to May, a rainy season from June to October, and a dry season from November to March. The country is flat and occupied by the huge Ganges-Brahmaputra Delta, and it's therefore exposed to floods as well as storm surges when cyclones hit the Bay of Bengal during the transitional seasons of April-May and October-November.

In the central area, which includes Dhaka, the capital city, and the Project area, lows are around 15°C (59 °F) and highs around 26°C (78.8°F) in January. Furthermore, from December to February, the north wind can sometimes bring cold temperatures at night, around 10 °C (50 °F) in the Project area and in Dhaka. In February, the temperature begins to rise, and by March, it begins to get really hot. From March to May, is the hottest season: the average maximum temperatures reach 35 °C (95 °F) in April in inland areas. The highest peaks are about 40 °C (104 °F) in Dhaka and in the Project area. Relative humidity gradually increases, and the heat becomes more and more stifling. In this season, lines of thunderstorms coming from the Himalayas, called northwesters, bring rainfall accompanied by hail and wind gusts, so much so that in May, more than 250 millimeters (10 inches) of rain fall in the south and 150 mm (6 in) in the north.

5.3 Natural Disasters

Information on cyclones, earthquakes, active faults, tsunamis, and storm surges in Bangladesh is as follows.

5.3.1 Cyclone

Bangladesh, due to its unique geographic location, suffers from devastating tropical cyclones frequently. The funnel-shaped northern portion of the Bay of Bengal amplifies the storm surge of landfilling tropical cyclones, affecting thousands of people. Some of the most devastating natural disasters in recorded history with high casualties were tropical cyclones that hit the region now comprising present-day Bangladesh. Among them, the 1970 Bhola cyclone alone claimed

approximately 300,000 to 500,000 lives, making it the deadliest tropical cyclone on record. Other major cyclones are as follows.

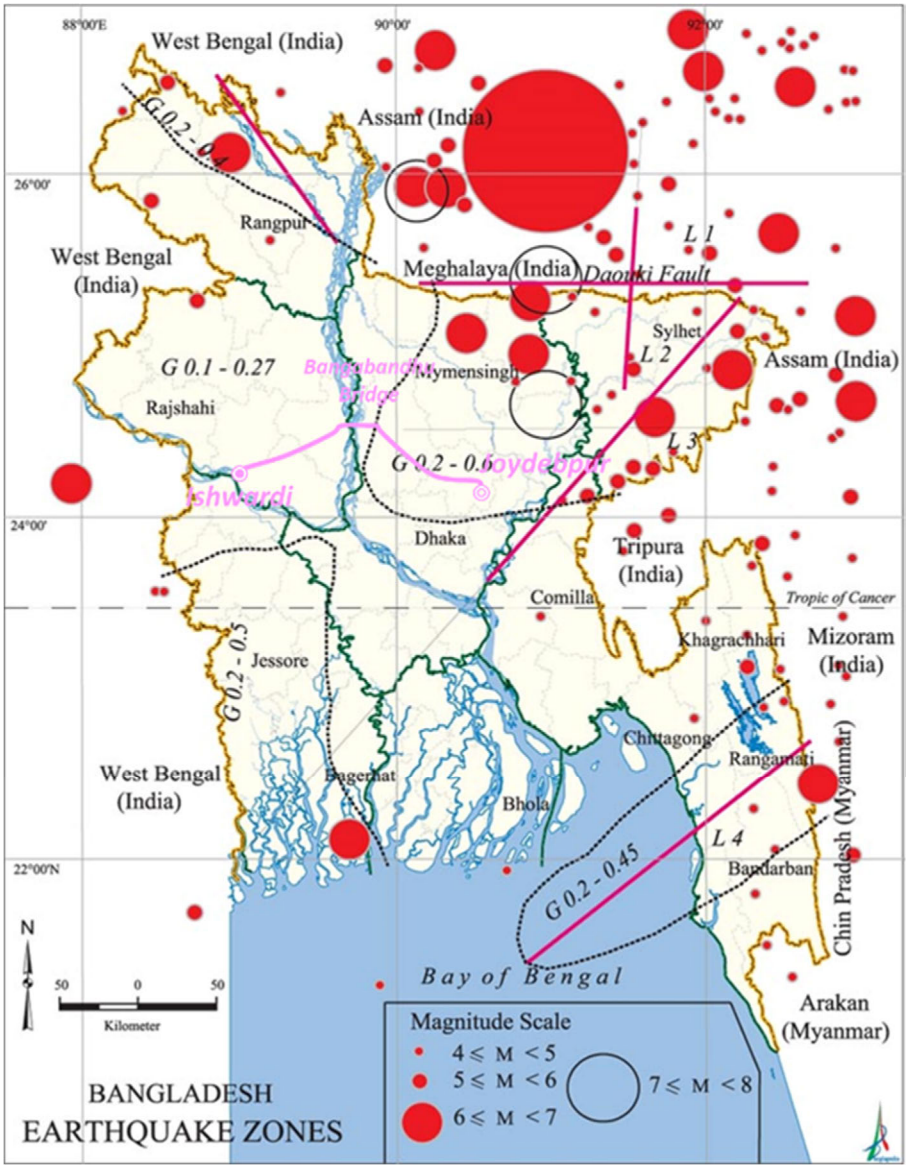
- On May 25, 2009, it landed in Bangladesh and caused damage, mainly in southern Bangladesh. The cyclone killed 190 people and affected 3,935,341 people. Economic damage losses amounted to US$270 million.
- On November 15, 2007, it landed on the coast of Bangladesh, causing 8,978,541 victims, 4,234 deaths, and US$2.3 billion in economic damage.
- In April 1991, the cyclone that hit Chittagong killed 138,866 people and affected 15,438,849 people. Economic losses amounted to US$1.78 billion.

Cyclone Sidr, which hit Bangladesh in 2007, reached a maximum wind speed of 69 m/s, making it one of the largest in recorded history.

5.3.2 Earthquake

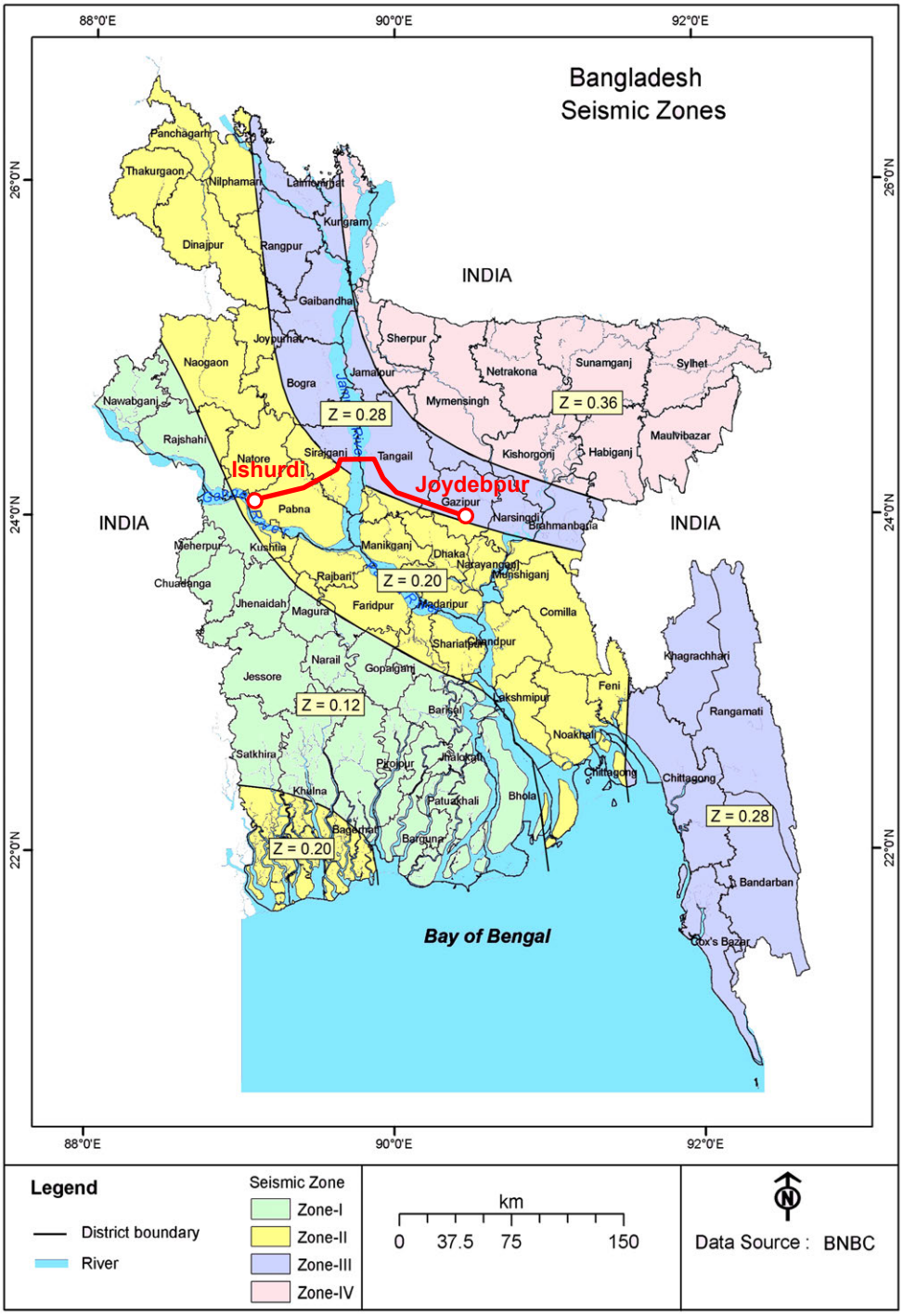
Bangladesh is an earthquake-prone country like Japan. Three plates, the Indian plate, the Eurasian plate, and the Myanmar microplate, collide with each other, forming long and large fault zones along their respective plate boundaries, which have caused large earthquakes in the past. The earthquake record suggests that since 1900 more than 100 moderate to large earthquakes have occurred in Bangladesh, out of which more than 65 events occurred after 1960. This brings to light an increased frequency of earthquakes in the last 30 years.

Figure 5.1 shows the epicenters of these past earthquakes and the Project area. Many earthquakes occurred in the northeast, and it can be seen that the number of sources decreases as going down to the southwest. According to the seismic zoning map for Bangladesh has been presented in the Bangladesh National Building Code (BNBC) published in 2020, there are three zones in the pam, Zone I, Zone II, Zone III and Zone IV. The scale of earthquakes increases from southwest to northeast, and the zone coefficients (Z) of the four zones are: Z=0.12 (Zone I), Z=0.20 (Zone II), Z=0.28 (Zone III) and Z=0.36 (Zone IV), respectively. The proposed Project area is in the area of Zone II and III, indicating a medium scale.



Source: BANGLAPEDIA (National Encyclopedia of Bangladesh: https://en.banglapedia.org/index.php/Earthquake)

Figure 5.1 Earthquakes Occurred in the Past around Bangladesh

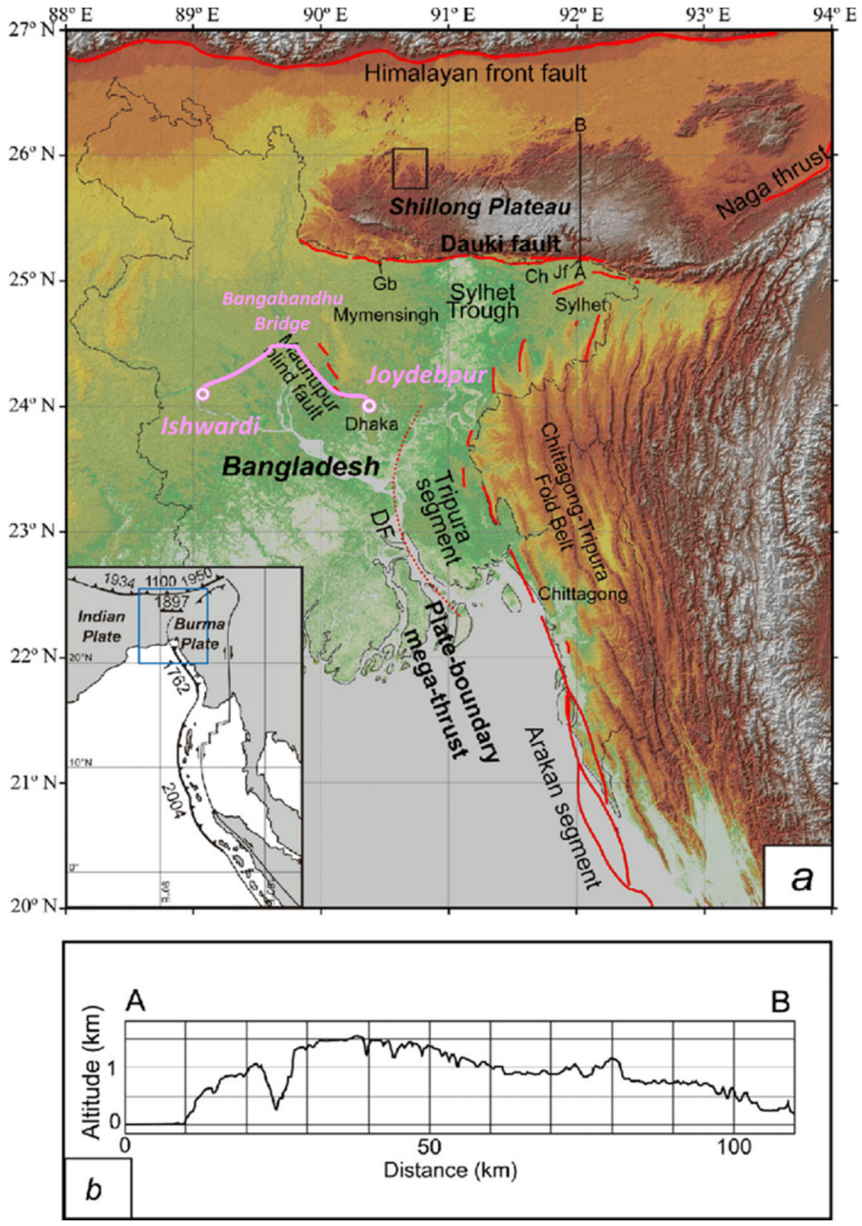


Source: JST based on Bangladesh National Building Code (2020)

Figure 5.2 Seismic Zoning Map in Bangladesh

5.3.3 Active Fault

Figure 5.3 shows the active faults map in Bangladesh overlaid with the Project area. According to the Figure, it seems that the Project area overlaps with the Madhupur Blind fault. However, considering that the existing railway is currently operated without problem, the existing railway may not overlap with the active fault. Further detailed confirmation on this issue is required in the detailed design stage.



Source: Web site: https://www.researchgate.net/figure/a-An-active-fault-map-of-Bangladesh-The-Dauki-fault-passes-along-the-southern-margin_fig1_263391442

Figure 5.3 Project Area and Active Fault Location

5.3.4 Tsunami

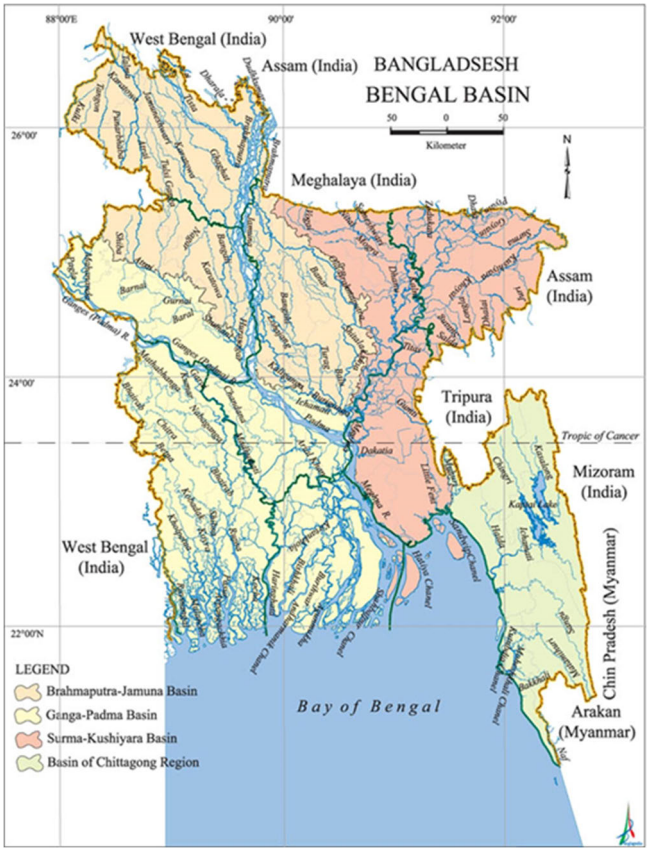
Although Bangladesh has suffered damage from tsunamis in the past, it is not mentioned in this report because the damage was limited to the south coast area in Bangladesh.

5.3.5 Storm Surge

Although Bangladesh has suffered a lot of damage from storm surges in the past, it is not mentioned in this report because the damage was limited to the south coast area in Bangladesh.

5.4 Hydrology

Bangladesh is called a land of rivers as it has about 700 rivers, including tributaries. The rivers are not, however, evenly distributed. For instance, they increase in numbers and size from the northwest of the northern region to the southeast of the southern region. The total length of all rivers, streams, creeks, and channels is about 24,140 km. In terms of catchment size, river length, and volume of discharge, some of these rivers are amongst the largest on the earth. Usually, the rivers flow south and serve as the main source of water for irrigation and as the principal arteries of commercial transportation. On the other hand, widespread riverbank erosion and regular flooding of the major rivers cause enormous hardship and destruction of resources, hindering development. But it is also true to say that the river system brings a huge volume of new silt to replenish the natural fertility of the agricultural land. Moreover, the enormous volume of sediments that the rivers carry to the Bay of Bengal each year (approximately 2.4 billion tons) builds new land along the seafront, keeping hope alive for the future extension of settlement. Finally, during the monsoon, rivers also drain excess discharge to the Bay. Thus, this great river system is the country's principal resource as well as its greatest hazard. The system can be divided into four major networks: (1) the Brahmaputra-Jamuna River system, (2) the Ganges-Padma River system, (3) the Surma-Meghna River system, and (4) the Chittagong region river system. The proposed Project area is in (1) the Brahmaputra-Jamuna River system and (2) the Ganges-Padma River system.

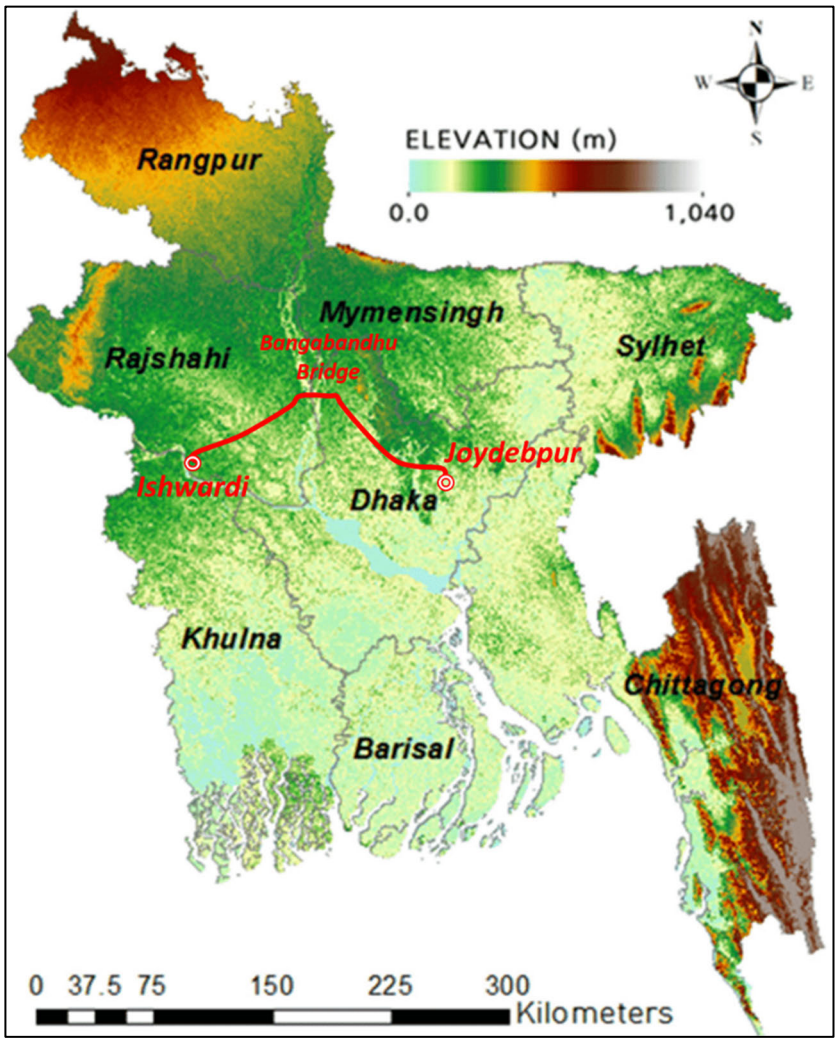


Source: Web site:
https://en.banglapedia.org/index.php/River_and_Drainage_System

Figure 5.4 River System in Bangladesh

5.5 Topographical Condition

Bangladesh is a country on the world's largest Ganges Delta, formed by the Ganges River flowing from the west and the Brahmaputra River flowing from the northeast. As shown in , the land is almost flat except for a part of the Rangpur Division in the northwest and a part of the Chittagong Division, and most of it is swampy land below 10m above sea level. As for the existing ground level along the Project, it exceeds 15m above sea level at the approaches on both sides of the Jamuna Multipurpose Bridge, but the other sections have 8-15m above sea level. Therefore, the longitudinal gradient of the track for the proposed Project is not steep.



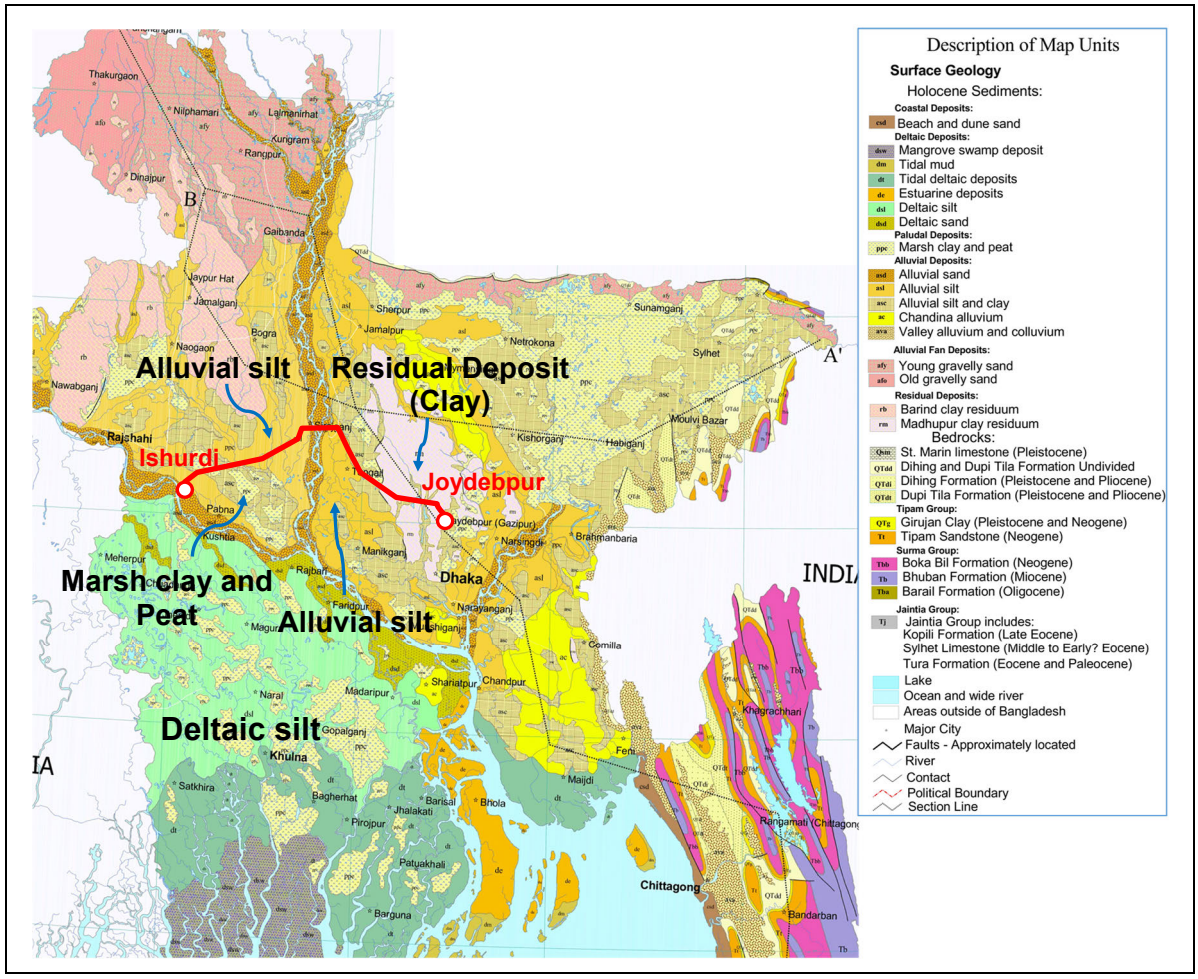
Source: JST based on Website Data (https://www.researchgate.net/figure/The-elevation-map-of-Bangladesh-data-source-https-SRTMcsicgiarorg_fig1_336798453)

Figure 5.5 Topographical Map of Bangladesh

5.6 Geotechnical Condition

Approximately 80% of Bangladesh's land area is covered by the fertile alluvial lowlands known as the Bangladesh Plain. The project section is located almost in the middle of that alluvial lowland, and the main geology consists of alluvial floodplain deposits and depressional deposits. Some sections pass through a lowland zone called the Chalan Beel, where organic soil layers can be found.

The Geology Map in Bangladesh is shown below:



Source: Consultants based Geological Map of Bangladesh[10]

Figure 5.6 Geology Map in Bangladesh

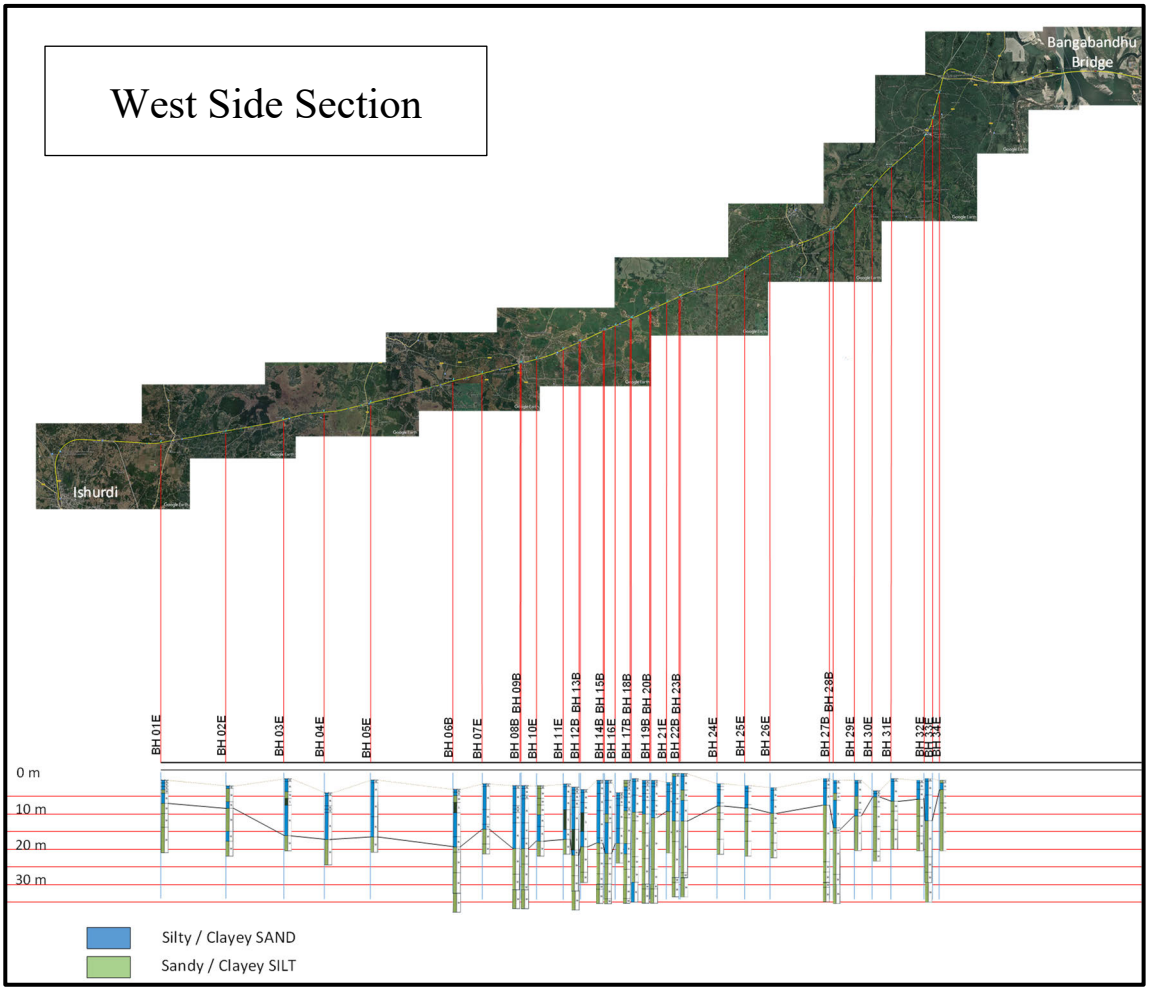
In the Prior F/S, a total of 40 boring surveys were carried out. Boring numbers with an "E" suffix are for embankments, and those with a "B" are for bridges. Since the effect of pressure in the depth direction of a single-line embankment is thought to be limited to approximately 20m, boring surveys for embankments were conducted up to a depth of 20m, and boring surveys for a bridge were conducted up to a depth of 35m to ensure bearing capacity.

There are 34 boring data on the west side of the Jamuna Bridge, while there are only six boring data on the east side of the bridge, and boring surveys are not necessarily conducted at the locations of bridges to be designed. Therefore, it is necessary to analyze the existing data of 6 borings so that the lack of data can be supplemented.

[10] Geological Map of Bangladesh, 1990, Md.Khurshid Alam, A.K.M.Shahidul Hasan, and Mujibur Rahman Khan (Geological Survey of Bangladesh), and John W. Whitney (United Stetes Geological Survey)

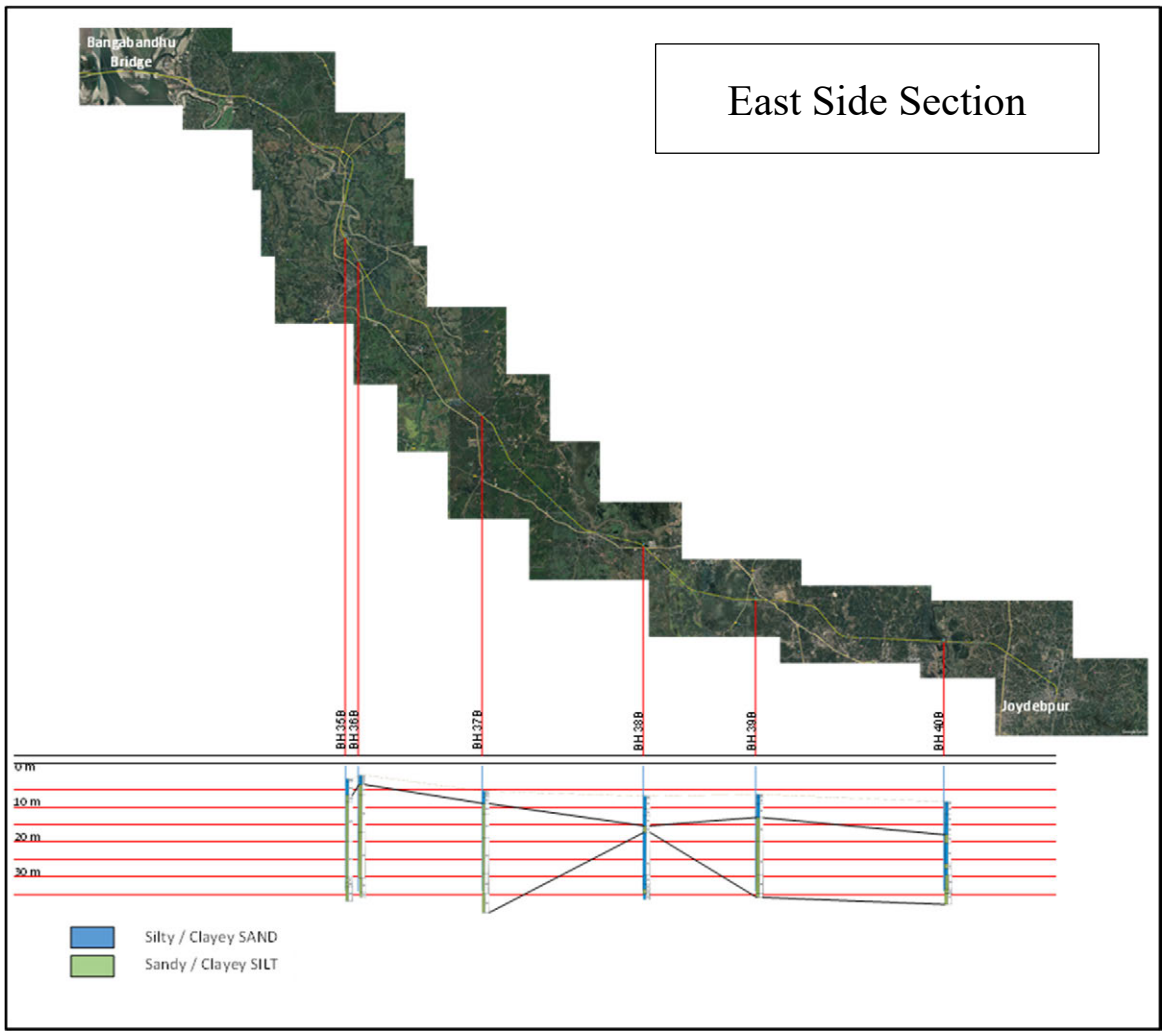
As a general trend, from the surface layer to a depth of about 10m, the soil is rather firm silty soil with an N value of 10 or less, and sandy soil with an N value of 15 to 30 below. Therefore, the ground along the Project is less susceptible to consolidation settlement and liquefaction.

Boring locations is shown below:



Source: JST based on the Existing Boring Data

Figure 5.7 Boring Logs of West Side Section



Source: JST based on the Existing Boring Data

Figure 5.8 Boring Logs of East Side Section

5.7 Consideration of consolidation settlement

The clay and silt layers in the Study area are classified as hard clay, even if the thickness of such layer is large, it can be said that serious consolidation settlement will not occur.

The result of consolidation settlement calculation is shown in 6.6.1.

Chapter 6 Conceptual Design

6.1 Introduction

This chapter describes the current situation and conceptual design between Joydebpur-Ishurdi section based on the site survey, data collection, discussion with BR, etc.

6.2 Design Parameter

Main technical railway standard and design parameters of new track are shown below:

Table 6.1 Main Technical Railway Standard of New Track

Item	Standards
Number of main lines	Double tracks
Gauge(mm)	DG consisting of BG (1676 mm) and MG (1000 mm)
Design running speed(km/h)	120km/h for BG passenger train, 100km/h for MG passenger train, and 80km/h for BG and MG freight train
Distance between Tracks (m)	Main lines: 6m*, station lines: 5.3m, major bridges: 12m or less**
Minimum curve radius (m)	500 m to match curves of existing track
Ruling gradient (‰)	0.5% (1 in 200), not flatter than 0.25% (1 in 400) in existing station yards. 0.04% per degree of curvature.
Types of traction	Diesel (Non-electrification)
Sleeper Spacing between sleeper centres	Main line track: 600 mm nominal (1,667 sleepers per km); and Tracks on other than main line: 658 mm nominal (1520 sleepers/km)
Minimum Ballast Cushion at rail seat	Under the mainline sleepers: 300mm Under loop line and station track sleepers: 250mm Under sleeper on ballasted deck bridges: 300mm
Effective length of receiving-departure track (m)	750
Block type	Absolute block system
Axle load	BG: 25t, MG: 15t

*: Distance between the existing and new track, including on the minor bridges and box culverts
**: Distance will be finalized on the detailed design stage.
Source: The Prior F/S

Table 6.2 Design Parameters of Railway Track

Item	Standards
Superelevation/Cant (maximum)	145 mm for BG* and 90 mm for MG (*to limit Superelevation to 90 mm on MG). Up to 165 mm considered, where required, for design of transition curves
Cant deficiency (maximum)	75 mm for BG and 50 mm for MG
Cant excess (maximum)	75 mm for BG and 65 mm for MG
Cant gradient	1 in 720 normally (1 in 360 in difficult locations for BG only)
Rate of change of Cant (maximum)	55 mm/sec for BG and 35 mm/sec for MG
Rate of change of Cant deficiency (maximum)	55 mm/sec for BG and 35 mm/sec for MG
Safe Speed (V safe) in Km/h	Vsafe =0.27√(R(Ca + Cd)) for BG Vsafe =0.344 √(R(Ca + Cd)) for MG (Centre to centre of rail heads assumed as 1750 mm for BG and 1072 mm for MG) Where Ca = Actual Super elevation/Cant in mm Cd = Cant Deficiency in mm
Superelevation / Cant and Cant gradient at commissioning	To suit commissioning speeds

Note: Loop lines and siding line tracks will not be provided with Superelevation /cant.
Source: The Prior F/S

6.3 Route and Alignment

6.3.1 Route

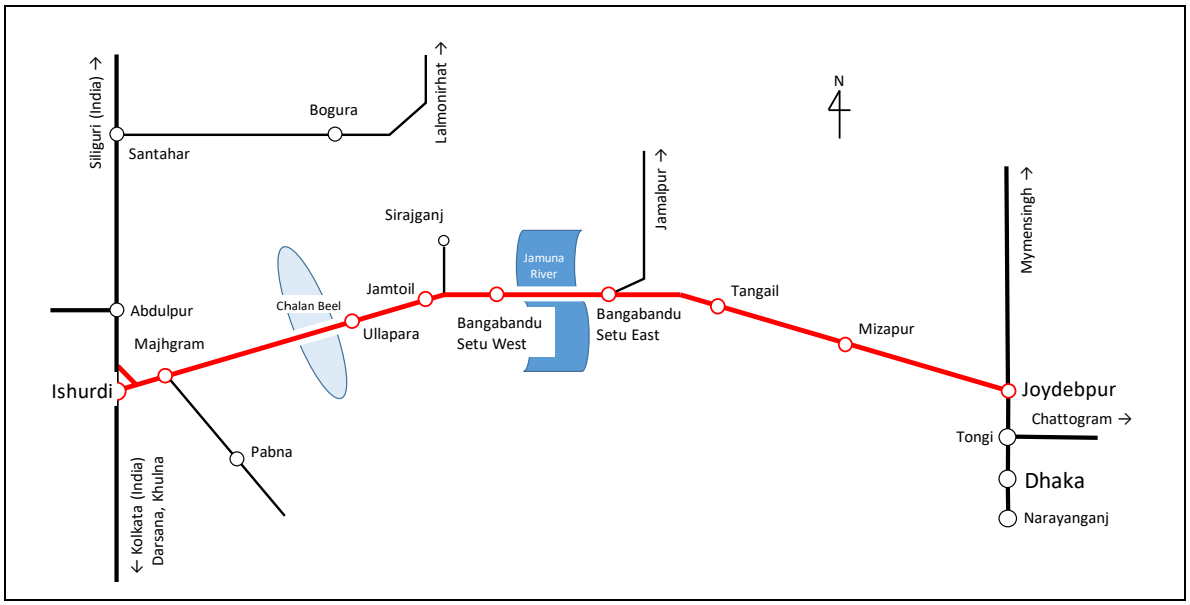
The Between Joydebpur-Ishurdi Section is a component of the main line joining Dhaka to various cities in the West Zone. Starting from Joydebpur, it crosses the Jamuna River over the Jamuna Bridge, then continues to Ishurdi. The total distance from Joydebpur to Ishurdi is 173.4km (from Dhaka to Ishurdi is 213.5 km).

Ishurdi Station is a key junction, with the southbound line crossing the Hardinge Bridge to connect southwestern Bangladesh (including Khulna, Bangladesh's third largest city) and Darsana towards Kolkata, India. A northbound line also connects other cities in the North Bengal region as well as Nepal via India. In the north of the Ishurdi station, there is a short-circuit line that allows direct trains to run between Dhaka and the northwest of Bangladesh without turning around at Ishurdi station. A Ishurdi Bypass station is located on this short-circuit line.

The other lines branch off at Majhgram, Jamtoil and Bangabandhu Setu East Stations.

The western section of the Between Joydebpur-Ishurdi Section, from Ishurdi to Jamtoil (Sirajganj), was opened in 1915-1916. After that, the Jamuna Bridge was opened in 1988, and the line reached Dhaka in 2003.

Schematic railway networks around Between Joydebpur-Ishurdi Section is shown below:



Source: JST

Figure 6.1 Schematic railway networks around Between Joydebpur-Ishurdi Section

6.3.2 Alignment

The proposed alignment of new double track lies on the north side, i.e., to the left of the existing track while travelling from Ishurdi to Joydebpur. Distance between the existing and new track will be at 6 m as the result of discussion with BR. At the minor bridges and box culvert, this distance is proposed to be at 6 to12 m to facilitate construction of these bridges on the new track without much interference with the existing track. To reduce construction costs, shortening these distances may be considered at the detailed design stage.

Since the topography of the entire route is almost flat, there are no continuous steep gradient sections, and all gradients are within 0.5%. And, the horizontal alignment is relatively straight, and most of the curves have a radius of 1,000m or more. The minimum curve radius for this line is 582m (Jamtoil to Shahid M. Mansur Ali and Mouchak to Joydebpur). The horizontal curve component along proposed Up Line (New Track) is shown in the following table:

Table 6.3 Horizontal Curve Component along Proposed Up Line (New Track)

Horizontal Curve Radius	Curve/Straight Length		Total Length
	ISD-BBW	BBE-JYR	
R< 600m	1,109m (1.4%)	2,347m (2.8%)	3,455m (2.1%)
600m =< R	17,071m (21.7%)	20,223m (24.3%)	37,295m (23.1%)
Straight	60,337m (76.8%)	60,605m (72.9%)	120,942m (74.8%)
Total Length	78,516m (100%)	83,175m (100%)	161,692m (100%)

Note: ( ) is percentage of total length
Source: JST based on the Prior F/S

The main technical railway standard of alignment is shown in the previous section.

And, the track layout is shown in Appendix 6-1.

6.4 Track Works

The proposed track structure based on the Prior F/S is described below:

6.4.1 Rails

UIC 60 kg new rails are applied for the new track. And BS 90A new/released rails are applied be used wherever renewals/extensions are required to the existing track.

Rails will be welded into Long Welded Rails (LWRs) at locations permitted by Bangladesh Railway Way and Works Manual (BRWWM) and Switch Expansion Joints (SEJs) will be used at the ends of LWRs. The photo of Switch Expansion Joint (SEJ) is shown below:

Source: JST

Figure 6.2 Switch Expansion Joint (SEJ)

Short Welded Rails (SWR) and Normal Fishplated track will be laid at other than LWR locations in accordance with the provisions of BRWWM.

JST recommend adoption of Head Hardened Rail (HHR) on sharp curve (R<600m), turnout and crossover sections (See Chapter 7).

6.4.2 Sleepers

In accordance with the guidelines in BRWWM, Wooden sleepers have been avoided.

Entire track on main line is proposed to be laid with monoblock prestressed pretensioned concrete (PSC) sleepers. On turnout, crossover sections and bridge, JST recommend adoption of Synthetic Sleepers (See Chapter 7 for the characteristics of synthetic sleepers).

Sleeper spacing proposed is:

- for main line track: 600 mm nominal between sleeper centres (1,667 sleepers per km); and
- for tracks on other than main line: 640 mm nominal between sleeper centres (1563 sleepers/km)

6.4.3 Fastening System

Anti-theft type elastic fastening system will be used with PSC sleepers.

6.4.4 Ballast

Crushed stone ballast will be used. Ballast cushion under sleeper at rail seat will be 300 mm for main line tracks and 250 mm for other tracks.

In the Prior F/S, ballast cushion under sleeper at rail seat will be 300 mm for on ballasted deck bridges. However, JST recommend the ballastless track with synthetic sleepers on deck bridges in order to reduce construction cost by reducing the weight of the superstructure, lowering the rail level and so on.

6.4.5 Turnouts

All turnouts on new track will be of 1 in 12 with UIC 60 kg rail and all new turnouts to be installed/ replaced on existing track will be of 1 in 12 with BS 90A rail.

The crossing body will be of Cast Manganese-Steel (CMS) and weldable.

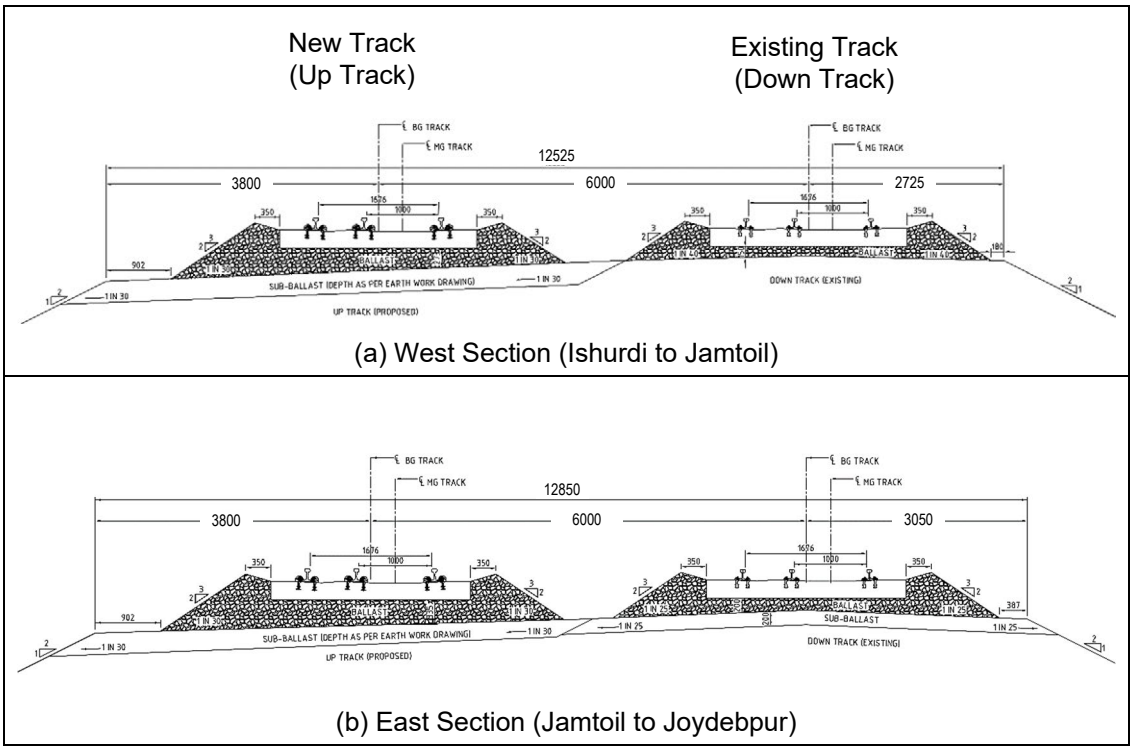
The photo of turnout for DG is shown below:

Source: JST

Figure 6.3 Turnout for DG

6.4.6 Typical Cross-section of Track Structure

Typical Cross-section of Track Structure is shown below:



Source: JST based on the Prior F/S

Figure 6.4 Typical Cross-section of Track Structure

In the Prior F/S, track spacing between Up track (new track) and Down track (existing track) is 7.0 m. However, it is conceivable to set 6.0m in order to reduce construction costs as the result of discussion with BR. Since the new track will be closer to the existing one, it will be necessary to pay more attention to the safety of trains running on the existing track during construction. In addition, the impact of the train load on the new track and the additional embankment on the existing embankment will be significant.

6.5 Bridge Works

Bridge groups targeted for the Project could be largely divided into two areas: "East Area" is from Joydebpur to Bangabandhu Setu East Stations and "West Area" is from Bangabandhu Setu West to Ishurdi Stations. Herein, bridges located between Bangabandhu Setu East and West Stations belong to another project.

6.5.1 Existing Bridges

In the Project section, there are a total of 204 bridges that have a total bridge length varying from approximately 1 m to 224 m. As for the number of spans in a bridge, there are several different types of bridges with a span arrangement of 1 to 10. According to hearings to BR, these existing bridges are grouped into two categories as follows.

[Minor Bridges]

- Bridges that have a waterway length less than 60 ft (18.3 m) with a multi-span arrangement, or
- Bridges that have a waterway length less than 40 ft (12.2 m) with a single-span arrangement

[Major Bridges]

- Bridges that have a waterway length more than 60 ft (18.3 m) with a multi-span arrangement, or
- Bridges that have a waterway length more than 40 ft (12.2 m) with a single-span arrangement

The relationships between the structural types (based on large categories) and the number of existing bridges in each area are described as follows.

Table 6.4 Structural Types and Number of Existing Bridges

Category	Structural Types	Number of Bridges		Subtotal	Total
		West Area	East Area		
Minor Bridges	Steel Girder	29	10	39	**138**
	Box Culvert	11	70	81	
	Pipe	2	16	18	
Major Bridges	Steel Girder	16	50	66	**66**
Total		**58**	**146**	**204**	**204**

Source: JST

A list of existing bridges located in West and East Areas is described in the attached Appendix 6-2-1.

In addition, through the field surveys, it could be found that there are bridges that have already been closed (e.g. Bridge No.34) and bridges that have recently been reconstructed from steel girders to box culverts (e.g. Bridge No.41A). It could also be confirmed that there are some discrepancies between the structural dimensions of the bridge list described in the Prior F/S and the simple measurements made by JST. Therefore, at the detailed design stage, it is essential for all existing bridges to reconfirm the presence or absence of closed bridges, reconfirm the structural type, and measure the detailed dimensions.

(1) Structural Types

Structural types listed below are the principal structures that exist along the Joydebpur - Bangabandhu Setu East section (East Area).

[Superstructures]

- Steel Semi-Through Plate Girder
- RC Box Culvert (regards as a superstructure)
- Pipe (regards as a superstructure)

[Substructures]

- RC Pier

- RC Abutment (including the Wing Wall and Retaining Wall)

Source: JST

Figure 6.5 Steel Semi-Through Plate Girder with RC Abutments (Bridge No.35)

Source: JST

Figure 6.6 Steel Semi-Through Plate Girders with RC Piers / Abutments (Bridge No.119)

Source: JST

Figure 6.7 Steel Semi-Through Plate Girders with RC Piers / Abutments (Bridge No.98)

Source: JST

Figure 6.8 RC Box Culverts (Bridge No.119/2, 48, 114 from the left)

Next, structural types listed below are the principal structures that exist along the Bangabandhu Setu West - Ishurdi section (West Area).

[Superstructures]

- Steel Plate Girder
- Steel Semi-Through Plate Girder
- Steel Deck Truss Girder
- Steel Through Truss Girder
- RC Box Culvert (regards as a superstructure)
- Brick Arch Pipe (regards as a superstructure)

[Substructures]

- Brick Pier
- Brick Abutment (including the Brick Wing Wall and Retaining Wall)

Source: JST

Figure 6.9 Steel Plate Girder with Brick Abutments (Bridge No.34)

Source: JST

Figure 6.10 Steel Plate Girders with Brick Piers / Abutments (Bridge No.26)

Source: JST

Figure 6.11 Steel Plate / Steel Semi-Through Plate Girders with Brick Piers / Abutments (Bridge No.33)

Source: JST

Figure 6.12 Steel Deck Truss / Steel Through Truss Girders with Brick Piers (Bridge No.35)

Source: JST

Figure 6.13 Steel Plate / Steel Through Truss Girders with Brick Piers / Abutments(Bridge No.24)

Source: JST

Figure 6.14 Steel Plate / Steel Through Truss Girders with Brick Piers / Abutments (Bridge No.23)

Source: JST

Figure 6.15 RC Box Culverts (Bridge No.119/20, 41A, 120 from the left)

(2) Qualitative Evaluations Through Visual Inspections

Firstly, simple field surveys over the whole line between Joydebpur Station and Ishurdi Station were conducted using an inspection car running on the track provided by BR. The schedule is as follows.

- East Area: Tuesday, July 26th, 2022: Joydebpur Station - Bangabandhu Setu East Station
- West Area: Wednesday, July 27th, 2022: Bangabandhu Setu West Station - Ishurdi Station

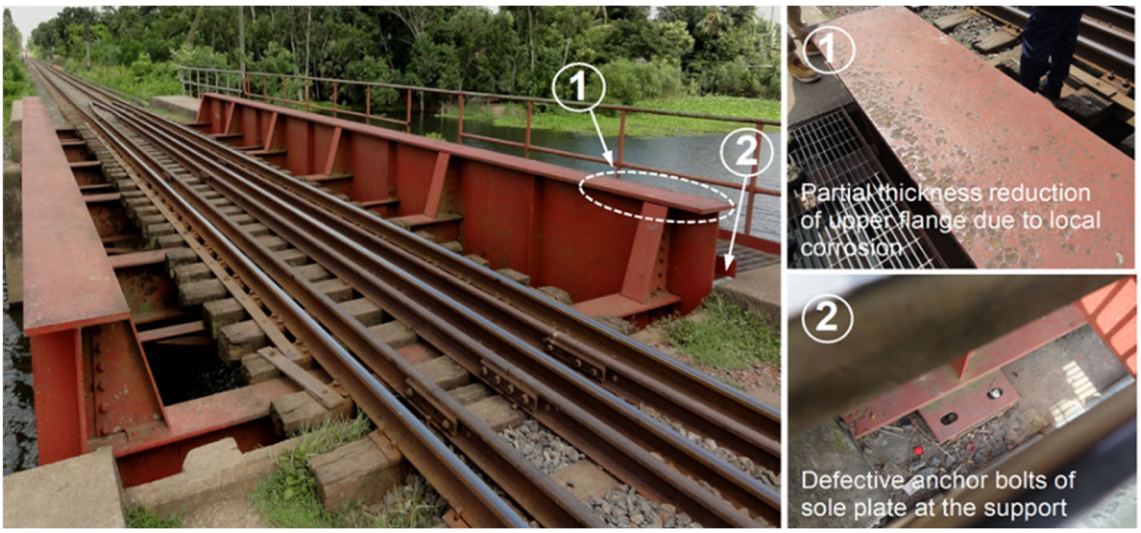
Secondly, in terms of further qualitative evaluations of the existing bridges between Joydebpur Station and Ishurdi Station, additional field surveys of the several existing bridges selected by JST that are accessible by car were conducted. The schedule and selected bridges are as follows.

- East Area: Thursday, August 11th, 2022: Joydebpur Station - Bangabandhu Setu East Station (Total 10 bridges; Bridge No. 35, 48, 98, 106, 110, 114, 116, 119, 119/2, 119/4)
- West Area: Tuesday, August 16th, 2022: Bangabandhu Setu West Station - Ishurdi Station (Total 7 bridges; Bridge No. 119-20, 119-24, 120, 41A, 35, 34, 23)

[Evaluations for East Area]

The Joydebpur - Bangabandhu Setu East section (East Area) is a relatively new line that started to operate in 2003. Bolted joints are used for the connections between the members of the steel girders. Based on the visual inspection through the inspection car running on the track, the superstructures are relatively new and could be qualitatively estimated as generally being in a sound condition. The substructures are also relatively new RC structures and could be judged as mostly being in a sound condition.

However, since minor aged deterioration and damage due to corrosion shown in the following figures were observed through the visual inspection for the bridges selected by JST, BR would be strongly recommended to continue doing the preventive maintenance instead of the corrective maintenance, as well as its repair and reinforcement works, regularly to keep all structures in a good condition for the future. Herein, the bridge engineers' comments for specifics of the major phenomena are described in the following figures.



Source: JST

Figure 6.16 Thickness Reduction due to Corrosion / Defective Anchor Bolts (Bridge No.35)

Source: JST

Figure 6.17 Local Corrosion due to Organic Excrement from Passing Trains (Bridge No.116)

Source: JST

Figure 6.18 Local Corrosion due to Wet-dry Cyclic and Organic Excrement (Bridge No.98)

In addition, it should be kept in mind that all existing structures were designed using less than 25 tons of axle load in contrast to BR's future train operation plans, while the design axle load for new civil structures due to the double tracking is planned to be used as the 25 tons.

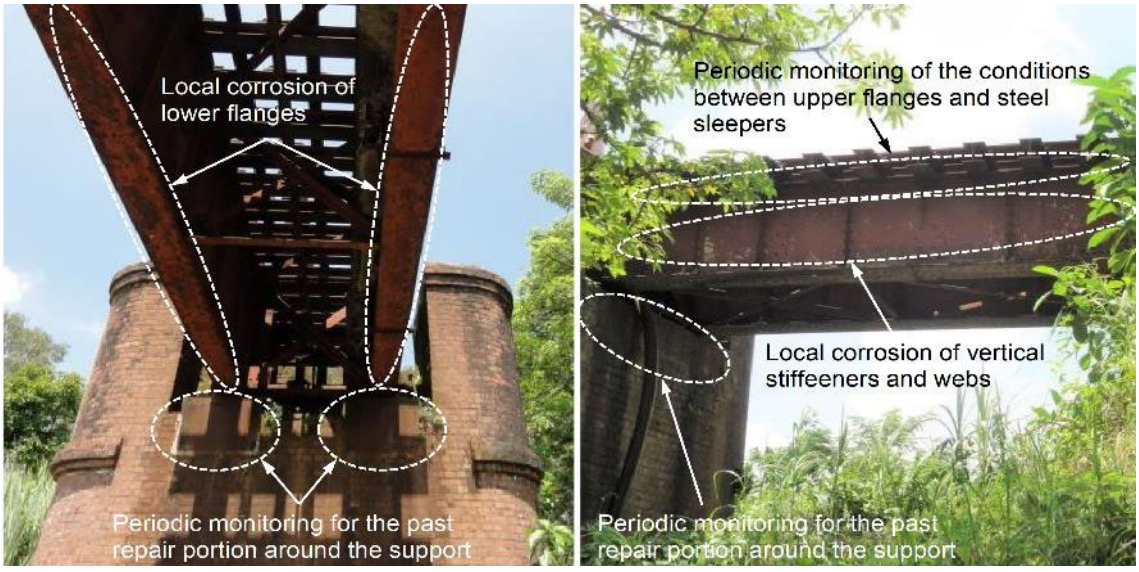
[Evaluations for West Area]

On the Bangabandhu - Ishurdi section (West Area), the section from Jamtoil Station to Bangabandhu Setu East Station (including the Jamuna Bridge) is a relatively new line that started to operate in 1998. However, the line between Ishurdi Station and Jamtoil Station is very old, as it was constructed over 100 years ago. Although riveted joints are used for the connections between the members of the steel girders, based on the visual inspection through the inspection car running on the track, it could be qualitatively evaluated that there would be no major problems with the continued use for the time being. The substructures composed of bricks could also be judged as relatively being in a sound condition from the viewpoint of the remaining load bearing capacity (except for the seismic capacity) required for the time being, even though they were constructed over 100 years ago.

On the other hand, since aged deterioration and damage due to corrosion shown in the following figures were observed through the visual inspection for the bridges selected by JST, the periodic monitoring and detailed investigations of the superstructures and substructures, which focus on the durability enhancement for life-extending, at relatively short intervals by BR would be strongly recommended. Additionally, the maintenance and management works based on the results of its investigations would be also required, as well as the repair and reinforcement works. Herein, the bridge engineers' comments for specifics of the major phenomena are described in the following figures.

Source: JST

Figure 6.19 Periodic Monitoring Items Required / Defective Anchor Bolts (Bridge No.34 constructed in 1914)



Source: JST

Figure 6.20 Periodic Monitoring Items Required / Local Corrosion due to Wet-dry Cyclic (Bridge No.35 constructed in 1914)

In addition to the above, from the viewpoint that the substructures are composed of old brick piers and abutments, it is necessary to pay enough attention to the problems about the seismic performance in being and future durability of the existing substructures. Furthermore, by the same token above, it should be noted that all existing structures were designed using much less than 25 tons of axle load.

Based on the above qualitative and comprehensive evaluations of the existing bridges on the east and west sides, it could be judged that the operation and management for the existing bridges would be done by BR itself for the time being. Therefore, they shall be excluded from the target structures for construction work in the Project.

[Recommendations for Policies and Countermeasures for Maintenance]

Periodic inspections for existing bridges are an important task in detecting something unusual or bad in structures. For example, cracks in members, exposures of reinforcing bars due to concrete flaking, movements or deformations of structures, and partial corrosion or abnormal noise of structures, etc. can be regarded as a precursor leading to serious damage or accidents. Therefore, it is extremely important to detect such damage at an early stage by carrying out regular inspections. In other words, early detection of any defects not only reduces the risk of users, but also contributes to the reduction of maintenance costs such as future repairs.

For periodic inspections and countermeasures for members in various types of bridge structures, it would be necessary to carry out at least once every two years. Additionally, it is desirable to carry out an extraordinary inspection immediately after an earthquake or a flood, which may damage to bridge structures and its members. In doing so, it would be essential for BR to create an investigation record book for each existing bridge and manage them countinuously based on the past and current structural statuses as well as the maintenance history. Herein, an example of investigation record sheets for bridges visually checked in the Study is attached in the Appendix 6-2-2.

As a reference example, the tables below show the inspection items and possible countermeasures for steel girders, where problems are relatively likely to occur.

Table 6.5 Inspection Items and Possible Countermeasures for Bearings

Types of Damage	Inspection Items	Possible Countermeasures
Accumulation of dirt / debris, defective movable bearings	Visual inspection in and around bearings	- Remove any dirt / debris collected on shoe seats - Apply grease etc. as needed
Deformation of rubber	Visual inspection for the out-of-tolerance deformation of rubber	- Jack up and release deformations or replace bearings if needed - Monitor continuously
Cracks, cleavages	Visual inspection for the cracks and cleavages in bearing bodies (laminated rubber, or steel bearings including welded sole plates and mounting bolts)	- Replace bearings, sole plates and mounting bolts
Slip or inclination	Visual inspection for the slip and inclination between structures and bearings	- Return in position and fix - If necessary, recast shoe seats and adjust its heights
Flaking of concrete on the front of shoe seats	Visual inspection	- Repair the front of shoe seats
Looseness or break of anchor bolts	Visual inspection	- Replace anchor bolts - Install new anchor bolts in different positions
Others	Inspection items recommended by BR	- Take measures with the consent of BR

Source: JST

Table 6.6 Inspection Items and Possible Countermeasures for Steel Girders

Types of Damage	Inspection Items	Possible Countermeasures
Deterioration and corrosion of coating film	Visual inspection (including local deformations under sleepers and around girders' ends, etc.)	- Repaint - Reinforce corroded parts and partially replace parts or members
Deformation of bolts or rivets	Visual inspection for corrosion, partial lack, looseness, and fall, etc.	- Implement anticorrosion by painting, etc. - Replace with new bolts
Deformation of welded parts and base materials	Visual inspection for cracks, etc.	- Shallow cracks: Remove by grinding - Deep cracks: Remove by gouging and reinforce with backing plates (including emergency treatments with stop holes)
Deformation of accessories such as sidewalks on the bridge side	Visual inspection for corrosion of steel materials, fall of metal pieces, damage to parts or members, etc.	- Repair deformed parts - Replace missing / damaged parts or members
Others	Inspection items recommended by BR	- Take measures with the consent of BR

Source: JST

6.5.2 New Bridges for Double Tracking

(1) Design Standards and Criteria

When designing railway bridges, it is necessary to take into consideration not only the country's own design standards and criteria, but also the records and situations applied in the country's past and ongoing projects. In addition, it would be required to select and apply the design standards and criteria that could lead to more optimal railway structures, by taking into account the design advantages and disadvantages of the respective material and structural properties from a viewpoint of the structural types and its composition members of various structures in railway bridges.

In general, there are the following design standards that have been used in many countries and its projects.

Table 6.7 Design Standards (1)

Items	Names of Design Codes
Bridges	***For design*:** • IRS (Indian Railway Standard) Rules Specifying the Loads for Design of Superstructures and Substructures of Bridges (Bridge Rules) • IRS (Indian Railway Standard) Code for Earthquake Resistant Design of Railway Bridges • IRS (Indian Railway Standard) Code of Practice for the Design of Steel or Wrought Iron Bridges Carrying Rail, Road or Pedestrian Traffic (Steel Bridge Code) • IRS (Indian Railway Standard) Code of Practice for Plain, Reinforced and Prestressed Concrete for General Bridge Construction (Concrete Bridge Code) • IRS (Indian Railway Standard) Code of Practice for the Design of Substructures and Foundations of Bridges (Bridge Substructures and Foundation Code) • BNBC (Bangladesh National Building Code) – 2020 • AASHTO (American Association of State Highway and Transportation Officials) LRFD Bridge Design Specifications • AASHTO (American Association of State Highway and Transportation Officials) Guide Specification for LRFD Seismic Bridge Design • AREMA (American Railway Engineering and Maintenance-of-Way Association) Manual for Railway Engineering • JRS (Japanese Railway Standards) Design Standard for Railway Structures • BS (British Standard) Steel, Concrete and Composite Bridges) Published by the British Standards Institution

Source: JST

Table 6.8 Design Standards (2)

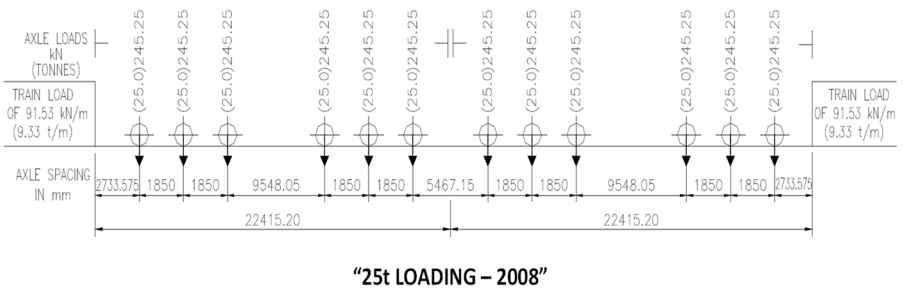
Items	Names of Design Codes
Materials	***In general*:** • Bureau of Indian Standard Codes • ASTM (American Society for Testing and Materials) • JIS (Japanese Industrial Standards) • Other Appropriate Material Standards and Guidelines on Concrete, Aggregates and Steel

Source: JST

In the Project, the basic policy is to apply the Indian Railway Standard (IRS), which has been used extensively in Bangladesh. However, with regard to the seismic design, BNBC in the table above assumes an earthquake return period of 2,500 years (the probability that occurs extremely rarely), while AASHTO assumes a return period of 1,000 years (the probability that occurs rarely). It is recommended that the latter be applied from the viewpoint of ensuring that the railway infrastructure transportation in Bangladesh could continue to function to the maximum extent possible even after an unexpected short-period major earthquake occurs. Furthermore, regarding the fatigue design of steel girders, it is recommended that the application of the Japanese Railway Standards that incorporates cyclic fatigue phenomena as performance design theories based on many research results, past experiences and knowledge.

In addition, each item of the design criteria shall be set by referring to the contents of the Prior F/S. Herein, the tables below show some items in the design criteria assumed in the Project. However, they shall be reviewed, revised and added as necessary in the detailed design stage.

Table 6.9 Design Criteria (1)

Items		Descriptions
Design Codes	-----	IRS, BNBC, AASHTO, AREMA, JRS, ASTM, etc.
Train Load	-----	25 tons Double Headed Diesel Loco (IRS Bridge Rules)  "25t LOADING – 2008"
Earthquake Load	-----	PGA: Zone II = 0.28g, 1:2500 years (BNBC). For seismic design, AASHTO is recommended as it considers earthquakes with a return period of 1:1000 years (rare occurrence) as compared to 1:2500 years (extremely rare occurrence) in BNBC.
Wind Load	-----	- Base Design V = 1.47 kN/m^2 (BNBC) - Exposure Category = C (flat, unobstructed area)
Fatigue	-----	For fatigue design of steel girders, the Japanese Railway Standards is recommended as it incorporates cyclic fatigue phenomena as performance design theory based on many research results, past experiences, and knowledge.
Load Combination	**SLS, ULS**	IRS (AREMA SLS and ULS used for checking)

Source: JST

Table 6.10 Design Criteria (2)

Items		Descriptions
Superstructure (main members)	**Type of Structures**	- Steel Semi-Through Plate Girder - RC Box Culvert
	Concrete	- Cube Compressive Strength: 40 N/mm^2 (28 days)
	Reinforcing Bar	- Design Yield Strength: 500 N/mm^2
	Structural Steel	- Tensile Strength: 490 N/mm^2 - Yield Strength: 350 N/mm^2 (t <= 20 mm) 330 N/mm^2 (20 < t <= 40 mm) 320 N/mm^2 (t > 40 mm)
Substructure (main members)	**Type of Structures**	- RC Pier - RC Abutment (including Wing Walls and Retaining Walls)
	Concrete	- Cube Compressive Strength: 35 N/mm^2 (28 days), for Columns 40 N/mm^2 (28 days), for Pedestals 15 N/mm^2 (28 days), for Blinding Concrete
	Reinforcing Bar	- Yield Strength: 500 N/mm^2 (For pier's columns, high-strength reinforcing bars shall not be used to allow the formation of hinges at the base of columns during seismic events)
Piles	**Type of Piles**	- Cast-in-situ
	Concrete	- Cube Compressive Strength: 35 N/mm^2 (28 days)
	Reinforcing Bar	- Yield Strength: 500 N/mm^2

Source: JST

(2) Structural Types and Span Arrangements

Basically, while referring to and adopting the contents of the Prior F/S, it shall be appropriately reviewed and partially revised from a technical point of view as necessary.

The sizes of opening areas as a cross-section of each river accompanying the construction of new bridges shall be kept at least the present ones. In case an event required to diminish the sizes of opening areas occurs during the detailed design stage, a one-dimensional method of non-uniform flow analysis etc. shall be conducted to confirm whether the river flow capability at the estimated high water level (H.W.L) could be met.

Furthermore, regarding the concept of the inhibitory rate of the cross-sectional area of a river in the case of constructing a new bridge, there is no clear standard. Therefore, it shall be planned based on the present inhibitory rate of the river width at each existing bridge location. In addition, the level of the girder bottom, as well as the level of the box culvert upper slab bottom, in the case of constructing a new girder shall be basically set to the same or higher than the present level.

[Minor Bridges]

For reference purposes, in the Prior F/S, the structural types and number of new bridges were planned as shown in the table below.

Table 6.11 Structural Types and Number of New Bridges (Minor Bridges) in the Prior F/S

Category	Structural Types	Number of Bridges	Remarks
Minor Bridges	Steel Semi-Through Girder	6	1 span (span length = 15 m)
	RC Box Culvert	132	1 or 2 or 3 cells (span lengths = 1, 3, 4, 4.5, 5, 6 m)
Total		**138**	

Source: JST

While referring to the contents of the Prior F/S, from the viewpoint of the economy, durability, and maintenance, etc., even where the existing bridges are not only box culverts but also steel girders, the new bridges at the time of double-tracking shall be constructed as a structural type of box culverts as much as possible. However, if the existing steel girders are close to the station premises or level crossings, it shall be planned to adopt a structural type of steel girders with open deck system (without ballast floor) with the main aim of minimizing the differences in height between the existing rail level and the new one when double-tracking. In terms of the above, the structural types and number of new bridges shall be planned as shown in the table below.

Table 6.12 Structural Types and Number of New Bridges (Minor Bridges) in the Study

Category	Structural Types	Number of Bridges	Remarks
Minor Bridges	Steel Semi-Through Girder	2	1 span (span length = 15 m)
	RC Box Culvert	135	1 or 2 or 3 cells (span lengths = 1, 3, 4, 4.5, 5, 6 m)
Total		**137**	Bridge No.34 has been closed

Source: JST

The figure below shows examples of construction of new box culverts with single-span and multi-span.

Source: JST

Figure 6.21 Examples of Construction of New Box Culverts

[Major Bridges]

For reference purposes, in the Prior F/S, the structural types and number of new bridges were planned as shown in the table below.

Table 6.13 Structural Types and Number of New Bridges (Major Bridges) in the Prior F/S

Category	Structural Types	Number of Bridges	Remarks
Major Bridges	Steel Semi-Through Girder	62	1 to 9 spans (span lengths = 15, 20, 25, 30, 35 m)
	RC Box Culvert	4	3 or 4 cells (span length = 6 m)
Total		**66**	

Source: JST

In general, the followings are conceivable structural types of superstructures for major bridges with relatively large bridge lengths and number of spans.

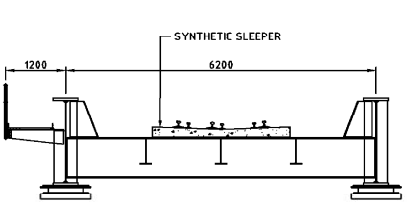
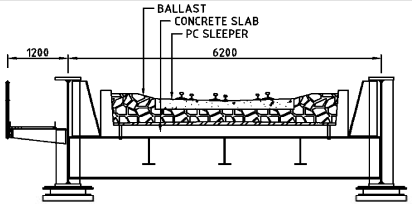
1) Steel Plate Girder
2) Steel Semi-Through Plate Girder
3) Steel Deck Truss Girder
4) Steel Through Truss Girder
5) Steel Composite Girder (I-shaped, Box-shaped)
6) Prestressed Concrete Girder (I-shaped, Box-shaped)

Most of the existing steel girders located in this surveyed section have been erected using steel semi-through plate girders as shown in the above 2). Therefore, if the above 1), 3), 5), and 6) to be deck

bridge structures are applied, the new rail level is required to be much higher than the existing rail level on the premise that the bottom surface level of new girders need to match the one of existing girders.

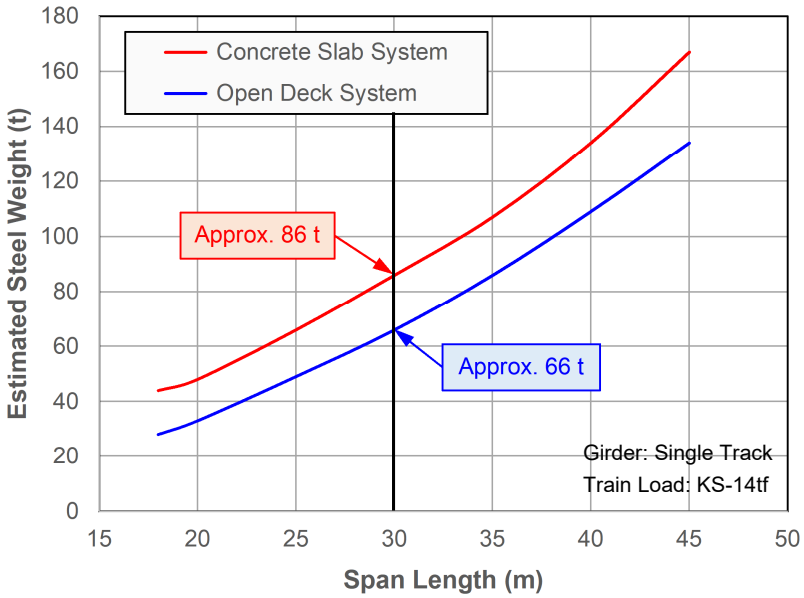
At the same time, the embankment sections near the front and back of the new girders also have to be raised, which would be disadvantageous in terms of cost, widening between tracks due to the difference in rail level between the up and down lines, and maintenance and management. Therefore, the application of the above 2) or 4) to be through bridge structures would be the most advantageous as girder structures when double-tracking in the Project. Here, the above 4) is a structural type that would be relatively effective when the span length is 40m or more, and it can reduce the number of substructures and is also excellent in landscape. On the other hand, there are also uneconomical aspects such as significant increases in steel weight, etc., and construction difficulties such as erection methods and construction periods. In the same project, if the number of truss girders adopting a same span length gets to be reduced, it becomes an even more uneconomical structural type. Therefore, in the Project, steel semi-through plate girders as shown in the above 2) shall be applied in a unified way to reduce construction costs as much as possible.

Furthermore, in the Prior F/S, concrete slabs and ballast are placed on the steel semi-through plate girder shown on the right side of the comparison table below. However, in the Project, from the viewpoint of keeping the new rail level as low as possible and reducing the cost as shown in the graph below (in the case of a girder with a span length of 30m, it would be possible to reduce the weight of steel materials by about 30%), it shall be planned to apply the steel semi-through plate girder with open deck system (without ballast floor) shown on the left side of the comparison table below. In addition, new span arrangements shall basically be planned to match the span arrangements of existing bridges as much as possible in order to secure the present inhibitory rate to the cross-sectional area of each river.

	Open Deck System with Synthetic Sleeper (Steel Semi-Through Plate Girder)	**Concrete Slab System with PC Sleeper and Ballast (Steel Semi-Through Plate Girder)**
General Description		
	➢ Sleepers are directly fixed on girders ➢ Vertical alignment can be kept lower ➢ Dead load is smaller ➢ Noise level is relatively high	➢ Sleepers are supported by ballast and concrete slab fixed by stud bolts on girders ➢ Vertical alignment goes up (40-50cm higher than the **Open Deck System**) ➢ Dead load is bigger (with increasing its bridge lengths) ➢ Noise level is relatively low
	Excellent	Fair
Construction Cost	➢ Superstructure would be approximately 25 % cheaper than the **Concrete Slab System** ➢ Substructure would be approximately 10% cheaper than the **Concrete Slab System**	➢ Total structure would be approximately 30% higher than the **Open Deck System**
	Excellent	Fair
Construction Period	➢ Construction period on site is shorter	➢ Construction period on site is longer
	Excellent	Fair
Comprehensive Evaluation	**Excellent**	**Fair**

Source: JST

Figure 6.22 Comparison of Steel Semi-Through Plate Girders with Different Track Structures



Source: Design Materials of Steel Bridges (5th Edition)

Figure 6.23 Comparison between Estimated Steel Weight of Steel Semi-Through Plate Girders with Different Track Structures

The main merits of adopting a steel semi-through plate girder with open deck system (without ballast floor) are listed below.

- It is an already-proven structural type of railway bridges in Bangladesh, as well as many other countries.
- By adopting a ballastless track with resilient sleepers, the bottom surface level of new girders can match the one of existing girders, and the difference between the existing and new rail levels can be minimized.
- The embankment height near the front and back of the new girders can be kept low, and the cost of embankment itself and land acquisition can be reduced.
- A large number of superstructures can be manufactured at the factory without waiting for the completion of the piling and foundation works, as well as the column work.
- Since it is made of steel, it is relatively easy to process and assemble at the construction site, and has excellent workability.
- By standardizing and grouping into a few girder structural types and span lengths, the design and construction periods and its costs can be significantly reduced.
- Synthetic sleepers can be used instead of PC sleepers because they are lightweight and have excellent durability and its life cycle cost.
- It is lighter than PC structures or ballasted tracks. That is to say, it is possible to reduce the dead load of girder bodies and the surcharge load on the girders, and to reduce the piling work (number of piles, pile length, pile diameter, etc.) as well as the size of the foundation and column bodies.

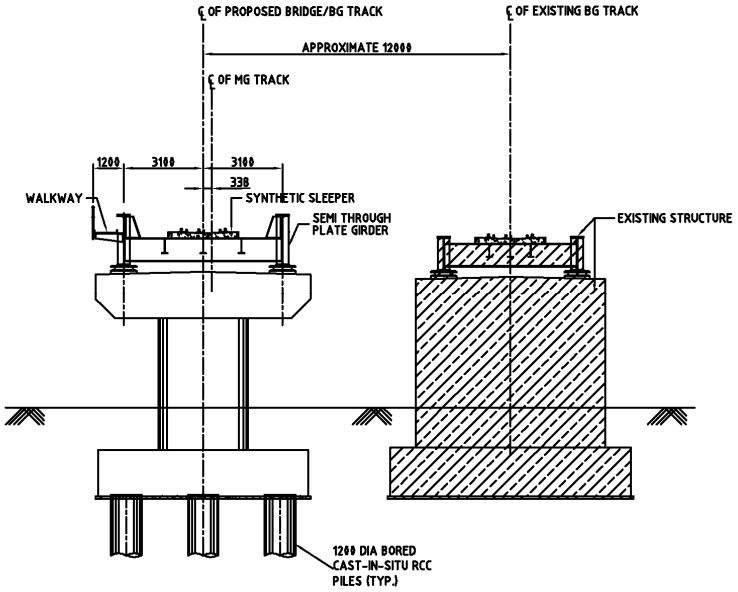
In terms of the above, the structural types and number of new bridges shall be planned as shown in the table below.

Table 6.14 Structural Types and Number of New Bridges (Major Bridges) in the Study

Category	Structural Types	Number of Bridges	Remarks
Major Bridges	Steel Semi-Through Girder	66	1 to 8 spans (span lengths = 15, 20, 25, 30, 35 m)
	RC Box Culvert	0	-----
Total		**66**	

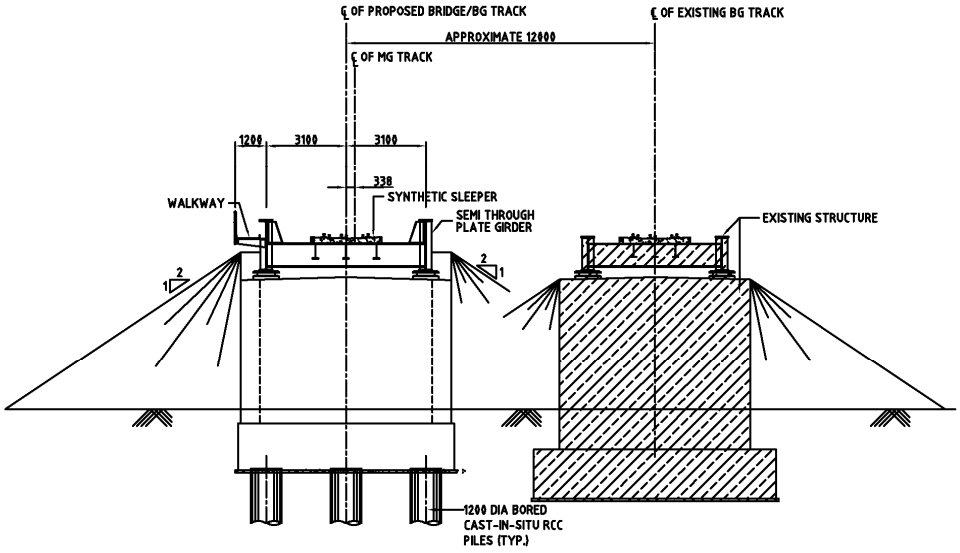
Source: JST

Here, the plan for new bridges on the new line when double-tracking (plans such as the application of steel semi-through plate girders or RC box culverts, and its details of span arrangements) is shown in the attached Appendix 6-2-1. Schematic sectional views of the superstructure and substructure are shown below.



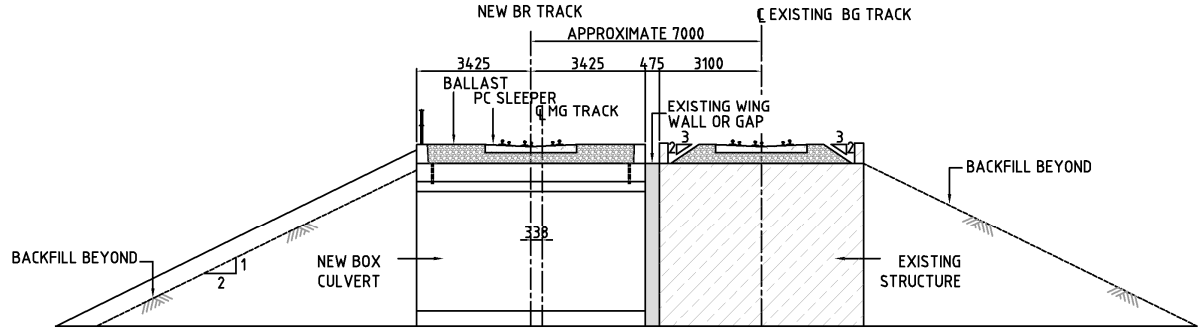
Source: JST

Figure 6.24 Schematic Sectional View (at the Pier)



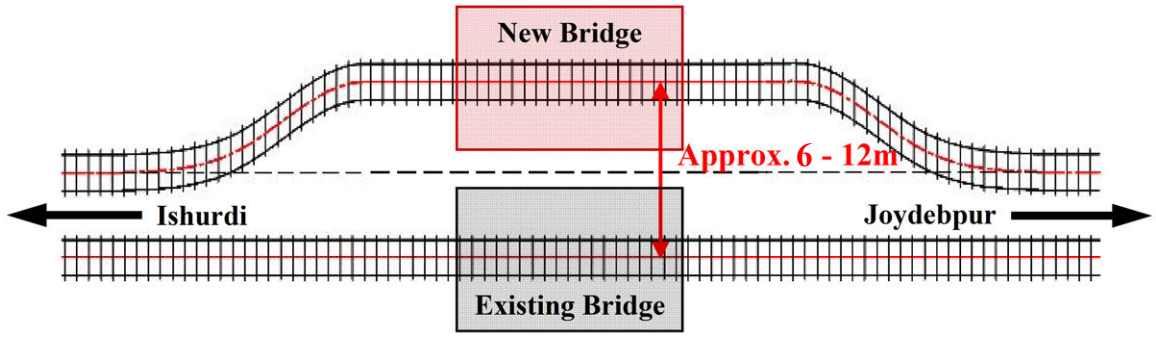
Source: JST

Figure 6.25 Schematic Sectional View (at the Abutment)



Source: JST

Figure 6.26 Schematic Sectional View (at the Box Culvert)



Source: JST

Figure 6.27 Plan of Track Spacing at the Bridge Location

In reference to the contents of the Prior F/S regarding the construction method of new bridges, when constructing a new girder bridge adjacent to an existing girder bridge, it shall be planned to secure a track center distance of approximately 12m between the existing line and the new one. In addition,

when constructing a new box culvert adjacent to an existing box culvert, it shall be planned to secure a track center distance of approximately 7m between the existing line and the new one.

Here, in the Minor Bridges, there are cases where new box culverts are constructed adjacent to existing girder bridges. In these cases, based on the conditions of each bridge location and the results of future detailed survey, etc., the track center distance shall be set appropriately between 6 and 12m.

Regarding the required distance from existing bridges due to the construction of new bridges, further reduction could be considered if construction plan, study and construction work are able to be carried out in accordance with the regulations such as neighboring construction manuals that have been frequently used in Japan. It is thought that the validity of these required distances could be determined individually according to the detailed conditions obtained from each bridge location during the detailed design stage.

Furthermore, in order to clearly set the design conditions that would be lacking at the detailed design stage in the near future and to proceed with the detailed design work quickly, it should be noted that the following measurements and surveys, as well as its conditions arranged must be conducted at the initial stage just after the detailed design starts.

- Topographic and alignment surveys for each existing bridge and its surrounding area.
- Measurements of shape and dimension for each existing bridge
- Geological boring surveys at each bridge location and its laboratory tests
- Data collection of high water level records at each bridge location or a basic survey for analyzing the flow capacity

6.6 Earthworks

6.6.1 Consideration of consolidation settlement

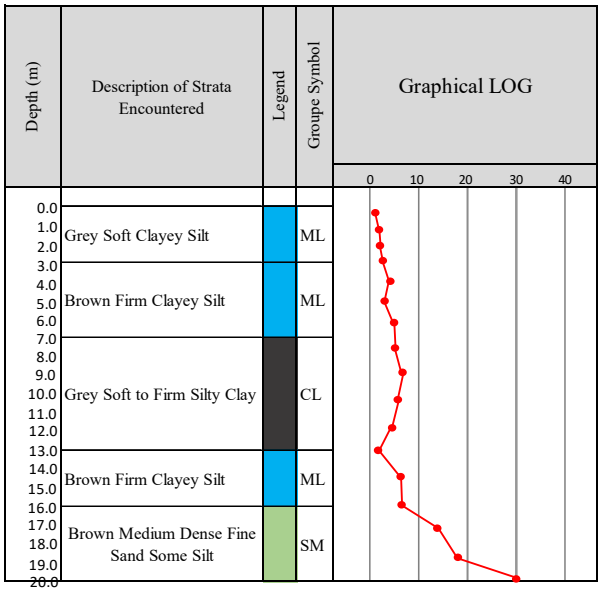
The amount of ground settlement and the possibility of circular landslip must be generally considered when examining an embankment. Regarding circular landslip, considering that the existing embankment is stable without any problems, it seems that there will be no problem even if the embankment is widened. However, it is necessary to pay attention to the consolidation settlement directly under the new embankment. Table 6.15 shows the consolidation test results of the geological survey conducted in the previous survey. Since the void ratio is 0.90 to 1.10 and the compression index is 0.17 to 0.23, most of the cohesive and silty layers in the study area are classified as hard clay. Therefore, it is assumed that ground settlement will not be so large. Calculating the amount of settlement in the case of embankment with height of 3m above the 6m thick clay layer of BH 11E (CL layer shown in Figure 6.28) gives the following values.

Amount of Settlement = Layer Thickness × (Comparison Index / (1 + Void Ratio) × log {(Overburden Pressure + Pressure caused by Embankment) / (Overburden Pressure) }

= 6.0 × 0.20 / (1 + 0.92) × log { (1.81 × 2.4 + 9.07 × (10.0 - 2.4) + 1.8 × 3.0) / (1.81 × 2.4 + 9.07 × (10.0 - 2.4)}

= 0.0193 m (1.93 cm)

Since the above calculation is based on only the clay layer with a thickness of 6 m, the amount of settlement will slightly increase if other silt layers are included. However, as mentioned above, the clay and silt layers in the Study area are classified as hard clay, and as can be seen from the above calculation, even if the thickness of such layer is large, it can be said that serious consolidation settlement will not occur. A silt layer with an N value of 2 or less has been confirmed within 3m of the surface layer from some boring data and it is necessary to pay attention to this layer at the next detailed design stage. The above-mentioned is not only for the west side of the Jamuna Bridge, but also for the east side of it.



Source: JST based on the Existing Boring Data

Figure 6.28 Boring Logs of BH 11E

Table 6.15 Result of Consolidation Test

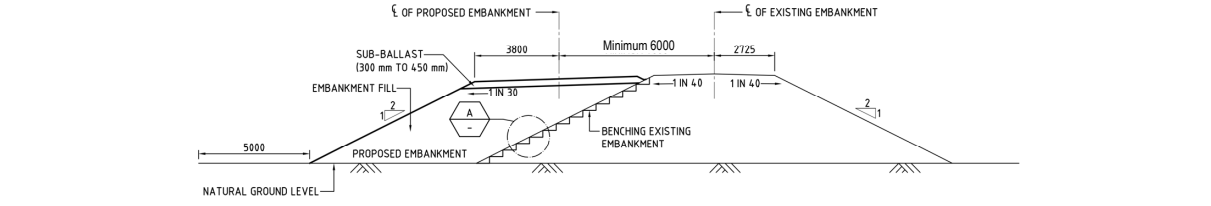
Boring No.	Void Ratio	Compression Index	Classification of Soil
BH 03E	0.90	0.17	Silty / Sandy Clay
BH 06B	0.95	0.23	Sandy / Clayey Silt
BH 11E	0.92	0.20	Silty / Sandy Clay
BH 16E	0.99	0.20	Sandy / Clayey Silt
BH 20B	0.96	0.20	Sandy / Clayey Silt
BH 24E	0.94	0.19	Sandy / Clayey Silt
BH 31E	1.10	0.21	Sandy / Clayey Silt
BH 40B	0.97	0.20	Sandy / Clayey Silt

Source: JST based on the Existing Boring Data

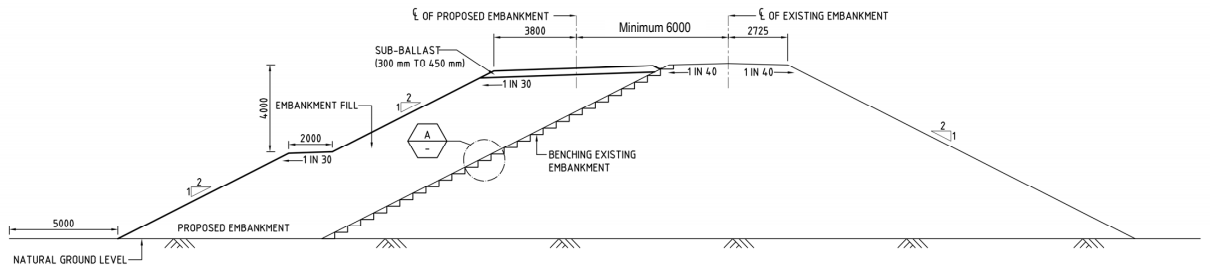
6.6.2 Embankment Widening

When constructing a new embankment by widening the existing embankment, care must be taken to prevent harmful subsidence of the existing embankment and track. According to the results of the above study on consolidation settlement, it is assumed that even if a new embankment is constructed, there will be almost no subsidence in the original ground and no track irregularities, however, it is necessary to reconsider at the stage of detailed design.

Typical Cross-section of Embankment is shown below:



(a) Typical Cross-section of Embankment Height ≤ 4m on Straight (Ishurdi to Jamtoil)



(b) Typical Cross-section of Embankment Height > 4m on Straight (Ishurdi to Jamtoil)

Source: The Prior F/S

Figure 6.29 Typical Cross-section of Embankment

6.6.3 Slope Protection and River Training Works

According to the Prior F/S, revetment work is planned around the abutments, and in the section where Chalan Beel passes (Saratnagar~Lahirimohanpur~Ullapara, about 13km), slope protection work is planned to protect against erosion caused by waves generated during strong winds.

During the field survey, no places where the embankment was heavily eroded were found, however, slope protective works will be installed as appropriate in places where embankments are subject to erosion due to flooding in rivers and surrounding areas. Also, in river areas, river training works such revetments and sluices will be planned as appropriate.

Photo of Slope Protection and River Training Work close to Bridge No.98 is shown below:

Slope Protection

River Training Work (under construction)

Source: JST

Figure 6.30 Slope Protection close to Bridge No.98

6.7 Station Plan

6.7.1 Plan (New Station, Renovation, Reconstruction)

There are currently 24 existing stations between Joydebpur and Ishurdi, and the Project will add new stations between Tangail - Bangabandhu Setu East and Joydebpur - Mouchak respectively, bringing the total to 27 stations.

Out of the existing 24 stations, 20 stations except Joydebpur Station, Ishurdi Junction Station, Ishurdi Bypass Station, Hi Tech City Station, Bangabandhu Setu West Station and Bangabandhu Setu East Station are planned to be renovated or renovated.

The station plan is shown below:

Table 6.16 Station Plan

	West Side (ISD-BBW)	East Side (BBE-JYD)
New Station (3 Stations)	-	Elenga, Karotia, Mirer Bazar
Renovation (13 Stations)	Shahid M. Mansur Ali, Jamtoil, Ullapara, Lahirimohanpur, Chatmohar, Mooladuli, Majhgram, Ishurdi Bypass, Ishurdi	Mouchak, Mirzapur, Mohera, Tangail
Reconstruction (7 Stations)	Salop, Dilpashar, Saratnagar, Baral Bridge, Bhangura, , Guakhara, Gafurabad	-
Out of Scope (4 Stations)	Bangabandhu Setu West	Joydebpur, Hi Tech City, Bangabandhu Setu East

Source: JST based on the Prior F/S

Adding this information to the existing Station List would result in the following.

Table 6.17 Station List

Sl. No.	Station Name	Existing Km	Design Km	Plan
1	Ishurdi Junction	204.80	204.800	Renovation
2	Ishurdi Bypass	208.58	-	Renovation
3	Majhgram	211.00	210.983	Renovation (Existing station building to be relocated by BR)
4	Mooladuli	216.70	216.629	Renovation
5	Gafurabad	224.11	224.273	Reconstruction (Type: T2)
6	Chatmohar	229.77	229.977	Renovation
7	Guakhara	235.00	235.121	Reconstruction (Type: T2)
8	Bhangura	239.26	239.424	Reconstruction (Type: T2)
9	Baral Bridge	241.00	241.132	Reconstruction and relocated at north (type: T1)
10	Saratnagar	243.50	243.640	Reconstruction (Type: T2)
11	Dilpashar	248.37	248.413	Reconstruction and relocated at north (type: T1)
12	Lahirimohanpur	254.00	254.139	Renovation
13	Ullapara	262.08	262.145	Renovation
14	Salop	267.34	267.446	Reconstruction (Type: T2)
15	Jamtoil	274.50	274.457	Renovation
16	Shahid M. Mansur Ali	281.00	280.759	Renovation
17	Bangabandhu Setu West	285.41	285.283	Modifications have been proposed under another project
18	Bangabandhu Setu East	294.60	294.560	Modifications have been proposed under another project
19	Elenga	-	306.015	New crossing station (FS position changed to km 308.700)
20	Tangail	315.50	315.460	Renovation
21	Karotia	-	323.100	New crossing station
22	Mohera	331.24	331.194	Renovation
23	Mirzapur	341.40	341.334	Renovation
24	Hi Tech City	-	350.800	Already opened as Hi Tech City station
25	Mouchak	362.20	362.111	Renovation
26	Mirer Bazar	-	370.073	New crossing station
27	Joydebpur	378.20	378.123	Modifications will be done under another project

Source: JST

6.7.2 Building

The Tentative Building Quantity Schedule for the subject route is shown in the following page.

We have modified the Building Quantity Schedule based on the Building Quantity Schedule of DPP issued in 2018, adding our views.

Telecom and Signaling Equipment Rooms have been added at Karotia and Mirer Bazar stations. We think that almost all of the electrical rooms need to be added or expanded.

Undisclosed

Undisclosed

Undisclosed

Undisclosed

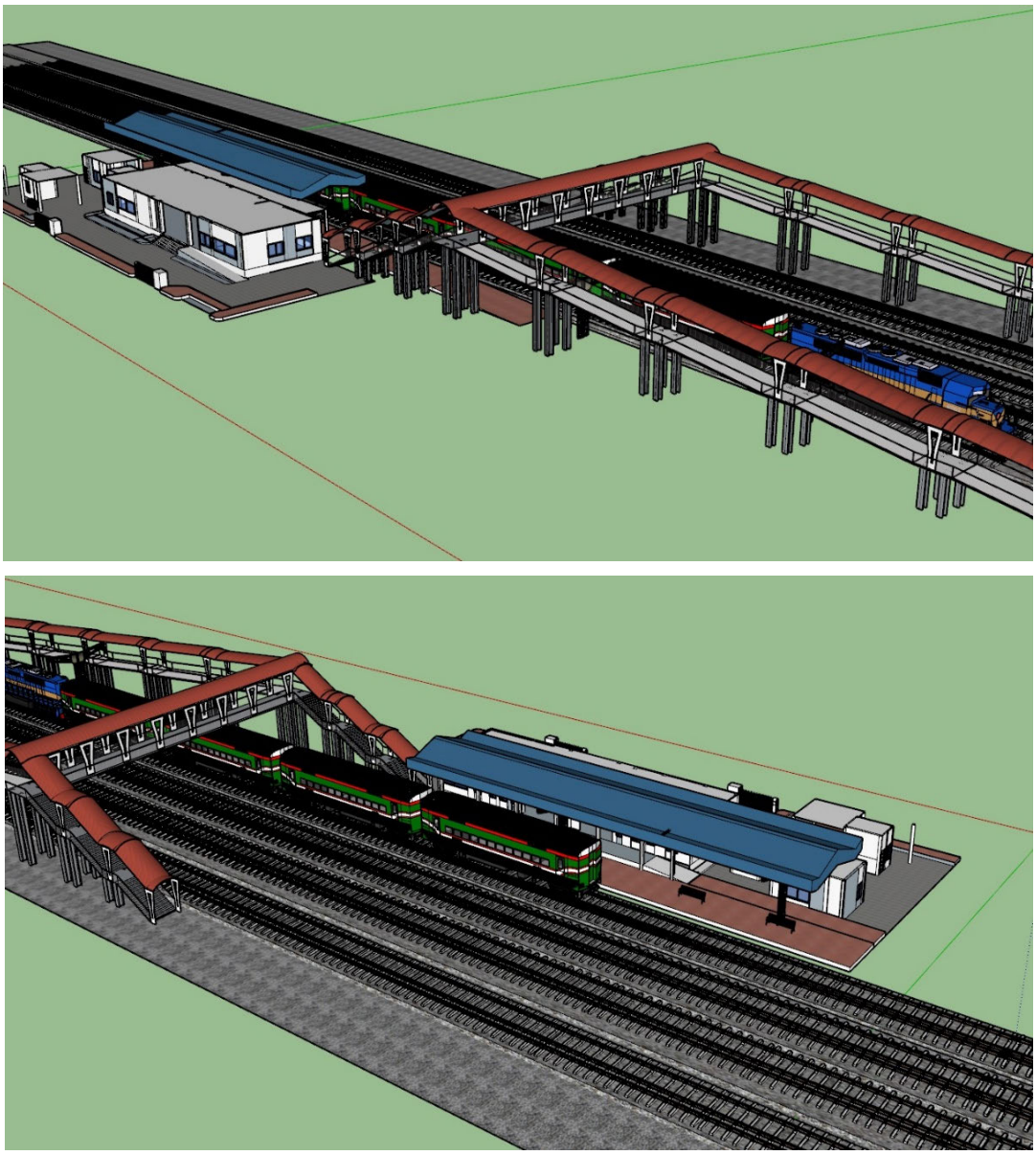
6.7.3 Perspective Drawing

The perspective drawing was prepared based on the existing drawings.

In order to make it easier for wheelchair users and the elderly with weak legs and hips to walk, we propose that a ramp be added next to the stairs from the perspective of barrier-free. Lifts or escalators are not considered appropriate from the perspective of difficulty and cost of maintenance. However, lifts at each station shall be provided separatory by BR after completion of the Project.

And station plaza and access road will be provided for each station.

The perspective drawing of a station is shown in the following figure.



Source: JST

Figure 6.31 Perspective Drawing of Station

6.7.4 Goods Yard at Mouchak or Mirzapur Station

As of 2023, few freight trains operate between Joydebpur and Ishurdi due to lack of track capacity and weight restrictions on the exiting Jamuna Bridge. With the completion of the Jamuna Railway Bridge and the Project, more freight trains will be able to operate in the future, but on the other hand, a goods yard on the Dhaka side are inadequate.

Therefore, BR plans to construct a goods yard consisting of 10 tracks with simultaneous loading/unloading facility from two tracks in Mouchak or Mirzapur station.

The Project does not include the construction of a goods yard. However, since the construction of a goods yard will improve the efficiency of cargo transport from India and contribute to increased

revenue for BR, BR and the engineering services consultant will discuss the need for the Project and implement plans for land acquisition and a goods yard.

6.8 Signal and Telecommunication

6.8.1 Overview

Improvement work of signaling system and level crossing equipment corresponding to the double track between Joydebpur and Ishurdi, and CTC conversion work of the section are planned.

(1) Station Class

According to "General Rules for Bangladesh Railway with the Subsidiary Rules Thereto", the definition of station classes related to signaling systems are as follows.

- Class "A" stations – where permission to approach may not be given for a train unless a running line on which it is intended to receive a train is clear for at least a quarter of a mile in advance of the Home signal;
- Class "B" stations – where permission to approach may not be given for a train unless the running line on which it is intended to receive a train is clear for at least a quarter of a mile in advance of the Outer signal;
- Class "C" stations – Block huts at which no trains are booked to stop and where permission to approach may not be given for a train unless the running line on which it is intended to receive a train is clear for at least quarter of a mile in advance of the Home signal.
- Non-block stations are Class D stations or stopping places situated between two consecutive Block stations and do not from the boundary of any Block section.

(2) Blocking operation

The section between Joydebpur and Ishurdi Junction will be standardized with ABS (Absolute Block System) stipulated in General and Subsidiary Rules (Bangladesh Railway, 1981). Transmission and reception of ABS conditions in the section is performed via OFC (Optical Fiber Cable).

(3) Establishment of B class station

In order to increase the transportation volume in the section, 3 stations will be newly established as B class stations. (Elenga, Karotia, Mirer Bazar)

(4) Installation of CBI

According to BR's policy, B class station will be equipped with CBI (Computer Based Interlocking) that integrates the ABS function.

(5) Renewal of existing interlocking device

The existing RI (Relay Interlocking, Ishurdi Junction only) and existing CBI are aging and difficult to

accommodate for double track and CTC conversion. Therefore, the interlocking device will be updated by newly establishment of CBI.

(6) Relationship with Another Project

Regarding the CBI, which will be newly established in another project on the premise of future double track and CTC conversion, we will carry out renovations in the Project after those start of use. (Shahid M. Mansur Ali, Bangabandhu Setu West, Bangabandhu Setu East)

(7) Establishment of SER

Since there is no space in existing SER (Signaling Equipment Room), a new SER will be installed to newly install the CBI.

(8) Commencement of CTC operation

After the completion of all improvements to signaling system and level crossing equipment for double track between Joydebpur and Ishurdi Junction, CTC (Centralized Traffic Control) will commence to operate at Paksey OCC (Operations Control Center).

Overview of signaling & Telecommunication is shown in Figure 6.32.

ABS: Absolute Block System, CBI: Computer Based Interlocking, CTC: Centralized Traffic Control, OCC: Operations Control Center, OFC: Optical Fiber Cable, SER: Signalling Equipment Room

Source: JST

Figure 6.32 Overview of Signaling & Telecommunication

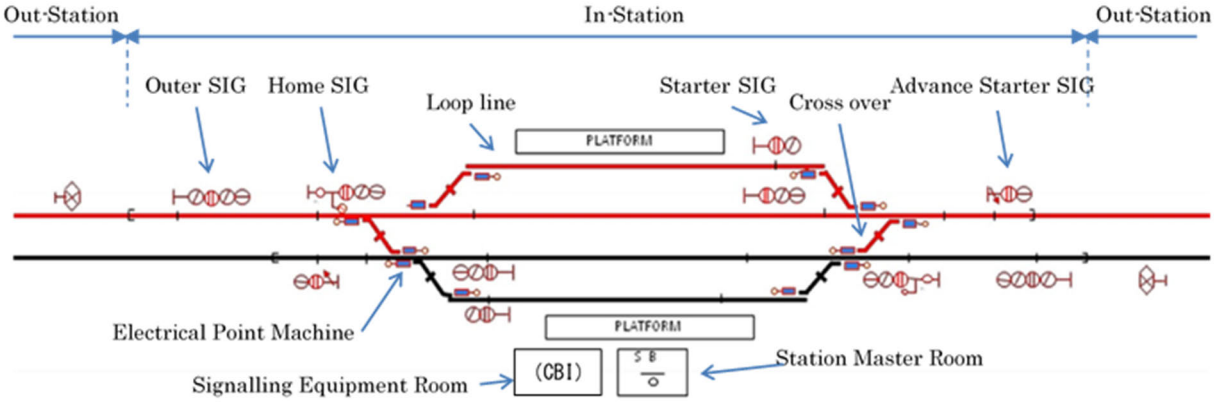
6.8.2 Station yard

(1) Track Layout and Signal Layout

The proposed track and signal layout for each B class station are shown in Appendices (GENERAL DRAWINGS (5060089-5.1-ST-1101~1123)) of the Prior F/S.

These proposals will be finally approved and decided by BR based on the future train operation plan, etc. However, from the viewpoint of construction cost and construction period, it is desirable that the number of facilities is as small as possible.

Typical track & signal layout for B class station is shown below:

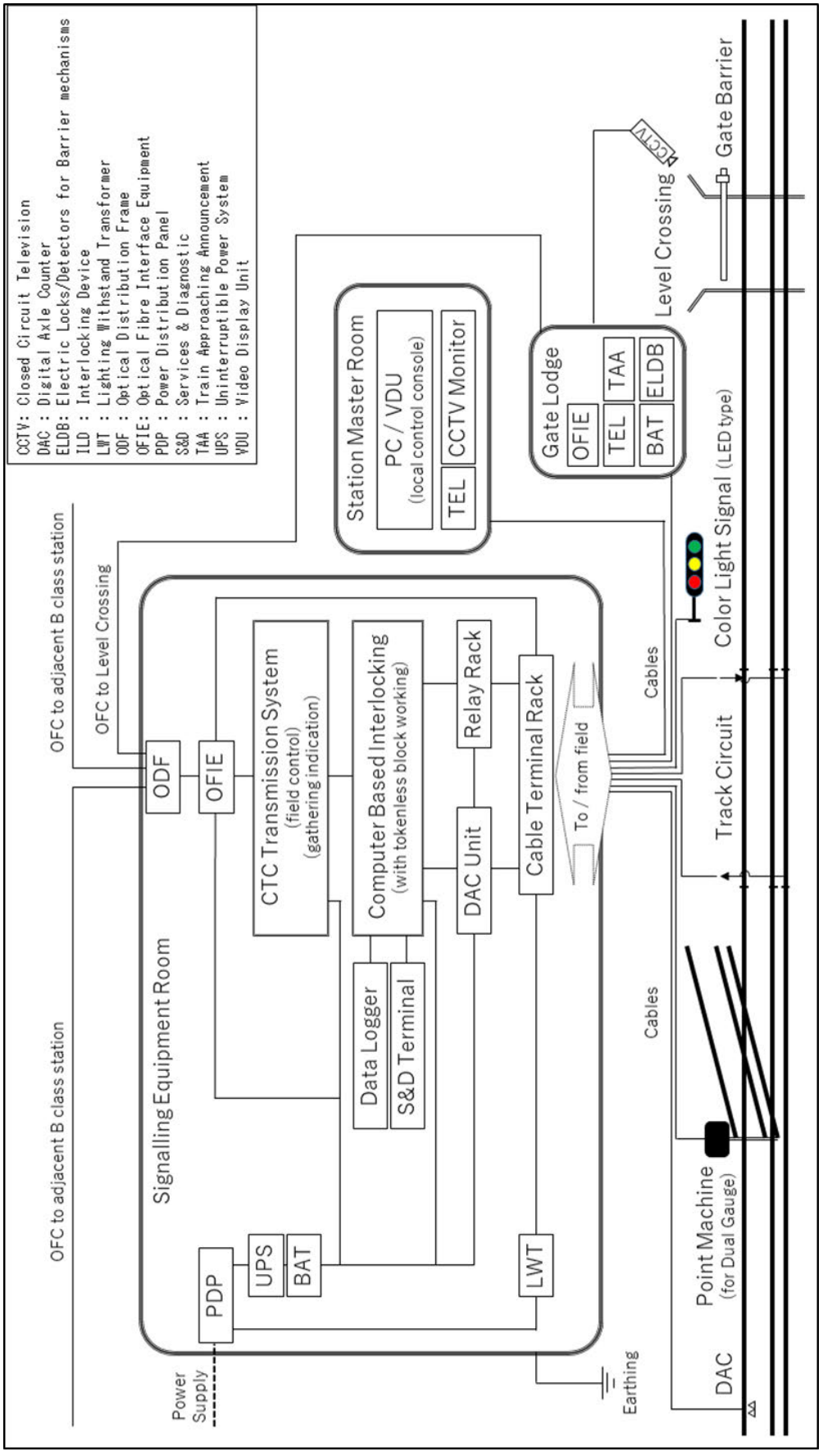


Source: JST

Figure 6.33 Typical Track & Signal Layout for B Class Station

(2) Signaling and Telecommunication Equipment Configuration

Example of the basic equipment configuration of B class station is shown in Figure 6.34.



Source: JST

Figure 6.34 Example of the Basic Equipment Configuration of B Class Station

(3) Points to Note in Planning and Design

In proceeding with the planning and design of the Project, the main content to be noted are bellow.

a. Track Circuit

Considering that the local power supply situation is unstable, it is premised on the introduction of DC track circuit that facilitates uninterruptible power outages using storage batteries.

In detail design stage, to reconfirm the possibility of flood damage, the presence or absence of iron sleeper, and the BR's intentions, and to consider changing to the axle detection method if necessary.

b. Digital Axle Counter

To install Digital Axle Counter that meets SIL4 (Safety Integrity Level 4) at advance starter signal and home signal in each station, for ABS working.

c. Electrical Point Machine

Although DC 110v type is common in BR, AC 110v type can also be installed if the following main requirements are met.

① Corresponds to conversion of 60K dual-gauge turnout.
② It is possible to individually detect the tip of the three tongue rails.
③ Functional configuration that automatically turns off the power supply if conversion is not completed 7 seconds after the start of conversion.
④ Others.

Due to double track, the maximum number of point machines that can be converted at the same time is expected to double. In detail design stage, the maximum power supply capacity will be reconfirmed.

d. Color Light Signal

The distance required for signal line-of-sight specified by BR is 800m for sections of 100km/h or more, and 600m for sections of less than 100km/h.

e. Battery

After charging is completed, the capacity to compensate for normal operation of the entire system (signaling, telecommunication, CTC) for 12 hours or more is required.

f. UPS

When the inverter fails, switching to the commercial power line shall be made instantly without causing any instantaneous power interruption.

Shall have bypass circuit to directly supply commercial power to the load during maintenance of UPS system.

g. Generator

In the Project, we plan to install an AC400v3-phase generator with power supply team.

h. Cable

Cable laying outdoors would basically be buried underground at a depth of 1m. However, the cable connection points will not be buried underground, but will be constructed by installing hand holes and joint boxes. If this method cannot be applied upon due to the local site condition, construction by accommodating the cable in a cable trough will also be considered.

When cable laying on bridges or laying to cross under rail and road, to be protected with pipes and ducts.

To ensure that there are 10% spares in the number of cable cores.

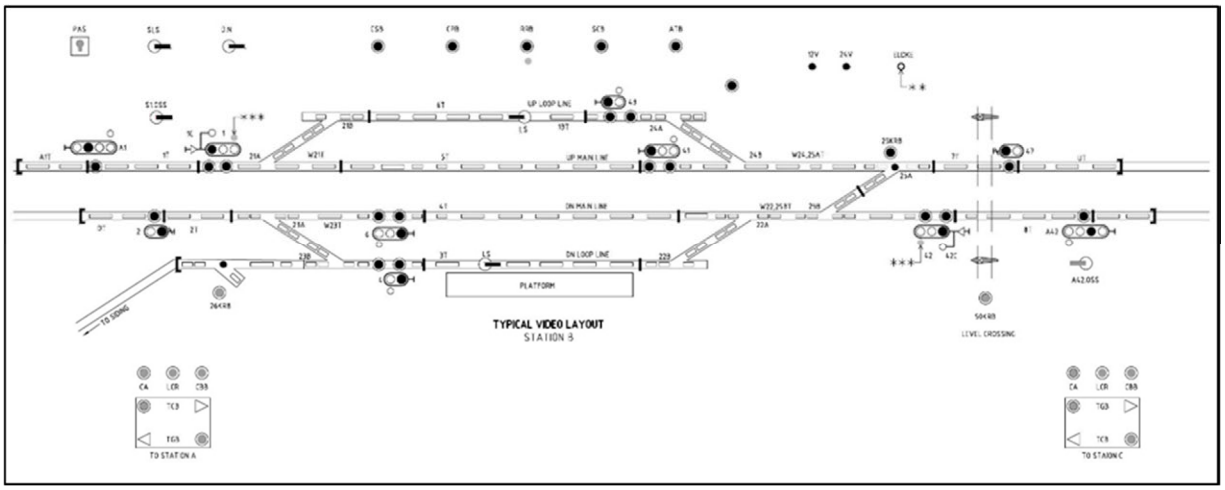
Regarding the two OFC to be laid between each station, the main routes will basically be separated into the north side of the new construction line and the south side of the existing line. Furthermore, regarding the main route on the south side of the existing line, work method will be considered to shorten the construction period by accommodating the cable in a cable trough.

i. CBI

To review that CBI meets SIL4 and with Hot Standby including input/output modules.

CBI is integrated with ABS function and display other related information such as the state of level crossings and the use of the crank handle on the screen.

Typical video layout of CBI is shown below:



Source: The Prior F/S

Figure 6.35 Typical Video Layout of CBI

6.8.3 Level Crossing

(1) Type of Level Crossing

Level crossings are classified into Special, A, B, C, and D in descending order of importance according to road traffic volume, train speed and geographical conditions such slope.

(2) Level Crossing Equipment

In proceeding with the planning and design of the Project, the main content to be noted are bellow.

a. Gate Barrier

Manual gate barriers will be newly installed at the Special class, A class and B class level crossings. The existing line side, which does not interfere with double track, will also be replaced on the assumption that it has deteriorated.

A gate barrier with boom locking function will be installed at level crossings to interlocking with signal.

b. Key Transmitter

A key transmitter as ELDB (Electric Locks/Detectors for Barrier mechanisms) will be installed in gate lodge at level crossing to interlocking with signal.

c. Telephone

IP phone will be installed in gate lodge at all level crossings except C class.

IP phone line will be connected to signaling equipment room (SER) of the nearest station.

d. Approach Warning System

Special class and A class level crossings will be equipped with approach warning systems to warn vehicles and people that a train is approaching the level crossing.

The necessity of installation of approach warning system at B class level crossing of In-Station will be examined individually in detail design stage.

Approach warning system consists of a device that emits bell/buzzer and two flashing red lights.

Digital axle counters will be used for the condition of starting and stopping the approaching warning system activation.

At level crossing of In-Station, to enhance reliability by using track circuit conditions.

e. Train Approaching Announcement

At level crossing where approach warning system is installed, TAA (Train Approaching Announcement) that displays the direction of approaching trains will be installed in the gate lodge.

f. CCTV Camera

Two CCTV cameras will be newly installed at each of the Special class and A class level crossing to supervise the status of the level crossing.

CCTV images will be monitored and recorded in the station master room of the nearest station and at CTC.

g. Power Supply

In principle, the power supply for signaling & telecommunication equipment will be supplied from the nearest SER. At some level crossings with long distance to station, it is planned to receive power individually from the power corporation (PBS).

Regarding battery, after charging is completed, the capacity to compensate for normal operation of the entire system (signaling, telecommunication) for 12 hours or more is required.

Existing level crossing facilities are shown below.

		
Gate Barrier with Boom Locking	Electric Locks/Detectors for Barrier mechanisms	Train Approaching Announcement, Telephone

Source: JST

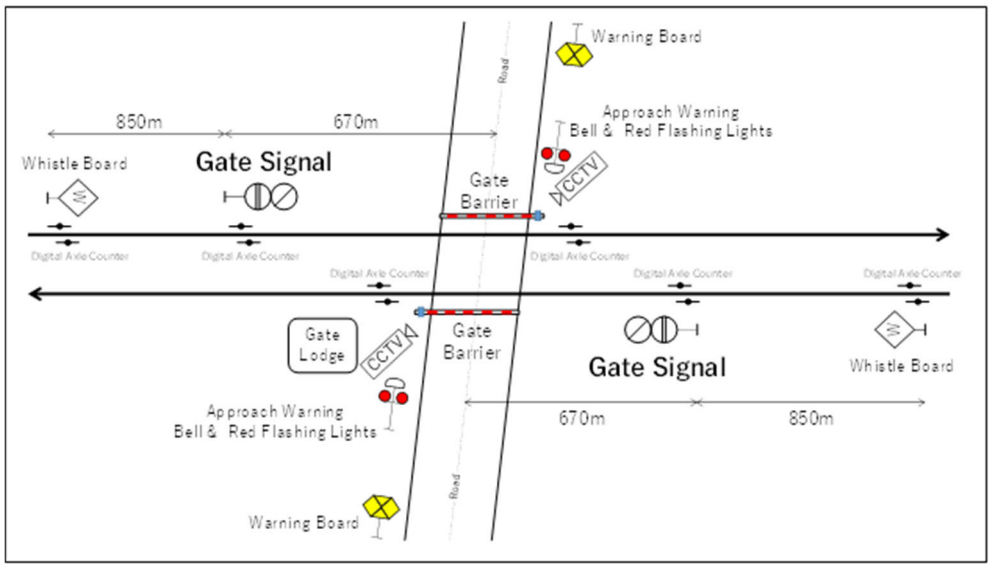
Figure 6.36 Existing Level Crossing Facilities

(3) Gate Signal

Gate signal will be installed at Special class and A class level crossing between stations (Out-Station), and will be interlocked with the level crossing. (localized signaling & interlocking)

Digital axle counters will be used for the condition of starting and stopping the approaching warning system activation.

Typical installation of gate signal and digital axle counter is shown in Figure 6.37.



Source: JST

Figure 6.37 Typical Installation of Gate Signal and Digital Axle Counter

(4) Instruction to Descend Gate Barrier

At each level crossing, gatemen receive verbal instructions to descend the gate barrier via a direct telephone line from the nearest station master regardless of the direction of travel of the train.

After the introduction of CTC, in normal situation that the nearest station is remote control, the gateman will receive verbal instructions by direct telephone from the CTC.

In situation that the nearest station is local control, the gateman will receive verbal instructions by direct telephone from the nearest station master as ever.

(5) Special class, A class and B class Level Crossing Equipment

Table 6.18 shows the Special, A and B class level crossings which are scheduled to be improved in this project and will be equipped with Signalling & Telecommunication Systems.

(6) C class Level Crossing Equipment

BR commented JST to check provision of Auto Bell System for unmanned gate.

Based on the following preconditions, the proposed level crossings where Auto Bell System will be installed are shown in Appendix 6-3.

a. The Bell will ring automatically when the train will be approach approximately 500m up and down of the level crossing.

b. In order to avoid an increase in the construction period and construction costs, the conditions for starting and stopping of the Bell will use relay contacts such as track circuit of each station, and add time element if necessary.

c. Auto Bell System will be installed at C class level crossings within the In-station range.

d. Installation of Auto Bell System at C class level crossing will be examined individually in detail design stage.

(7) Consideration of utilizing GPS (Global Positioning System) function

BR commented JST additionally, to study the plan that C class level crossings have Auto Bell System with GPS tracker.

In detail design stage, to consider a method for detecting train approach using GPS functionality, and study the additional costs, construction period, and issues involved in its introduction.

Table 6.18 Installation of Signaling & Telecommunication Systems at Level Crossing

2023/4/12

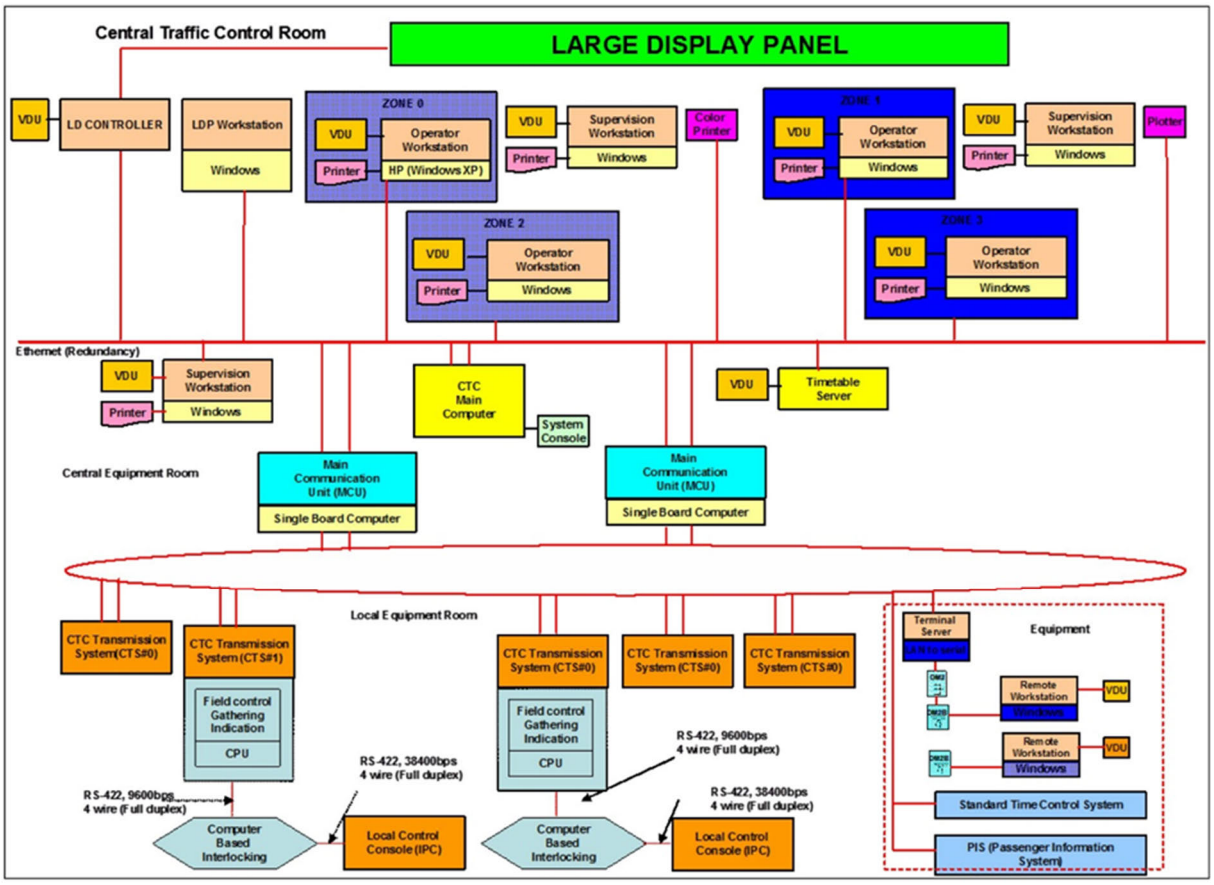
No.	Level Crossing	Design Kilometre	Class	Categori	Protection Arrangement	IP TEL	Approach Warning to Road	CCTV Monitoring	Gate Signal	Power Supply	Remark
1	T/7	216k046m	Special	In-station	interlocked with Mooladuli CBI	○	○	○		Mooladuli SER	Proposed RoB
2	E/24	238k175m	Special	Out-station	interlocked with Bhangura CBI	○	○	○		Bhangura SER	Change to In-station
3	T/38	262k602m	Special	In-station	interlocjed with Ullapara CBI	○	○	○		Ullapara SER	Proposed RoB
4	E/78	281k006m	A	Out-station	localized signaling & interlocking	○	○	○	○	PBS	Will be implemented in another project
5	E/76	282k494m	A	Out-station	localized signaling & interlocking	○	○	○	○	PBS	Will be implemented in another project
6	E/62	306k367m	B	Out-station		○					TEL connect to Elenga, Replace gate barrier
7	E/61	306k939m	Special	Out-station	localized signaling & interlocking	○	○	○	○	PBS	TEL connect to Elenga
8	E/59	308k299m	B	Out-station	interlocked with Elenga CBI	○	△			Elenga SER	Change to In-station
9	T/53	316k016m	A	In-station	interloched with Tangail CBI	○	○	○		Tangail SER	
10	E/45	322k613m	A	Out-station	interlocked with Karotia CBI	○	○	○		Karotia SER	Change to In-station
11	E/44	322k751m	B	Out-station	interlocked with Karotia CBI	○	△			Karotia SER	Change to In-station
12	T/36	331k757m	B	In-station	interlocked with Mohera CBI	○	△			Mohera SER	
13	T/29	340k799m	B	In-station	interlocked with Mirzapur CBI	○	△			Mirzapur SER	
14	T/28	341k854m	B	In-station	interlocked with Mirzapur CBI	○	△			Mirzapur SER	
15	E/19	352k752m	B	Out-station		○					TEL connect to Hi Tech City, Replace gate barrier
16	E/18	353k363m	A	Out-station	localized signaling & interlocking	○	○	○	○	PBS	TEL connect to Hi Tech City
17	E/16-2	355k272m	A	In-station	interlocked with Hi Tech City CBI	○	○	○		Hi Tech City SER	
18	E/15	360k211m	B	Out-station		○					TEL connect to Mouchak, Replace gate barrier
19	T/14	361k610m	B	In-station	interlocked with Mouchak CBI	○	△			Mouchak SER	
20	E/12	363k929m	B	Out-station		○					TEL connect to Mouchak, Replace gate barrier
21	E/2	376k498m	Special	Out-station	localized signaling & interlocking	○	○	○	○	PBS	TEL connect to Joydebpur
22	T/1	377k914m	Special	In-station	interlocked with Joydebpur CBI	○	○	○		Joydebpur SER	

Source: JST

6.8.4 CTC (Centralized Traffic Control) System

(1) System Configuration

CTC system configuration in the Project is shown below:



Source: Revised Feasibility Study Report (Feb 2019) Figure 13.2 CTC Network Topology

Figure 6.38 CTC System Configuration

(2) Points to Note in Planning and Design

a. Safety of Network

IEC62280 (EN50159-2): Railway applications - Communication, signaling and processing systems - Safety related communication in transmission systems.

b. Early determination of display and control content

If there is a change in the middle due to user requests, etc., it will have a large impact on the design and production of the entire system, including not only the central unit but also the field equipment. Therefore, to early arrange the specific specifications of content with BR in detail design stage.

For example:

① Is it necessary to display the condition of interlocking between Special/A class level crossing and gate signals (localized signaling & interlocking) which are located in out-station ?

② Is it necessary to remote control the shunting signal from the center, at shunting operation in Ishurdi Junction and Joydebpur? In general, shunting operation is done locally controlled at stations rather than remotely controlled by CTC center.

6.8.5 Others

(1) Signalling Equipment Room

In detail design stage, to create a layout proposal for equipment considering the space for equipment renewal (approximately 30%) and the size of cable entrances so that the same equipment room can be used continuously in the future.

It is recommended to introduce a raised floor that superior in terms of workability, lightning surge countermeasures, and maintenance.

Condition inside the existing signaling equipment room at Hi Tech City Station is shown below:

Source: JST

Figure 6.39 Condition inside the Existing Signaling Equipment Room (Hi Tech City Station)

6.9 Power Supply

6.9.1 Overview

In this project, new electrical power supply system will be installed to energize necessary power for Dual Gauge-Double Line construction between Joydebpur - Ishurdi section. Here, the primary priority is to provide appropriate and adequate electrical power with maximum safety for the indoor and outdoor (station yard) signaling and telecommunication system(s) for token-less computer based interlocking block station(s). Alongside the primary target, the secondary target is to energize general electrical & electro-mechanical equipment and fixtures with maximum safety used in a standard commercial building(s).

6.9.2 Current Condition

(1) Survey

JST executed site survey at 27 stations between Joydebpur-Ishurdi section (West Zone) and Pakshi BR office in order to recognize current power supply system condition(s). In this area, all electrical power energizations are feeded by Polli Biddut Samaity (PBS), except Ishurdi jn. station and Pakshi BR office premises. Where these two structures are energized by the regional local electrical distribution authority named Northern Electricity Supply Company Limited (NESCO).

Table 6.19 shows the existing power supply system of each station and Pakshi BR Office. Current status of station power receiving consists of 20 (twenty) three phase electrical power receiving stations except for Pakshi BR Office and 4 (four) single phase power receiving stations. Figure 6.40 shows that the present power supply equipment and cables at actual site locations.

(2) Features of Existing Power Supply System

Features confirmed by site joint survey are indicated as below.

① There is normally 11kV/400V power receiving transformer on concrete pole near station. It consists of three 1f (single - phase) transformers arranged in triangular shape to provide 3f (three - phase) electrical power to the station building(s).

② Energy meter for power consumption provided by PBS are existing at all stations. And upstream portion of the meter is possessed by PBS, and downstream portion of the meter is possessed by BR. The meter actually indicates their mutual border of maintenance & construction.

③ All energy meters were installed on the downstream side of transformer.

④ All block stations have diesel generators which supply power energization to only signaling system. And they have the capability to energize important loads at least 7 (seven) hours continuously.

⑤ There are TS (Transfer Switch) at all block stations. Where the switches are manually operated to change the source of electric power from PBS authority or battery backup to diesel generator backup power.

⑥ At all block stations, there are battery backup units (consists of re-chargeable batteries and its re-charge unit) that provide electrical power to the signaling system in case of electrical power outage.

⑦ Only Tangail station has AVR (Automatic Voltage Regulator) equipment.

⑧ B class LC and C class LC do not have power receiving system.

⑨ There are some overhead power lines crossing above targeted railway route. Asset of these power lines is stored by PBS.

Table 6.19 Existing Power Supply System of Each Location

No.	Station Name etc.	Phase of Load		Signal Load	Generator	Solar	Present Load condition (As per survey) kW	Present Generator Backup Capacity (Only Signaling) kVA
		Single	Three					
1	Paksey Sub-Station for CTC Center		○	○	○	X	240	30
2	Ishurdi Jn.		○	○	○	X	240	30
3	Ishurdi Bypass		○	○	○	X	30	11.5
4	Majhgram		○	○	○	X	30	11.5
5	Mooladuli		○	○	○	X	2	11.5
6	Gafurabad	○				X	0.5	0
7	Chatmohar		○	○	○	X	15	11.5
8	Guakhara					X	0.5	0
9	Bhangura		○	○	○	X	15	11.5
10	Baral Bridge	○				X	1	0
11	Saratnagar		○			X	2	0
12	Dilpashar		○	○	○	X	14.9	11.5
13	Lahirimohanpur		○	○	○	X	14.9	11.5
14	Ullapara		○	○	○	X	14.9	11.5
15	Salop	○				X	0.5	0
16	Jamtoil		○	○	○	X	15	11.5
17	Shahid M. Mansur Ali		○			X	9	0
18	Bangabandhu Setu West		○	○	○	X	X	40
19	Bangabandhu Setu East		○	○	○	X	X	40
20	Elenga					X	0	0
21	Tangail		○	○	○	X	25	40
22	Karotia	○				X	1	0
23	Mohera		○	○	○	X	30	40
24	Mirzapur		○	○	○	X	30	40
25	Kaliakoir		○	○	○	X	60	40
26	Mouchak		○	○	○	X	60	40
27	Mirer Bazar					X	0	0
28	Joydebpur		○	○	○	X	200	40

Source: JST

(a) Disconnecting Switch

(b) High voltage transformer in the electric room

(c) Distribution panel

(d) Battery Panel

(e) Emergency generator

(f) High voltage transformer on the pole

Source: JST

Figure 6.40 Current Power Supply Equipment

6.9.3 New System Plan

(1) Basic Design Philosophy

Currently, blackout occurs on a daily basis in Bangladesh. Sometimes the power supply is not recovered for a long time. In addition, the voltage is unstable and may frequently drop during heavy load consumption time of the day. That is unsafe for the safety operation of signaling components. The voltage fluctuation rate allowed for the signal power supply is ± 10%, but the present condition of electrical power at all stations were found (during survey) at much unstable condition than the acceptable stability limit.

In response to such power supply circumstances, the following measures are expected to be planned.

① Receiving high voltage power is relatively stable.
② In order to suppress voltage fluctuation at the location of the loads, using a three-phase four-wire transformer equipped with Load Tap Changer (LTC).
③ In order to rectify small voltage fluctuation, using an Automatic Voltage Regulator (AVR).
④ For blackout and intense voltage drop, installing emergency generator (EG) as a backup system.

A LTC adjusts the voltage by automatically changing the winding ratio of the transformer. It prevents decrease in energy loss, but implementation of LTC equipment is much expensive and its periodic maintenance cost is much higher as well.

On the other hand, implementation of AVR units are much less expensive and requires less maintenance in comparison to LCT. And in Bangladesh, AVR implantation to ensure the safety of the electrical equipment is more common and general.

And due to the inconsistencies of electrical power supply and stability, it is assumed that EG will be used frequently. If the power supply for the signaling equipment is lost, it will cause a catastrophic effect on the safety and consistent operation of train. There are various products of EG, but it is important to choose a high-quality product, not a product that is cheap and prone to break down.

In addition, power supply connection method of PBS authority can basically be described as follows.

① 11kVA power receiving (for most of commercial connections).
② The distribution transformer provided from the PBS authority doesn't ensure any electrical power protection for their connections. They (PBS authority) just connect the line to energy meter. Hence, in each stations Circuit Breaker and other necessary means of electrical power connection must has to be considered and applied accordingly.
③ As for the method of installing the transformer, in principle, PBS authority provides pole mounted transformer up to the capacity of 112.5 kVA. If the load exceeds this limit, installation of transformer in ground has to be considered with all necessary electrical power distribution.

(2) Target Locations

In the project, new electrical system will be installed on the below locations.

① 25 (twenty-five) stations excluding Bangabandhu Setu East and Bangabandhu Setu West stations.
② In addition to the 25 (twenty-five) stations, Paksey BR Office premises that includes CTC center as well.
③ Upgradation (re-construction) of 3 (three) substations at Joydebpur, Ishurdi Jn., and Paksey BR office.
④ 5 (five) Important LCs (Level Crossing Gate Lodge).

Since Bangabandhu Setu East and Bangabandhu Setu West stations will be improved by Bangabandhu bridge replacement project, Electrical power distribution system for these 2 (two) stations consideration is not required in this project.

As per confirmation of signaling person in charge of JST, there are 5 (five) important LCs need power receiving. The details of these 5 (five) LC gates are as follows;

ⓐ E/78; 281k006m, Class A
ⓑ E/76; 282k494m, Class A
ⓒ E/61; 306k939m, Class Special
ⓓ E/18; 353k363m, Class A
ⓔ E/2; 376k498m, Class Special

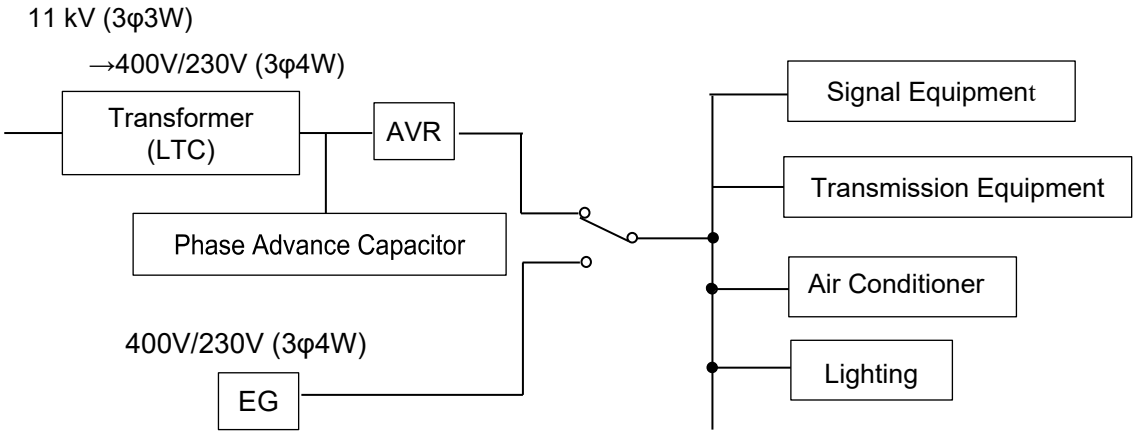
In addition, Paksey BR Office, Ishurdi Jn., and Joydebpur station's electrical substations and their housing structures have deteriorated and aged; thus, these substations will be replaced in the project.

(3) New System Overview

Proposed new power supply system mainly consists of high voltage power receiving, distribution of power and implementation of maximum safety electrical equipment and emergency generator.

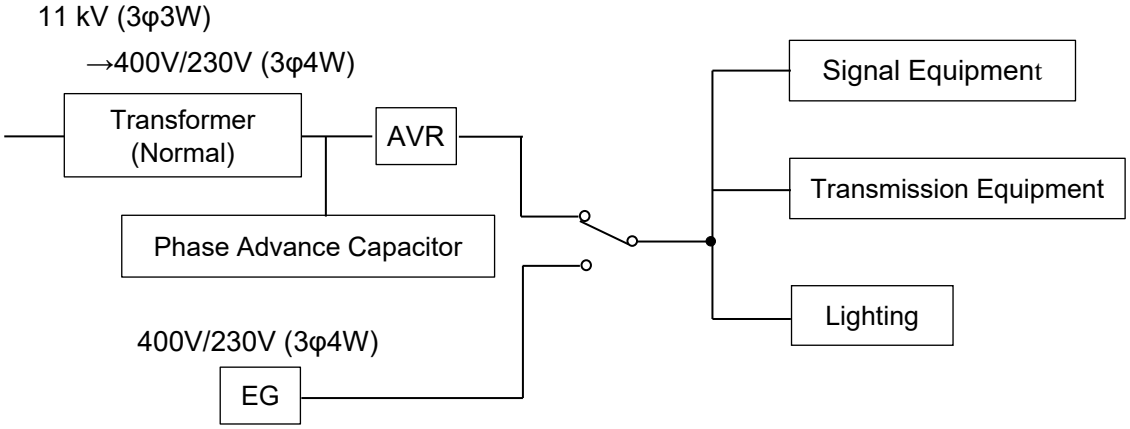
Figure 6.41 shows new system proposal for stations and Paksey BR Office.

Figure 6.42 shows new system proposal for important LC.



Source: JST

Figure 6.41 Configuration of the Power Supply System at stations & Paksey BR Office



Source: JST

Figure 6.42 Configuration of the Power Supply System at Important LC

Undisclosed

Undisclosed

Undisclosed

6.9.4 Others

(1) Related to PBS

Detail design for power system on the upstream from the energy meter will be implemented by power system contractor(s), and these design document(s) should be submitted to PBS authority via BR. Actual construction will proceed after PBS authority approve these design documents.

Above mentioned construction will be conducted by PBS authority up to the PBS provided distribution transformer. And project side should prepare electrical power distribution cost and proper safety equipment. All correspondence related to PBS will be enforced via BR. However above menstioned all matters will be reconfirmed and negotiated in detail design stage.

(2) Relocation of PBS Overhead Power Line

According to the PBS regulation of Bangladesh, height between rail level and lowest position of overhead power line shall ensure at least 25 feet (7,620mm). There are some such situated where overhead power line has crossed over the railway track. Thus, it is necessary to coordinate and confirm this issue with PBS during basic design stage and detail design stage. Actual locations were summarized on previous feasibility survey.

(3) Power System Regulation in Bangladesh

In absence of a proper electrical regulation manual in Bangladesh railway, Electrical regulation manual issued by the PBS authority commonly known as '**Red Schedule**', or to be more precise, '**PBS Instruction 100-20/BREB Instruction 500 – 07 issued by Bangladesh Rural Electrification Board**' will be considered as reference text for the basic and detail design phase. Most of the distribution transformers are pole mounted in rural areas of Bangladesh. If required, transformer(s) installed on the ground level should at least have a clearance level of 1 to 1.5 feet i.e., 304.8mm to 457.2mm to prevent the transformer from submerging due to the rise of water level in the rainy season.

(4) Solar Power Generation System

Signaling equipment requires high quality power supply, therefore solar power generation cannot be applied to energize any signaling equipment; however, it is no problem to energize general building loads with solar power. And in Bangladesh, as per '**Red Schedule**' or '**PBS Instruction 100-20/BREB Instruction 500 – 07 issued by Bangladesh Rural Electrification Board**' requires installing solar powered electrical energy source to energize 2 to 3% of total load of a commercial building. Hence, it is necessary to consider solar power energization for station building loads only (excluding all signaling equipment) and Paksey BR Office during basic design stage and detail design stage.

6.10 Train Operation Plan

6.10.1 Calculation of the line capacity and existing condition of the Project section

(1) Calculation of the line capacity

The block section with the smallest track capacity in the Project section will define the overall line capacity. Therefore, it is necessary to check the capacity of each block section in order to calculate the line capacity.

The formula below is a simplified version for calculating line capacity. The formula divides the total operating hours in the designated section by the slowest run time of the section. The run time should include operating factors such as signal operating time, block operating time, and turn out operating time. In the CBI system, the block operating time includes the abovementioned factors.

$$N = \frac{1440 \times f}{t + c}$$

N : Number of trains possible to be accommodated in the designated section

f : Track occupancy rate

t : Run time

c : Block operating time

The track occupancy rate varies by line characteristics. UIC leaflet 406 specifies the track occupancy rate appropriate for the different line characteristics.

In this UIC leaflet, the proposed track occupancy time rate varies 70-60% daily.

Table 6.20 Proposed Track Occupancy Time Rate

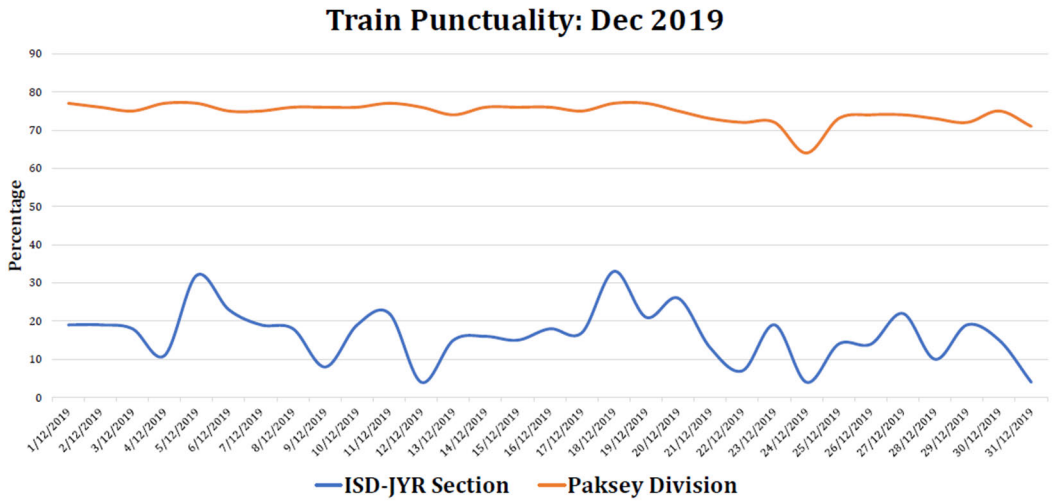
Type of line	Peak hour	Daily period
Dedicated suburban passenger traffic	85%	70%
Dedicated high-speed line	75%	60%
Mixed-traffic lines	75%	60%

Source: UIC leaflet 406

The Project section is regarded as a “mixed-traffic line”. Because the section has a level crossing, the trains with different speed profiles are operated. Therefore, track occupancy time rate will be 60%.

(2) Existing condition of the Project section

Thirty-seven passengers and two freight trains operate daily in the Project section maximum, and chronic train delays are an issue. In the section, train punctuality rates in 2019 are 20-65 %. The worst result was recorded in December 2019 shown on the below graph. It was approximately 75% lower than the average train punctuality in the area. (Figure 6.43)



Source: BR internal report

Figure 6.43 Train Punctuality Rate of December 2019 in Joydebpur-Ishurdi

BR regards that the Jamuna Bridge section causes the train delay. The section accommodates 37 trains per day. 31 out of 37 trains pass the bridge daily. However, from the calculation 24-25 trains can pass the bridge daily. As a result, Jamuna Bridge becomes a bottleneck of the routes. The calculation formula is shown below.

$$24.69 = \frac{1440 \times 60\%}{30 + 5}$$

The track occupancy rate is fixed at 60%, which is specified in the UIC 406. The JST regards that a figure for the mixed-traffic lines in UIC406 meets the current condition in the Jamuna Bridge section.

The run time is 30 minutes. The operating speed in the Jamuna Bridge section is restricted to under 20km/h. It is calculated approximately 30 minutes to pass the Jamuna Bridge section.

The block operating time is the time required for all procedures for the train departure. It includes the time for the confirmation of line clear, operation of a route set, level crossing, and other procedures. In this calculation, it is assumed to be 5 minutes.

Based on the same calculation, the section between Tangail- Bangabandhu Bridge East is regarded as a bottleneck. This section can accommodate 25-26 trains per day. However, the section needs to accommodate 37 trains per day.

The below table shows the existing line capacity of the Project section. JST calculated the run time based on the average booked speed of 44km/h.

Table 6.21 Line Capacity of Each Section as of 2023

Section		Distance (km)	Capacity (Trains/day)
(West)	Ishurdi - Majhgram	6.18	61.71
	Majhgram - Mooladuli	5.65	66.46
	Mooladuli - Chatmohar	13.35	36.00
	Chatmohar - Bhangura	9.45	48.00
	Bhangura - Lahirimohanpur	14.72	33.23
	Lahirimohanpur - Ullapara	8.00	54.00
	Ullapara - Jamtoil	12.31	39.27
	Jamtoil - BBW	10.83	43.20
	BBW - BBE	9.23	24.69
(East)	BBE - Tangail	20.90	25.41
	Tangail - Mohera	15.73	32.00
	Mohera - Mirzapur	10.14	45.47
	Mirzapur - High-Tech City	13.60	36.00
	High-Tech City - Mouchak	7.17	57.60
	Mouchak - Joydebpur	16.01	32.00

Source: JST

The valid run curve of each train is necessary for a punctual train timetabling. JST cannot confirm the validity of the existing train run curve. Precise consideration for the run curve and other operational factors is required for the operation planning in the E/S phase.

6.10.2 Condition related to the Train Operation Plan

The study was carried out on the assumption that the project will be able to operate under almost the same operating conditions as those of the existing line sections. There are no new operating plan constraints, such as steep curves or huge gradient in the section between Joydebpur-Ishurdi compared to the current operating conditions.

It was assumed that there would be a 750m of the Clear Standing Length (CSL) at each passing loop station so that there would be no constraints on train operation planning. However, Joydebpur, Chatmohar, Sarat Nagar, and Jamtoil stations may need relocation of level crossings to accommodate CSL. Those stations have the special or C-class level crossing in the station range. This point requires a detailed layout study during the E/S phase.

The operating speed of train in the operation planning after the Project will not change from 90km/h (passenger train) and 60km/h (freight train) because upgrading of existing track is not realized in the Project. JST calculated the run time based on the average booked speed of 44km/h.

The CTC will control signaling of entire section. However, the operation of CBI is not automated. CTC dispatcher will set the route and signal for each train. It will require the block operating time even after the centralization of the system.

The line capacity is calculated using the various parameters given in Chapter 6.3 and the layout proposed in Appendix 6-1. The Joydebpur-Ishurdi section will have 20 passing loop stations and 19 block sections.

The entire section will be double-tracked, resuming the Saratnagar and adding three stations at Elenga, Karotia, and Mirer Bazar.

The line capacity will increase to 68 trains/day from 25 trains/day. The lowest capacity section is the BBE-Elenga section. The line capacity of each block section is organized in the table below.

Table 6.22 Line Capacity of Each Section after the Project

Section		Distance (km)	Capacity (Trains/day)
(West)	Ishurdi - Majhgram	6.18	122
	Majhgram - Mooladuli	5.65	132
	Mooladuli - Chatmohar	13.35	72
	Chatmohar - Bhangura	9.45	96
	Bhangura - Saratnagar	4.22	156
	Saratnagar - Lahirimohanpur	10.50	86
	Lahirimohanpur - Ullapara	8.01	108
	Ullapara - Jamtoil	12.31	78
	Jamtoil - BBW	10.83	86

Section		Distance (km)	Capacity (Trains/day)
	BBW - BBE	9.28	96
(East)	BBE - Elenga	14.14	68
	Elenga - Tangail	6.76	114
	Tangail - Karotia	7.64	108
	Karotia - Mohera	8.09	100
	Mohera - Mirzapur	10.14	90
	Mirzapur - High-Tech City	13.61	72
	High-Tech City - Mouchak	7.17	114
	Mouchak - Mirer Bazar	7.96	108
	Mirer Bazar - Joydebpur	8.05	108

Source: JST

As explained in 6.8.1, JST presumed to apply the ABS for the section between Joydebpur and Ishurdi Junction. This operation method only allows one train to enter the section between each station. Expanding the line capacity by implementing the intermediate block system, such as automatic block signaling, may be possible.

6.10.3 Operation Plan based on the Demand Forecast

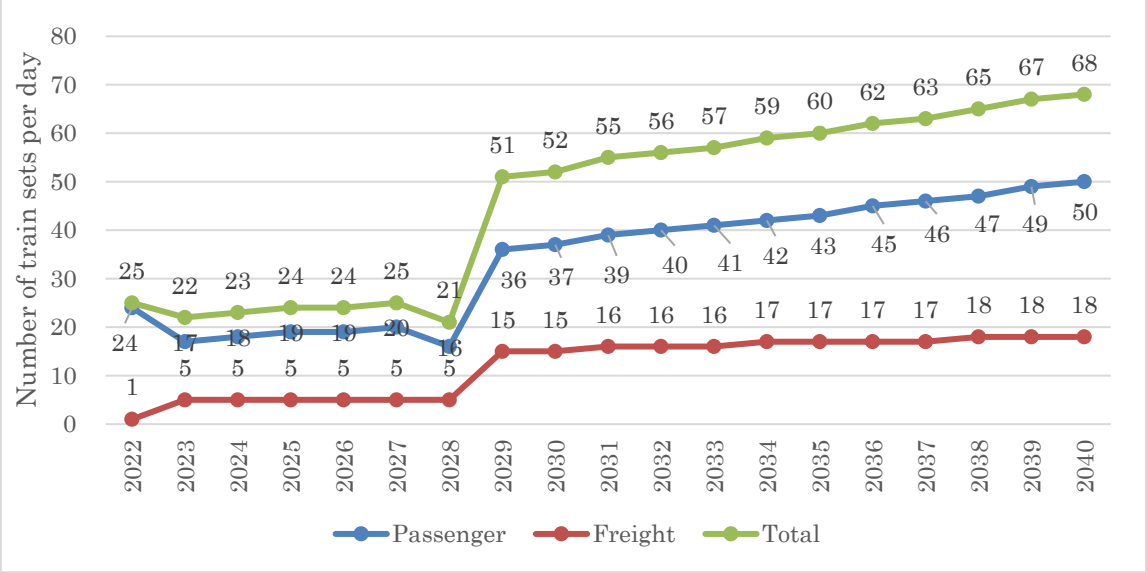
JST calculated the train operating slots between Joydebpur - Ishurdi based on the demand forecast. JST assumed that the train slots would be occupied for North-bound trains in the Project section since the new route (Padma Bridge route), which is scheduled to open in 2023, is possible to cater the Khulna-bound and India-bound transport demand in the Project section.

JST assumed that Lalmonirhat and Kaunia-bound passenger demand will be catered by the Shahid M Mansur Ali - Bogura route after the 2028.

The Project section will reach its maximum capacity in 2040 with 68 trains including freight service shown in Figure 6.44. Part of the existing trains services are assumed to be diverted to the Padma Bridge route.

It is estimated that the Shahid M Mansur Ali - Bogura route can accommodate a limited number of trains converted from the Shahid M Mansur Ali -Ishurdi route. This is because the section is a single line on DG, and the section from Bogura to another area is MG. It means the trains operating on the Shahid M Mansur Ali -Bogura route are limited to those heading to the MG section.

As of 2022, about six trains are heading to the MG section out of the 24 northwestern bound trains. Therefore, it is unlikely that trains traveling on the Project section will be able to be substantially reallocated to the Shahid M Mansur Ali - Bogura section. Currently, JST cannot estimate the exact number of trains diverted to the Shahid M Mansur Ali - Bogura section because the track capacity of the project still needs to be determined.



Source: JST

Figure 6.44 Number of Train Slots in the Project

Schematic figures of the operating routes are shown in the below figure. (Figure 6.45)

As an opening of the Padma Bridge, the Padma Bridge route can cater to 18 passenger trains and 23 freight trains.

As of now, approximately 25% of the operating routes running throughout the Project are southbound trains that can be diverted to the Padma Bridge route.

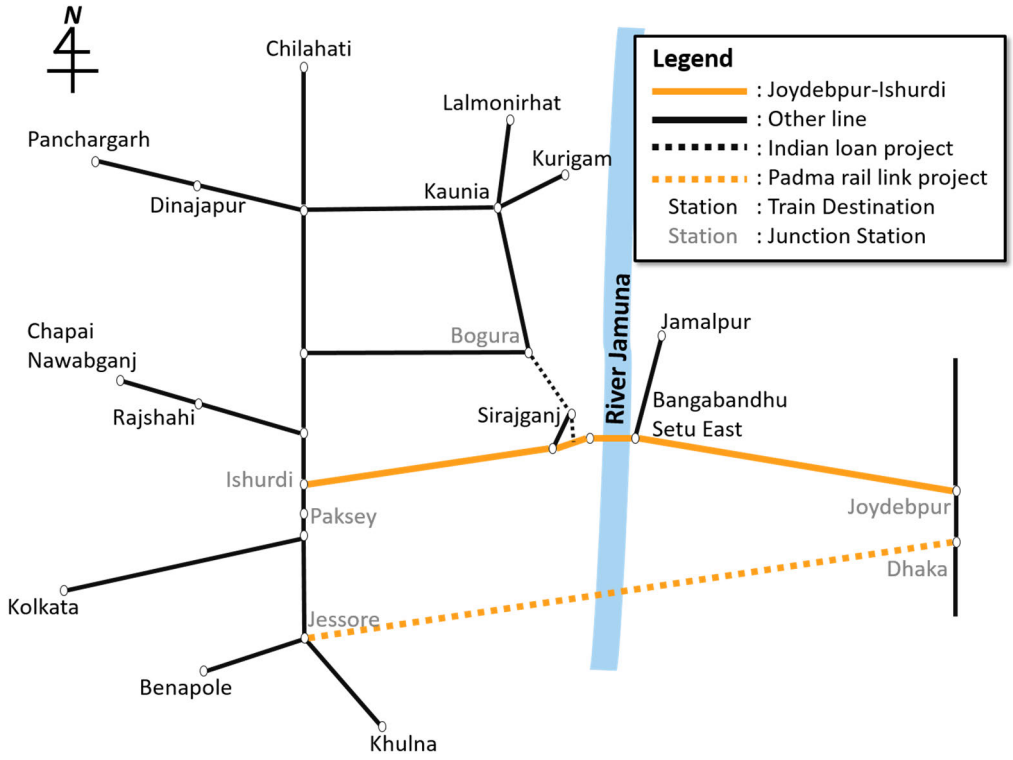
It should be noted that until the Padma Bridge route reaches its maximum capacity, some of the northbound trains need to be diverted to the Padma Bridge route to maximize the capacity of the Project section. The northbound trains for the Rajshahi and Chapai Nawabganj run shorter lengths than other northbound trains. Therefore, it is possible to divert those short-routed trains to the Padma Bridge route.

It is considered possible to reduce the impact of the increase in journey time since the punctuality rate will be improved.

In addition, it is also possible to reallocate some of the outbound trains that depart from Dhaka to the Padma Bridge route in order to secure train slots. It would allow diverting the train services to the Padma Bridge route without increasing the travel time to Dhaka.

It should be noted that it may decrease the punctuality of the international passenger train service between Dhaka and Kolkata when diverting to the Padma Bridge route because the international train will be necessary to pass the Dhaka Kamalapur station area, which is hugely congested. In such cases, diverting some outbound trains from Dhaka to the Padma Bridge route is possible to create train slots for international services.

The consideration will be required to determine the journey times and operation plans, including Padma Bridge route diversion, in the future survey.



Source: JST

Figure 6.45 Schematic Operation Routes of the Trains Operated between Joydebpur-Ishurdi Section

6.10.4 Number of Rolling Stocks for Train Operation between Joydebpur-Ishurdi Section

JST calculated the number of rolling stocks for passenger service in the section based on the number of train slots and Prior F/S data. The number of rolling stocks required for passenger service is organized in the table below. (Table 6.23)

JST calculated the number of rolling stocks for freight service in the section based on the cargo traffic data of the Jamuna Bridge. The number of rolling stocks required for freight service is organized in the table below. (Table 6.24)

JST assumed the maximum passenger train composition as 19 cars. It is based on the performance of the locomotives and the condition of the existing operation. The maximum freight train composition was assumed as 32 cars. It is based on the current status of BR's freight service.

Those compositions do not include rolling stocks for services such as generator or train guard coaches.

Train Composition also varies according to gauge. However, JST calculated the number of rolling stock used for passenger service in the section based on the BR's statistics data for BG because most of the trains operated in the Project section are BG.

Fourteen cars/train is applied to 2022 since the average composition of BR's BG trains is 13.6 cars/train. The number of coaches per train was set at 16 cars/train until 2027, with the expectation that the

number of cars in the trains will continue to increase transport capacity until the completion of the double-tracking. As the transport capacity needs to be maximized after the double-tracking, the maximum train composition of 19 cars/train is applied after 2028.

The multiplication of number of trains in operation and the number of coaching vehicles in train composition was multiplied by the availability rate of existing rolling stock. It is divided by the ratio of BG to MG to calculate the gauge-wise number of vehicles required for passenger service.

The increased rate of rolling stock in BR was also applied to increase the train composition in the future.

It is necessary to consider the BR's overall rolling stock procurement plan, operation plan, and maintenance capacity to determine the necessity of procuring new rolling stock for passenger service. And a study of operational plans and vehicle schedules for BR's entire freight network is required to consider freight wagon reallocation from other sections.

JST tried to collect further information regarding the number of rolling stocks used in this section. However, JST cannot confirm the actual number of coaches used in this section for passenger service. It needs to be studied further in a future survey.

It may require implementing low-noise and low-vibration rolling stocks for environmental and social considerations. Individual measures are required for the vehicle for noise and vibration reduction after identifying the noise or vibration sources.

It is possible to consider implementing hybrid diesel locomotives for the reduction of noise emissions. BR has already procured diesel-electric locomotives in recent years, and the new procurement plan for MG locomotives is still ongoing.

Those items should be studied precisely in a future survey on the E/S stage.

Table 6.23 Number of Rolling Stocks required for Passenger Service

Type of rolling stock	2023	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39	'40	'41	'42	'43	'44	'45
Numbers of Passenger Coaches (cars)	16	16	16	16	16	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Passenger Train (trains)	17	18	18	19	20	35	36	37	38	39	41	42	43	44	46	47	49	50	50	50	50	50	50
Passenger Coaching vehicle total (cars)	389	315	334	334	352	371	770	792	814	836	858	902	924	946	968	1012	1034	1078	1100	1100	1100	1100	1100
Passenger Coaching vehicle BG (cars)	328	266	282	282	297	313	649	667	686	704	723	760	779	797	816	853	871	908	927	927	927	927	927
Passenger Coaching vehicle MG (cars)	61	49	52	52	55	58	121	125	128	132	135	142	145	149	152	159	163	170	173	173	173	173	173
Locomotive including freight trains (cars)	31	28	29	29	30	31	62	63	64	67	68	70	73	74	75	78	80	83	84	84	84	84	84
Locomotive BG (cars)	27	24	25	25	26	27	53	54	54	57	58	59	62	63	64	66	68	70	71	71	71	71	71
Locomotive MG (cars)	4	4	4	4	4	4	9	9	10	10	10	11	11	11	11	12	12	13	13	13	13	13	13

Note: Availability of coaching vehicles: 86.43%, Availability of locomotives: 81.47%
Source: JST

Table 6.24 Number of Rolling Stocks required for Freight Service

Type of rolling stock	2023	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39	'40	'41	'42	'43	'44	'45
Tank Wagon (34tonnes)	19	20	20	21	22	22	23	24	24	25	26	27	28	29	30	31	32	33	33	33	33	33	33
Bc Wagon (33tonnes)	6	6	6	6	7	411	420	429	437	445	454	463	472	480	489	497	506	515	515	515	515	515	515
Container (TEU)	343	345	348	352	356	361	365	369	374	379	385	390	395	399	402	406	410	414	414	414	414	414	414

Note: BR statistics defines and organizes the number of TEUs as the number of vehicles. The same description was used for this report.
Source: JST

6.11 Maintenance Plan

1) Human Resource Plan for Maintenance and Operation

JST calculated the number of O&M staff to be increased after the Project's completion. JST calculated the number of staff based on the number of existing staff per track km. The estimated number of staff is organized in the table below. It is estimated that 888 staffs need to be added to the O&M field.

Estimated Number of Staff to be increased by the Project in O&M Departments is shown in Table 6.25. The existing conditions are collected from the information book 2020.

Table 6.25 Estimated Number of Staff to be increased by the Project in O&M Departments

Department	Current No. of Staff	No. of Staff Per Km	Staff increased by the project
Engineering	6,165	1.39	240.75
Signal & tele communication	1,192	0.27	46.55
Mechanical	7,006	1.58	273.59
Electrical	1,342	0.30	52.41
Railway Police	2,397	0.54	93.60
Traffic	4,648	1.05	181.51
Total	22,750	5.13	888.41

Note: * Track km operated 4438.4km (2020) ** 173.32km will be added by the project
Source: JST

2) Increase in Maintenance and Human Resource Costs

JST estimated the increase in maintenance and human resource costs resulting from the project based on the Information Book 2020. The 412,958.3 thousand BDT of maintenance cost and 382,475.8 thousand BDT of human resource cost will be increased by the project.

The maintenance cost is calculated by multiplying the maintenance cost per km of the existing track length by the track length increased by the Project.

And annual employee cost is calculated by multiplying the existing employee by the estimated employee increased due to the Project.

The calculations are below.

The increase in maintenance cost:

- Total Maintenance Cost ÷ Track km operated = Maintenance cost/track km
  10,575,087 thousand BDT ÷ 4438.4km = 2,382.63 thousand BDT
- Maintenance cost/track km × Track km increased by project=the increase in maintenance cost
  2,382.63 thousand BDT × 173.32km = 412,958.3 thousand BDT
- The increase in human resource cost
  Existing employee cost per year × Increased staff = Increase in human resource cost
  430,716 BDT × 888 staff = 382,475.81 thousand BDT

Chapter 7 Applicability of Innovative Technologies

A series of 3 seminars listed below to discuss the selection of suitable innovative technology for the "Dual Gauge Double Line between Joydebpur-Ishurdi Section Project" (the Project) was held.

① **1st Seminar**: Introductory seminar on candidate innovative technologies held on August 1st, 2022.

② **2nd Seminar**: Screening seminar of candidate innovative technologies held on September 24th, 2022.

③ **3rd Seminar**: Final selection seminar held on December 11th, 2022.

7.1 Candidate Innovative Technologies

The 1st Seminar was organized by the Project Director of BR inviting 13 officials of diverse fields of BR such as technical development, infrastructure, track, signaling & telecommunications and maintenance. The purpose of the 1st Seminar was to introduce the participants to candidate Innovative technologies selected by the JICA Survey Team (the JST) for the Project.

Before proceeding to explain about the respective innovative technologies, the JST informed that incorporation of Innovative technology components is not a compulsory condition in line with the comments given by the JICA Tokyo and the JICA Dhaka Office on July 13th and 25th, 2022 respectively but a general guidance applied for Yen Loan assisted projects, while its application will have benefits for the railway operation of BR.

Among a wide range of choices of Innovative technologies, the 8 technologies listed below were selected as candidates considering the simplistic setup of the Project.

① **Reinforced Railroad with Rigid Facing Method Embankment (RRR Embankment)**

② **Direct Rail Fastener (DRF)**

③ **Fiber-reinforced Foamed Urethane Synthetic Sleeper (FFU Synthetic Sleeper) on Bridge and Turn-out Sections**

④ **Automatic Train Protection (ATP) Specifically Low Cost ATS-DX**

⑤ **Japanese Construction Manual in the Vicinity of Train Operation in Service**

⑥ **Weathering Steel for Bridges**

⑦ **Head Hardened Rails (HHR)**

⑧ **On-site Gas Heat Pressure Welding Machine (GHPW Machine) for Long Rail System**

The JST set 3 steps of conditions required as follows to be complied with before selecting the innovative technologies.

- **Condition 1 (Recipient Side Conditions)**: Conditions to motivate the application such as site conditions, scheduling, and benefits for the Project owner.
- **Condition 2 (Provider Side Conditions)**: Conditions to draw attention of the technology provider.
- **Condition 3 (Rationales)**: Conditions to balance the advantages and disadvantages of the respective technology.

The presentation at the 1st Seminar just scratched the surface of the respective technologies due to time constraints and the details including cost and engineering matters were discussed at the 2nd and the 3rd Seminar only for those technologies that drew BR's attention. Hereunder are the explanations made at the 1st Seminar.

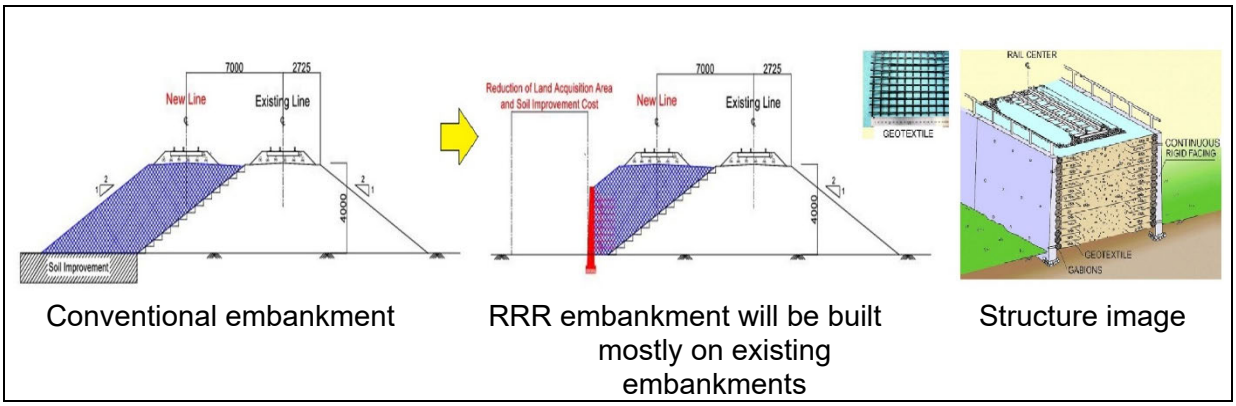
In order to save time, the dialogue at the 1st Seminar was carried out based on the answers to the questionnaire (Appendix 7-2) distributed to BR in advance.

7.1.1 ① RRR Embankment

This is a type of reinforced embankment on which railway track is built. While the Terre Armée, developed by the French in 1963 is world famous in this category and widely used for road structures also in Japan, it is not used for railway structures due to poor seismic performance. Therefore, the Terre Armée is assumed to be not suitable for earthquake prone countries like Bangladesh.

On the other hand, the RRR embankment developed in the early 1990s by the Railway Technical Research Institute (RTRI) of the Japanese National Railways (JNR) is robust against earthquakes. Its high seismic performance was dramatically proved when a very strong earthquake hit the Osaka and Kobe area and about 6,500 people were killed in 1995. The RRR embankment was still standing with almost no damage while surrounding houses collapsed. Here are the major advantages of the RRR embankment.

- **Small land acquisition scale**: The land acquisition scale can be minimized because the sloped base area on both sides of conventional embankments is not necessary thanks to vertical walls.
- **Light foundation work**: Since the majority of the infrastructure of the Project are embankments on wetland areas, RRR embankments are expected to lighten the foundation building work on the wetland area thanks to the solid structure.
- **Solid track bed**: Although it is not relevant to the Project at the moment, RRR embankments are capable of supporting "Maintenance free track" such as "Slab Track" which requires a solid track bed.



Source: RTRI modified by the JST

Figure 7.1 RRR Embankment

The 3 conditions for compliance requirement before selecting this technology are as follows.

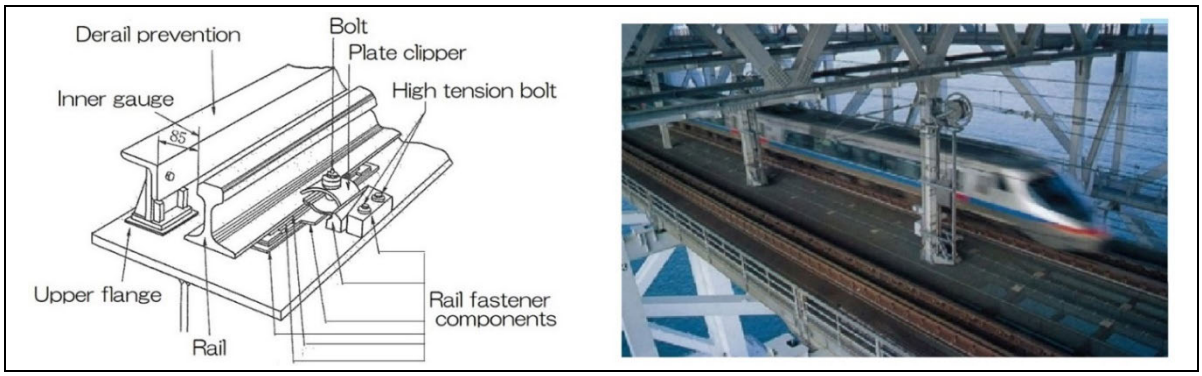
- **Condition 1 (Recipient side conditions)**: If embankment height is over 4m and Right of Way (ROW) width is not sufficient for double track structure construction, cost performance becomes evident.
- **Condition 2 (Provider side conditions)**: Contract package should be sizable enough, construction site security of long distance & isolated location should be secured and partnerships with capable local contractors should be formulated in order to promote technology provider participation.
- **Condition 3 (Rationales)**: Pros and cons should be assessed in advance in which advantages are land acquisition scale saving, socio-environmental impact alleviation, ground improvement cost saving, solid ground capable of laying maintenance free track if needed and overseas market opportunity for local contractors if technology transfer is successful, while the disadvantage is a unit cost hike despite land acquisition cost saving.

7.1.2 ② Direct Rail Fastener (DRF)

This is a type of rail fastener specifically developed for railway track to be placed on steel bridges.

The advantage of DRF is cost savings thanks to the simple installation work process which doesn't require sleepers and accordingly contributes to a shortened construction schedule.

DRF is already planned to be used on the Jamuna Railway Bridge Construction Project. Compliance of DRF for heavy train traffic on broad gauge track has already been confirmed and it is ready for production now.



Source: JST

Figure 7.2 Direct Rail Fastener (DRF)

The 3 conditions for compliance requirement before selecting this technology are as follows.

- **Condition 1 (Recipient side conditions)**: Only applicable for steel type bridges.
- **Condition 2 (Provider side conditions)**: Contract package should be formulated sizable enough in such a way as integrating DRF component into the steel bridge construction contract in order to promote technology provider participation.
- **Condition 3 (Rationales)**: Pros and cons should be assessed in advance in which advantages are cost reduction thanks to a simple working process and schedule reduction and larger local contractor involvement if technology transfer is successful through the Jamuna Railway Bridge Construction Project, while disadvantages are louder noise and no availability of local production.

7.1.3 ③ FFU Synthetic Sleeper

This is a type of track sleeper developed by the RTRI in 1979 and similar products made by other countries than Japan have come on the railway track market later.

While the sleeper material for general sections is Reinforced Concrete (RC) or Pre-stressed Concrete (PC), synthetic sleepers are used for particular sections such as bridges, crossings and turn-outs where the sleeper length varies depending on site conditions and sleeper weight must be light. The advantage of synthetic sleepers is that the length and the fastener position can be adjusted depending on site conditions in the same way as for wooden sleepers.

The durability of synthetic sleepers is much higher and the weight is lighter than wooden sleepers which contributes to easy handling on site compared to concrete sleepers. Numerically, the lifespan of synthetic sleepers is at least 50 years while that of wooden sleepers is about 10 years, and the unit weight of synthetic sleepers is 0.7 to 0.8g/cm^3 while that of wooden sleepers is 0.6 to 0.7 g/cm^3. It means that the Life Cycle Cost (LCC) will be reduced by saving maintenance costs and sleeper replacement costs by introducing FFU synthetic sleeper.

FFU type synthetic sleeper recommended in this survey has advantages in its light-weight and long life use due to the patented material and structure which is different from other types of low cost synthetic sleeper.

Source: Sekisui Chemical Company, Limited modified by JST

Figure 7.3 FFU Synthetic Sleepers

The 3 conditions for compliance requirement before selecting this technology are as follows.

- **Condition 1 (Recipient side conditions)**: Cost reduction policy of LCC rather than initial cost should be agreed.
- **Condition 2 (Provider side conditions)**: Experienced suppliers capable of complying with diverse design requirements in terms of heavy train load, broad gauge track, and dual gauge track shall be identified and local plant shall be set up in case a large quantity is necessary.
- **Condition 3 (Rationales)**: Pros and cons should be assessed in advance in which advantages are LCC saving by cutting maintenance and replacement costs, high durability and easy handling due to light weight, while disadvantages are high initial cost of 5 to 6 times of wooden sleepers, requirement of wearing gloves when handling and unavailability of local production so far.

7.1.4 ④ ATS-DX Type ATP

Automatic Train Stop (ATS) is equivalent to the European Train Control System level 1 (ETCS level 1) which controls train speed for safe operation.

ATS assists the train driver to run the train with optimum speed by guidance supplied by an onboard device to which information is transmitted by a “Transponder” which is equivalent to the “Valise” of ETCS level 1. It shall be noted that ATS came in prior to ETCS level 1 and the cost is lower due to its simple function and the human interface of the device.

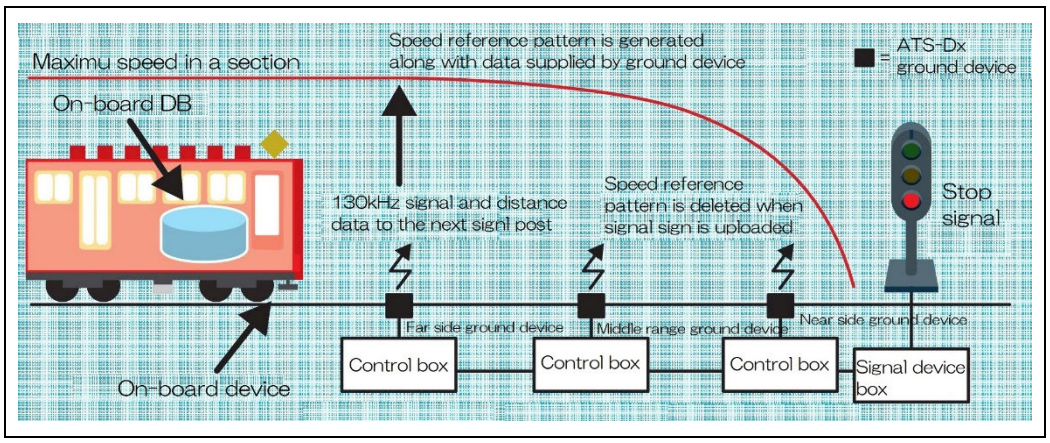
If the train driver doesn’t observe the guidance, the train will be stopped automatically so that accidents can be avoided while achieving punctual train operation by running at optimum speed. The function varies depending on the ATS version and speed can be controlled automatically in advanced versions of ATS such as ATS-P.

As a countermeasure in the aftermath of the train crash accident that killed 107 people near Amagasaki Station on the Fukuchiyama Line in 2005, the Ministry of Land Infrastructure and Transportation (MLIT) ordered all railway operators to deploy ATS-P or its equivalent, by which information is transmitted digitally.

However, since this system was expensive, some railway operators could not afford to comply with the Ministry’s order. Then, more economical derivative systems were developed such as ATS-DN for

JR Hokkaido and ATS-DK for JR Kyusyu. The cost is about 1/3 of ATS-P. These systems are collectively called ATS-DX and this is the system proposed for BR.

However, the JST must have dropped this proposal acknowledging that it is too early for the time being in Bangladesh. A track circuit system to detect train location is necessary before introducing this system and it is difficult for dual gauge track to be functional in terms of the risk of malfunctioning and the high standard of maintenance work. It is therefore expected to be introduced when the broad gauge track network is ready for service.



Source: JR Hokkaido modified by JST

Figure 7.4 ATS-DX Type ATP

The 3 conditions for compliance requirement before selecting this technology are as follows.

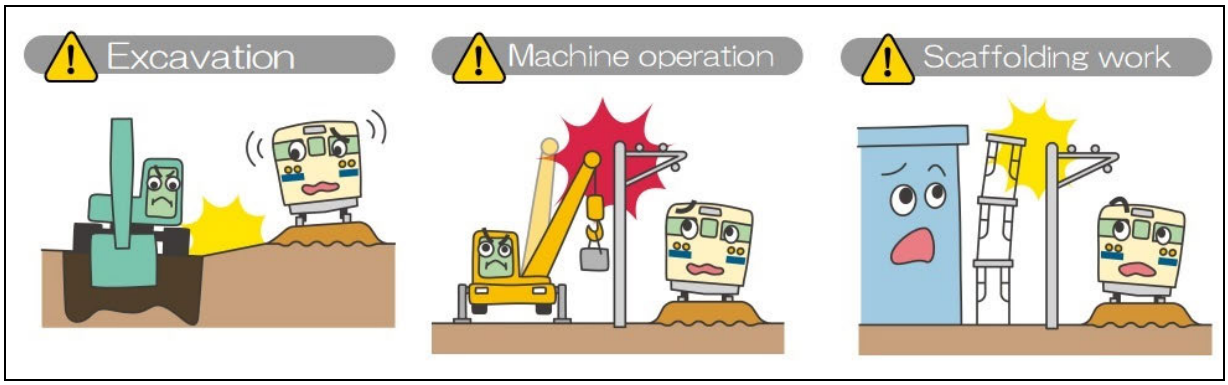
- **Condition 1 (Recipient side conditions)**: It should be agreed at BR that the current signaling system is not satisfactory, the Operation and Maintenance (O&M) capability of BR for the new system is ensured, application to the entire section (378km) of the Project instead of a part (170km) should be agreed and drastic transportation capacity increase as well as drastic safety & steady operation should become necessary.
- **Condition 2 (Provider side conditions)**: Cooperation of system operators such as JR Hokkaido for ATS-DN and JR Kyusyu for ATS-DK as well as system developers which is the RTRI should be available.
- **Condition 3 (Rationales)**: Pros and cons should be assessed in advance in which advantages are low cost of about 1/3 of full-scale ATP such as ATS-P and ETCS level 1 and drastic increase of transportation capacity as well as train operation safety, while disadvantages are high cost compared to the current system due to procurement of equipment such as track circuits, signal posts, data transmission cables, ground and on-board devices, necessity of a driver training program and unavailability of partial application to the Project.

7.1.5 ⑤ Japanese Construction Work Manual

In a densely populated country like Japan, it is difficult to secure wide land space for construction work, particularly in urban areas. Therefore, a designated construction manual was established based

on experiences acquired from past successes and failures by which construction work can be carried out safely and efficiently in narrow spaces without disturbing commercial train operations.

Although most of the railway alignment of the Project is located within swampy or wetland areas, this manual will be useful for urban areas where temporary land acquisition for construction work may be difficult. If applied, the construction schedule can be reduced and temporary land use costs can be saved. As a whole, construction costs can be reduced.



Source: Ministry of Land, Infrastructure, Transportation and Tourism modified by JST

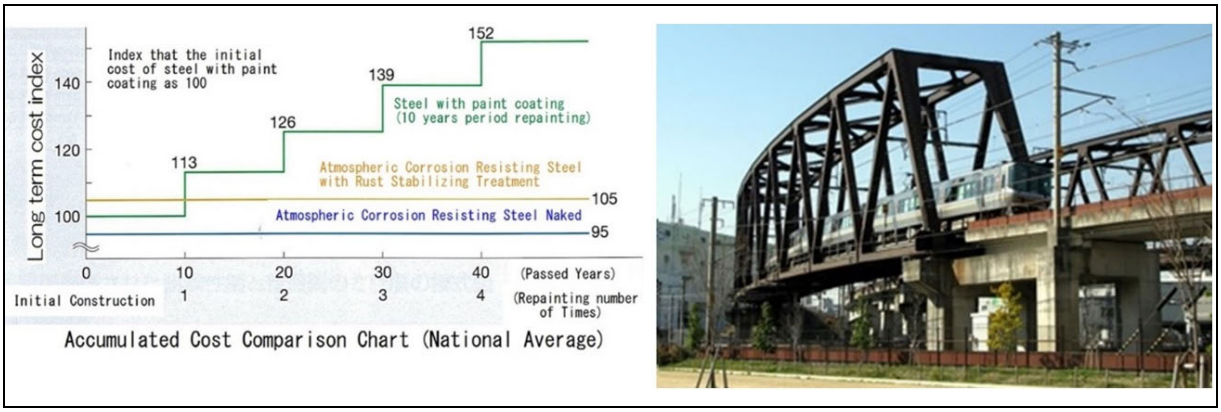
Figure 7.5 Japanese Construction Work Manual

The 3 conditions for compliance requirement before selecting this technology are as follows.

- **Condition 1 (Recipient side conditions)**: In case the current safety manual is either not satisfactory in terms of construction safety assurance or simply doesn't exist in Bangladesh, it can be replaced by a new manual and if the ROW width of the Project is not sufficient for double track infrastructure construction, this should be useful.
- **Condition 2 (Provider side conditions)**: A worker training program should be implemented for the manual to be effective.
- **Condition 3 (Rationales)**: Pros and cons should be assessed in advance in which advantages are temporary land acquisition scale saving, socio-environmental impact alleviation, train operation profit loss reduction during construction and application to other BR lines particularly in urban areas if technology transfer is successful, while the disadvantage is the necessity of a worker training program to learn how to use the new manual.

7.1.6 ⑥ Weathering Steel for Bridges

The advantages of steel bridges in comparison with RC and PC bridges are rapid construction, easier quality control and recyclable bridge members after use, but disadvantage is higher maintenance costs specifically repainting work aside from loud noise and vibration (N&V). Weathering steel will contribute to reduce the maintenance cost as it is already acknowledged on the Jamuna Railway Bridge Construction Project.



Source: Source: Nippon Steel Co., Ltd. modified by JST

Figure 7.6 Weathering Steel for Bridges

The 3 conditions for compliance requirement before selecting this technology are as follows.

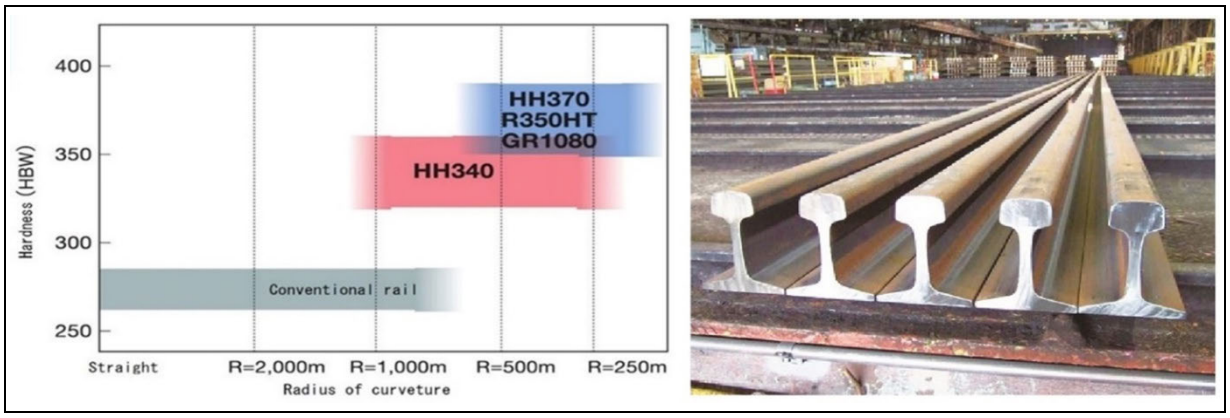
- **Condition 1 (Recipient side conditions)**: A sizable number of new and replacement bridges should be identified and steel structures should be selected for bridge construction to make the advantage evident.
- **Condition 2 (Provider side conditions)**: A sizable steel bridge contract package should be formulated by combining multiple bridge components into one package instead of contract packaging by section which includes double tracking work and bridge construction work in order to attract technology providers.
- **Condition 3 (Rationales)**: Pros and cons should be assessed in advance in which advantages are schedule reduction by rapid construction, O&M cost reduction particularly repainting work, larger local contractor involvement if technology transfer is successful through the Jamuna Railway Bridge Construction Project and bridge components are recyclable, while disadvantages are louder noise, higher cost compared to conventional steel bridges and unavailability of local production.

7.1.7 ⑦ Head Hardened Rails (HHR)

This is a type of rail is usually used for steep slope sections and sharp curved sections, but it can also be used for general sections, particularly when frequent maintenance work is not expected.

The head part of the rail is harder and more durable than other parts of the rail so that attrition by rolling action of train wheel tire is less, rail replacement period is longer and LCC is smaller compared to conventional rail.

Use of HHR is recommended considering the fact that the maintenance cost of the Project will not be funded by JICA, while the initial cost will be, although BR has to allocate extra budget for the HHR.



Source: Source: Nippon Steel Corporation modified by JST

Figure 7.7 Head Hardened Rails (HHR)

The 3 conditions for compliance requirement before selecting this technology are as follows.

- **Condition 1 (Recipient side conditions)**: Cost reduction policy should be placed on LCC rather than initial cost. .
- **Condition 2 (Provider side conditions)**: A sizable HHR work contract package should be formulated by combining multiple HHR work components into one package instead of contract packaging by section which includes HHR work and embankment work to attract technology providers.
- **Condition 3 (Rationales)**: Pros and cons should be assessed in advance in which the advantage is long life use with less frequency of rail replacement, while disadvantages are higher cost compared to conventional rail and unavailability of local production.

7.1.8 ⑧ On-site GHPW Machine

This is a method to connect standard size rails to each other.

This is not actually a welding method, because the heating temperature is not as high as welding, instead the two rails to be connected will be pressed together. Since the rail faces are half melted so that the physical nature of the steel won't change and the inner part of the rails come out to the surface by pressing until invisible inner flaws due to rust or oil stains which constitute weak spots will be surfaced. Once sufficient half melted steel comes out at the connection point, the excess steel will be removed by a sliding action of the machine before the rail cools down and becomes stiff. After cooling down, the surface is grinded for finishing.

The advantage of this connecting method is that the connection point is flawless. Therefore, high durability, particularly fatigue strength against repeated loading is ensured.

This method is usually employed at a long rail factory for rolling out the maximum transportable size of long rail units, because the connecting machine is not transportable. But the units must be connected to each other on site again with the same method in order to keep the connection quality consistent.

Thanks to the development of a compact connecting machine, this has become possible. This machine

doesn't require a large electricity power supply unlike other on-site welding machines such as Enclosed Welding and Flash Pad Welding. Furthermore, it doesn't require much training for handling, because the heating, pressing and sliding actions are all automatic.

Source: JFE Technos Co., Ltd. modified by JST

Figure 7.8 On-site GHPW Machine

The 3 conditions for compliance requirement before selecting this technology are as follows.

- **Condition 1 (Recipient side conditions)**: Long rail system with high connecting quality should be required.
- **Condition 2 (Provider side conditions)**: The welding work component should be integrated into the long rail system supply contract in order to attract technology providers.
- **Condition 3 (Rationales)**: Pros and cons should be assessed in advance in which advantages are connecting point strength particularly fatigue strength comparable to brand new rails, easy welding flaw detection by ocular inspection, no need of a large electricity power supply and creation of overseas market opportunities in case technology transfer is successful, while disadvantages are high cost of the machine, not as handy as conventional welding machines such as Flash Butt and Thermite and necessity of a worker training program for the new machine operation.

7.2 Response to Proposed Innovative Technologies

Undisclosed

Undisclosed

Undisclosed

7.3 Narrowing Down of Candidate Technologies

Undisclosed

Undisclosed

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7.4 Last Discussion for Final Decision

Undisclosed

Undisclosed

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7.5 BR Decision after the Last Seminar

A total of 11 technologies and subjects listed below were discussed throughout the series of 3 seminars. The JST urged BR to inform its final decision with the letter of Ref. No. JIDLP-PS-014 dated December 15, 2022.

① **RRR Embankment**
② **DRF**
③ **FFU Synthetic Sleeper**
④ **ATP/ ATS-DX**
⑤ **Japanese Construction Manual**
⑥ **Weathering Steel**
⑦ **HHR**
⑧ **On-site GHPW Machine**
⑨ **Automatic Level Crossing**
⑩ **USP**
⑪ **Track Structure on Bridge**

7.5.1 BR Decision

BR has selected the following innovative technologies to be considered for adoption in the Project.

① **RRR Embankment**: Will be applied for embankments in densely populated urban areas.
② **Direct Rail Fastener**: Will be applied for track on steel bridge sections.
③ **Synthetic Sleeper (FFU)**: Will be applied for track sections with turn-outs, crossings, and steel bridges.
⑥ **Weathering Steel for Bridges**: Will be applied for steel bridge design.
⑦ **Head Hardened Rail (HHR)**: Will be applied for track sections with sharp curves (R<600m) and turn-outs.

Cost increase due to the application of innovative technologies is incorporated in the cost estimation in this survey, although the impact is minimal while the LCC will be decreased in exchange for the capital cost increase.

Chapter 8 Project Cost Estimation

This chapter is kept undisclosed.

Chapter 9 Project Implementation Plan

This chapter is kept undisclosed.

Chapter 10 Project Evaluation

First of all, the economic and financial analysis of the Study is conducted based on the standards and methods specified in the "IRR Calculation Manual" issued by JICA in September 2017.

Then, the Development Project Proforma/Proposal (DPP) was prepared in October 2018, and the calculation result is as follows. The following calculation was conducted with a discount factor of 15%.

Table 10.1 Economic and Financial Analysis Results in DPP

Net Present Value (NPV)	Financial	4,723 million BDT
	Economic	49,741 million BDT
Benefit-Cost Ratio (BCR)	Financial	1.06: 1
	Economic	1.55: 1
Internal Rate of Return (IRR)	Financial	15.7%
	Economic	19.8%

Source: DPP

The result of the Study was updated based on the revised demand forecast, train operations planning, and cost estimation.

10.1 Financial Analysis

10.1.1 Review of the Existing Studies

The two studies below are the main references in the Study's calculation. Therefore, the preconditions and methodologies are updated from these two studies.

1. The ADB F/S in February 2019 (called the "Prior F/S")
2. The F/S of the Jamuna Railway Bridge Construction Project (called the "Jamuna Bridge F/S")

The Prior F/S is referred to as the existing study of the same project while the Jamuna Bridge F/S is referred to as a similar railway project financed by JICA in Bangladesh.

(1) The ADB F/S (The Prior F/S)

1) Preconditions and Methodology

The initial Prior F/S was conducted in June 2015 and revised in February 2019. In the latest study, the project-specific assumptions of the Prior F/S were set as follows.

1. Scenarios

- Without-Project case
  - Jamuna Railway Bridge will be constructed simultaneously in 2025.
- With-project case
  - Ishurdi - Joydebpur line section with double-track and dual gauge will be completed in 2025.

2. Preconditions

The preconditions of the Prior F/S are shown below.

Table 10.2 Preconditions of Financial Analysis in the Prior F/S

Parameters	Assumptions
Price Level	2018
Construction Period (including Detailed Design(D/D))	5 years
Opening Year	2023
Price Escalation	5 %/year
Analysis Period	30 years
Contingency	N/A
Interest during Construction (IDC) for ODA Loan	N/A
Front End Fee	N/A

Source: The Prior F/S

The capital cost (financial cost) was 141,267 million BDT, which was uniquely divided into the initial five years in the cash flow, and the analysis considered the subsidy of 52.5% of the revenue from the Government. Furthermore, 75% of the capital cost was included as the residual value in the cash flow after 30 years of completion.

2) Calculation Results

1. Calculation Results

The calculated results of the financial analysis are shown below. The calculated FIRR was more than 15 % and the project was concluded as viable in the Study.

Table 10.3 Financial Analysis Results in the Prior F/S

Items	Results
NPV @ 15% discount rate	47,230 Lakh BDT
NPV @ 18% discount rate	-152,495 Lakh BDT
B/C @ 15% discount rate	1.06
B/C @ 18% discount rate	0.79
Financial Internal Return Rate (FIRR)	15.7 %

Source: The Prior F/S

2. Weighted Average Cost of Capital (WACC)

The Weighted Average Cost of Capital (WACC) was calculated to assess the target rate of return. The WACC was 3.3%, which was smaller than FIRR, 15.7%. This value of WACC supported the cost of liability, and the cost of equity and satisfied the creditor and the equity shareholder.

(2) The F/S of the Jamuna Railway Bridge Construction Project (The Jamuna Bridge F/S)

1) Preconditions and Methodology

This project is to construct a new railway bridge of double tracks with a dual gauge parallel to the existing Jamuna Bridge. Therefore, the procurement of new rolling stocks was not considered a part of the Study.

1. Scenario

- Without-Project case
  - The construction of the Dual Gauge (DG) Line between the Joydebpur-Ishurdi Section of Bangladesh Railway (except for the new bridge section)
  - The procurement of new rolling stocks sufficient to meet an increase in railway demand after the opening of the new bridge
  - The Padma Bridge Railway Link Project, which is a new railway line construction connecting Dhaka (via Padma Bridge) with Jessore, is planned in single line scheme
  - The Khulna - Mongla Port Railway Line Project, which will provide a new and short-cut railway route to Dhaka
- With-project case
  - Ishurdi-Joydebpur line section with double-track and dual gauge will be completed in 2025. The line capacity after the completion will be lifted to 88 train sets per day. However, since converted traffic to railway reached the capacity in 2040, the number of coaches per train will be increased to carry 1200 passengers per train set.
  - Widened the existing Jamuna Multipurpose Bridge (4 lanes) reaches theoretical capacity in 2047. The existing Jamuna Multipurpose Bridge duplication is not included in the project assessment.

2. Preconditions

The preconditions of the Jamuna Bridge F/S are shown below. In the Study, the residual value of infrastructure was considered in the cash flow analysis (the infrastructure life is 100 years and the evaluation method of the residual value is the straight depreciation method).

It was also considered that BR paid the utility charge to use the railway track of the existing Jamuna Multipurpose Bridge owner, Bangabandhu Bridge Authority (BBA), and this amounts to 5 million

BDT per year, which would not be necessary after the completion.

Table 10.4 Preconditions of Financial Analysis in the Jamuna Bridge F/S

Parameters	Assumptions
Price Level	2017
Evaluation Period (including Detailed Design(D/D))	32 years (3 years for D/D (2017-2019) and 30 years after construction)
Opening Year	2023
Price Escalation	FC: 1.7 % LC: 4.65 %
Contingency	Construction: 0.10 % Consultant: 0.05 %
Interest during Construction (IDC) for ODA Loan	0.2 %
Front End Fee	2017

Source: The Jamuna Bridge F/S

The financial cost was calculated at 147,121 million JPY.

Regarding railway infrastructure O&M costs, 32.0 million JPY (22.9 million BDT) was included as annual maintenance costs for five years after the completion of the bridge.

2) Calculation Results (including sensitivity analysis results)

The target rate of return was set at 1.0% since the Japanese Government was supposed to finance the project and its loan interest is 1.0%.

The Financial IRR was 2.5%. To reach the opportunity cost (1.0%) of capital, a subsidy was not required. The net present value (NPV) was minus 66.9 billion JPY in 2017 price at a discount rate of 12% per annum.

10.1.2 Financial Analysis in the Study

Undisclosed

Undisclosed

Undisclosed

Undisclosed

Undisclosed

Undisclosed

10.2 Economic Analysis

10.2.1 Review of the Existing Studies

(1) The ADB F/S (The Prior F/S)

1) Preconditions and Methodology

The preconditions of the economic analysis of the Prior F/S are shown below. The conversion factor from financial to economic costs was uniquely set at 0.8 in the Study.

Table 10.5 Economic and Financial Analysis A Calculated in the Prior F/S

Parameters	Assumptions
Price Level	2018
Construction Period (including Detailed Design(D/D))	5 years
Opening Year	August 2023
Analysis Period	30 years
Conversion Factor (from financial to economic value)	0.8

Source: The Prior F/S

In the Prior F/S, economic benefits were categorized into passenger and freight transport, as shown below. Since the calculated economic benefits correspond to the benefits in the JICA IRR Calculation Manual, the same economic benefits are updated in the Study.

Table 10.6 Economic Benefits Calculated in the Prior F/S

Passenger Transport	Freight Transport
Vehicle Operation Cost (VOC) Savings of Buses	VOC Savings of Trucks
Savings in road accidents reduction costs	Savings of road maintenance caused by trucks
Travel Time Cost (TTC) Savings (all passengers)	Savings in road accidents reduction costs
Savings in GHG emissions	Savings in GHG emissions

Source: The Prior F/S

2) Calculation Results (including sensitivity analysis results)

1. Calculation Results

The calculated results of the economic analysis are shown below. The discount rate of 12% was set as a threshold referring to the ADB guideline, so the Project was reckoned as economically viable.

Table 10.7 Economic Analysis Results in the Prior F/S

Items	Results
NPV @ 15% discount rate	497,415 Lakh BDT
NPV @ 18% discount rate	-19,637 Lakh BDT
B/C @ 15% discount rate	1.55
B/C @ 18% discount rate	0.97
Economic Internal Return Rate (EIRR)	19.7 %

Source: The Prior F/S

2. Sensitivity Analysis

The sensitivity analysis of the economic analysis for the above results was conducted as follows.

Table 10.8 Sensitivity Analysis for Economic Analysis in the Prior F/S

Items	Results
Base Case	19.7 %
Capital Cost +10%	18.9 %
a) Passenger Cost -10%	19.5 %
b) Passenger Benefits -10%	19.8 %
c) Freight Cost -10%	18.8 %
d) Freight Benefits -10%	18.6 %
a) + b) + c) + d)	18.6 %

Source: The Prior F/S

As seen from the results, even in the worst case, the required EIRR by the Bangladesh Government (12%) was achieved, so the project was confirmed as economically viable.

(2) The F/S of the Jamuna Railway Bridge Construction Project

1) Preconditions and Methodology

1. Preconditions

The preconditions of the Jamuna Bridge F/S are as shown below. The conversion factor from financial to economic costs was uniquely set at 0.8 in the Study.

Table 10.9 Preconditions of Financial Analysis Calculated in the Prior F/S

Parameters	Assumptions
Price Level	2017
Construction Period (including Detailed Design(D/D))	32 years (3 years for D/D (2017-2019) and 30 years after construction)
Opening Year	November 2023
Conversion Factor	0.8

Source: The Jamuna Bridge F/S

2. Economic Benefits

Applied economic benefits for the Jamuna Bridge F/S are listed as follows. Savings in goods' damage were not included since the length of the bridge section is short to specify the value of goods' damage.

- Saving in Travel Time Costs (TTC) (both passenger and freight)
- Savings in Vehicle Operation Costs (VOC) (both passenger and freight)
- Savings in O&M cost of roads (both passenger and freight)
- Savings in accident reduction (both passenger and freight)

Since vehicle running speed is required to calculate the TTC, the delay-flow relationship applied in the Prior F/S report in May 2015 was also adopted in the Study.

The data on the VOC costs was referred from the Road Highway Department (RHD) and updated by the JST in the Study.

3. Economic Costs

As capital costs, the new bridge cost was included, which was converted from the financial cost with a conversion factor of 0.8. The economic cost was calculated at 107,335 million JPY, about 73% of the financial cost, 147,121 million JPY.

2) Calculation Results (including sensitivity analysis results)

1. Calculation Results

A discount rate of 12% was used, following ADB's Guidelines for Economic Analysis. The Economic IRR was 13.3% and the Economic Net Present Value (NPV) was 10.9 million JP with a 12% discount rate.

2. Sensitivity Analysis

When the cost increases by 5%, 10%, and 15%, the value of EIRR is 12.9%, 12.6%, and 12.2%.

10.2.2 Economic Analysis in the Study

Undisclosed

Undisclosed

Undisclosed

Undisclosed

Undisclosed

Undisclosed

Undisclosed

10.3 Consideration of Alternative Plan

Undisclosed

Undisclosed

10.4 GHG Emission Reduction Amount Calculated by the JICA Climate FIT

The GHG emission reduction amount is calculated by the JICA Climate FIT, as explained in 10.2.2. GHG emission reductions will be realized through both passenger and freight modal shifts from motor vehicles to railways. The emission is calculated as "Baseline emission" – "Project emission" and the preconditions for the calculation are as follows.

Table 10.10 Preconditions for the Calculation by Passenger and Freight

Data/Source	Jamuna Bridge F/S	The Study	Remarks
Project emission (passenger transportation)			
Fuel consumption of passenger railway (diesel)	11,809 t/year	33,325t/year	Calculating by the ratio of passenger-km/year
The CO_2 emission factor of diesel fuel	74.1 t-CO_2/TJ	74.1 t-CO_2/TJ	The same value is applied.
The net calorific value of diesel fuel	43.0 TJ/Gg	43.0 TJ/Gg	The same value is applied.

Data/Source	Jamuna Bridge F/S	The Study	Remarks
Project emission (freight transportation)			
Fuel consumption of freight railway (diesel)	5,061 t/year	23,163 t/year	Calculating by the ratio of ton-km/year
The CO_2 emission factor of diesel fuel	74.1 t-CO_2/TJ	74.1 t-CO_2/TJ	The same value is applied.
The net calorific value of diesel fuel	43.0 TJ/Gg	43.0 TJ/Gg	The same value is applied.

Source: JICA Climate-FIT (Mitigation) Examples of GHG emission reductions estimation

Based on the preconditions and distributed calculation sheets by JICA, estimated GHG emission reductions are calculated as follows.

Table 10.11 Estimated GHG Emission Reduction by Passenger and Freight

(Unit: t-CO_2/year)

	2030	2035	2040
1. Passenger			
Emission reduction	130,062	152,960	179,159
Baseline emission	221,174	259,035	302,507
Project emission	91,112	106,075	123,348
2. Freight			
Emission reduction	76,067	83,573	98,132
Baseline emission	158,543	174,851	196,728
Project emission	82,467	91,278	98,596
3. Total			
Emission reduction	206,129	236,533	277,291

Source: JST

10.5 Project Evaluation Indicators

10.5.1 Quantitative Evaluation Indicators

(1) Operation Indicators

The expected operation indicators are listed in the following table as per the requirement from the JICA guideline.

Table 10.12 Operation Indicators of the Project

#	Operation Indicators	2020	2024	2030	2031	2032	2033	2034	2035	2040
1	Number of train operations (No. per day)	25	23	52	55	56	57	59	60	68
2	Number of train cars per train set	13	16	19	19	19	19	19	19	19
3	Train operation kilometer (million train-km/year)	20.6	23.3	62.5	66.1	67.3	68.5	70.9	72.2	81.8

Source: JST

(2) Evaluation Indicators

The expected evaluation indicators are listed in the following table as per the requirement from the JICA guideline.

Table 10.13 Evaluation Indicators of the Project

#	Evaluation Indicators	2020	2024	2030	2031	2032	2033	2034	2035	2040
1	Travel time from Joydebpur to Ishurdi (hour)	6.0		4.0 to 4.5						
2	Passenger fare revenue (million BDT/year)	817	744	2,089	2,153	2,220	2,288	2,359	2,432	2,828
3	Freight transport charge (million BDT/year)	654	768	3,117	3,182	3,249	3,317	3,376	3,436	3,716
4	Maximum train operation speed (km/h)	East Side : 75km/h West Side : 95km/h		Passenger : 120km/h (Broad Guage), 100km/h (Meter Guage) Freight : 80km/h (Broad & Meter Guage)						
5	Scheduled speed (km/h)	27.4 (for both passenger and freight)		44 (for both passenger and freight)						
6	Passenger kilometer (million pax-kilometer/year)	967	882	2,476	2,552	2,630	2,711	2,795	2,883	3,352
7	Freight kilometer (million ton-kilometer/year)	30.2	327	1,327	1,354	1,383	1,412	1,463	1,463	1,582

Source: JST

10.5.2 Qualitative Evaluation Indicators

The qualitative impacts expected from the project are described based on the discourse obtained in the Focal Group Discussion (FGD) conducted as a part of environmental and social considerations in the Study and the results of interviews with BR staff.

Table 10.14 Qualitative Impacts of The Study

Indicators	Details
Improvement of traffic conditions	- Traffic congestion will be mitigated by the modal shift from road to railway transport.
Improvement of service level	- The increase in the number of train operations will make it easier to use the railway, whereas previously it was difficult to purchase tickets without making reservations in advance. - Since the current capacity of the line between Joydebpur and Ishurdi is less than the actual demand, more people will use the railway once the Project is completed.
Improvement of safety conditions	- The number of road traffic accidents is to be reduced as a result of the modal shift from road to railway transport. - On the other hand, there is concern that the increase in the number of train operations and the speed of operation due to the capacity increase by the Project will increase the number of railway accidents (by the Project, at some level crossing, new warning equipment (lights and sounds) will be installed to alert passing vehicles and persons, which is not currently available, to reduce the number of accidents at level crossings).
Revitalization of the local economy	- More passengers will increase the flow of people, which will increase business opportunities. - A better transportation system will enable to transfer of daily projects, including agriculture, more conveniently.
Direct and indirect job creation during construction and operation	- A large number of respondents expressed interest in the construction activities generated by the implementation of the Project. On the other hand, the majority of women have not expressed interest in engaging in construction activities. - The increase in railway will be pleased by cab and rickshaw drivers near stations, who will see an increase in customers.
Social and economic impacts, including gender equality and poverty reduction	- Measures such as women-only ticket booths, nursing and worship spaces, and matching the height of platforms and trains boarding areas in consideration of the elderly and disabled have been implemented and will be introduced at newly built stations. - Since BR is trying to introduce one women-only car per train set, the train service will become even more user-friendly for women as the number of trains increases.

Source: JST

Chapter 11 Operation and Management System

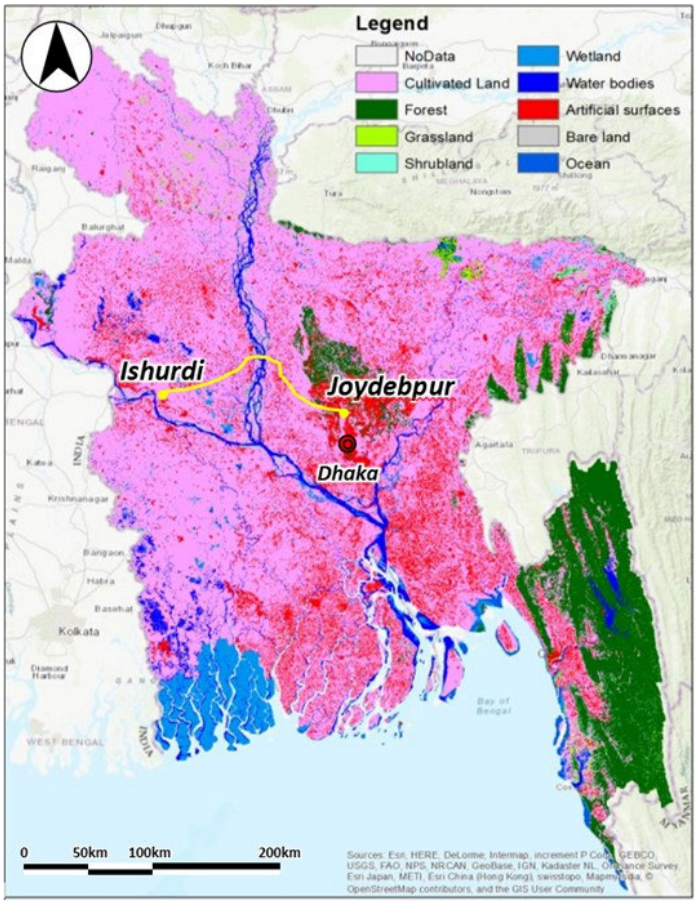
This chapter is kept undisclosed.

Chapter 12 Environmental and Social Consideration

12.1 Current Condition of Natural and Social Environment

12.1.1 Land Use

The railway alignment crosses mostly agricultural land crisscrossed by rivers/canals with loamy soils predominantly on the highlands and clayey soils on the lowlands. The majority of the Project's social impact area (a land corridor of 100 m on either side of the train tracks extending for 17 km) land use is agriculture (2,614.72 ha), forest (29.26 ha), rail stations (17.14 ha), settlements (653.70 ha) including educational instructions (school and madrasas), places of worship, graveyards, post offices, industries, etc., surface water bodies in streams, ponds, and rivers (162.70 ha) totaling approximately 3,477.52 ha.



Source: Global Land Cover by National Mapping Organizations (GLCNMO) – ISCGM

Figure 12.1 Land Use Map along the Rail Line in Bangladesh

Joydebpur – Bangabandhu Setu East	
	
Joydebpur St.	Joydebpur-Mouchak
	
Mouchak St.	High-Tech City
	
Mirzapur	Mohera- Mosjid
	
Elenga	Bangabandhu Setu East

Source: JST

Figure 12.2 Environmental Condition along the Railway Line (Joydebpur – Bangabandhu Setu East)

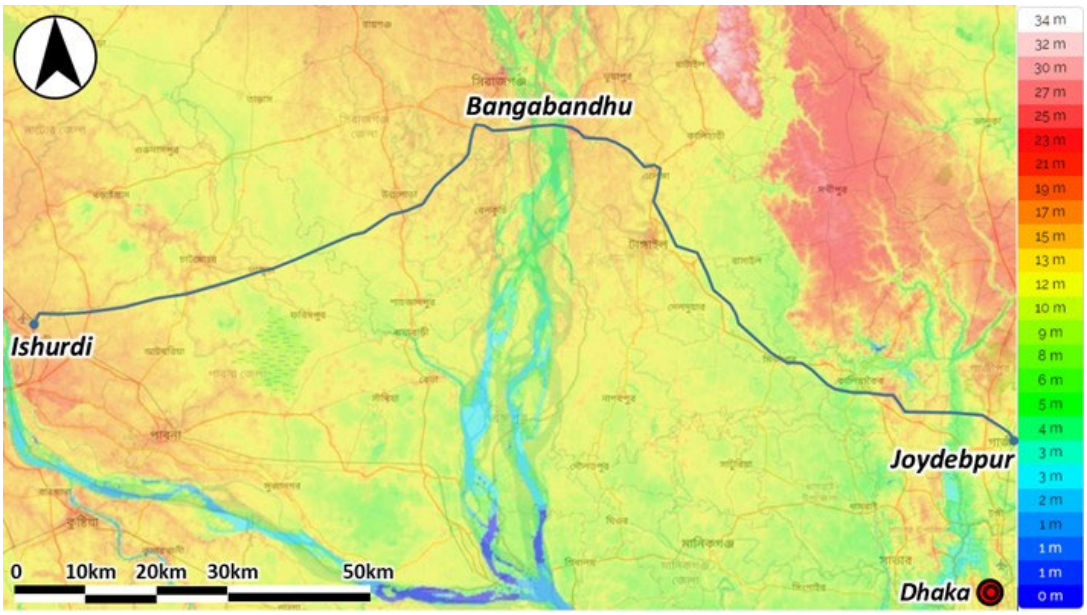
Bangabandhu Setu West-Ishurdi	
	
Bangabandhu Setu Wet St.	Chalan Beel
	
Bhangura-Guakhara	Chatmohar
	
Majhgram St.	Ishurdi St.

Source: JST

Figure 12.3 Environmental Condition along the Railway Line (Bangabandhu Setu West-Ishurdi)

12.1.2 Topography

The area is mainly flat and is crisscrossed by rivers, tributaries, wetlands, and canals. Elevation across the study area is characteristically flat, varying from approximately one to two meters above mean sea level. Topography generally slopes north to south, with the low-lying Chalan Beel affecting approximately 13 km of the western alignment.



Source: JST based on topographic-map.com

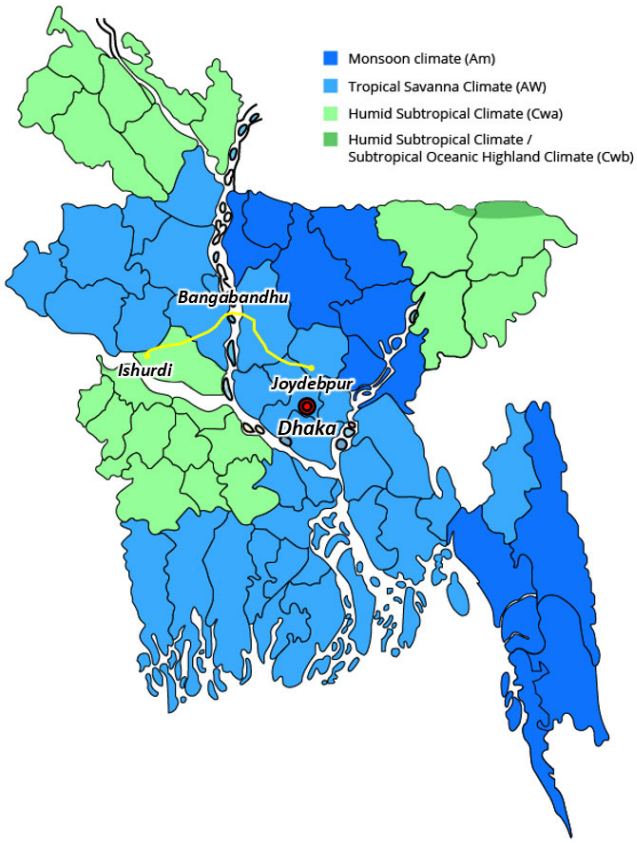
Figure 12.4 Topographic Condition along the Alignment

12.1.3 Geology

The geological profile along the proposed alignment consists of alluvial deposits underlain by deltaic deposits of the Brahmaputra-Ganges- Jamuna River systems. These deposits include mostly fine sandy, silt and clay materials. Numerous incised channels and depressions within the alignment area are lined with recent alluvial deposits comprising lowland alluviums, which are particularly evident along parts of the western alignment where it crosses the Chalan Beel.

12.1.4 Climate

In the Köppen climate classification, Bangladesh has a Monsoon climate (Am), Tropical savanna climate (Aw), Humid subtropical climate (Cwa), and Oceanic highland climate (Cwb) as listed. The project railway section is located in Aw and Cwa. The Project area has four distinct seasons, namely the dry or winter season from December to February; the pre-monsoon hot season from March to May; the monsoon or rainy season from June to September and the post-monsoon or autumn season from October to November. The temperature difference is large between the pre-monsoon/rainy season and the dry season. The maximum temperature rises to over 30°C except in the dry season, while in the dry season it is around 25°C. Based on the Meteorological data, the average yearly rainfall in Dhaka is 2,148 mm.



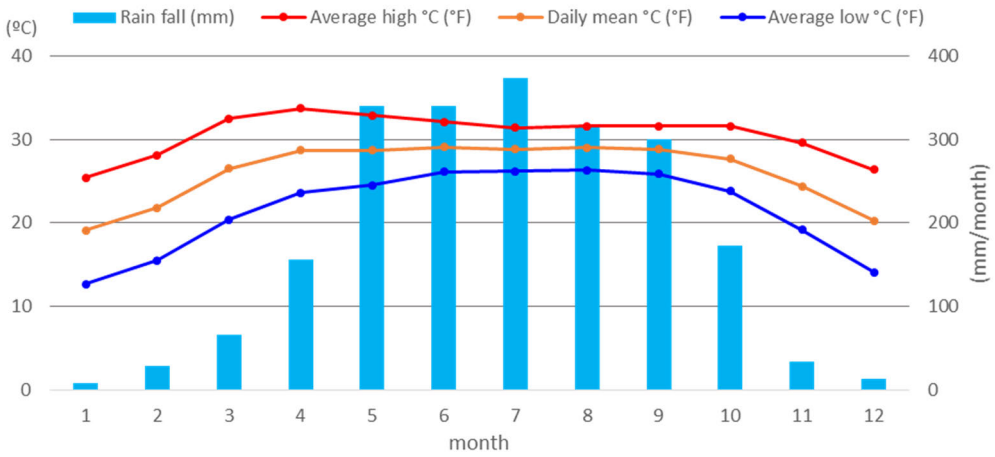
Source: Peel, M. C., Finlayson, B. L., and McMahon, T. A. (2007) (University of Melbourne)

Figure 12.5 Köppen Climate Classification for Bangladesh

Table 12.1 Weather Conditions in Dhaka

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall	7.7	28.9	65.8	156.3	339.4	340.4	373.1	316.5	300.4	172.3	34.4	12.8	2,148
Max Temp	25.4	28.1	32.5	33.7	32.9	32.1	31.4	31.6	31.6	31.6	29.6	26.4	30.6
Average Temp	19.1	21.8	26.5	28.7	28.7	29.1	28.8	29	28.8	27.7	24.4	20.3	26.1
Min Temp	12.7	15.5	20.4	23.6	24.5	26.1	26.2	26.3	25.9	23.8	19.2	14.1	21.5

Source: Bangladesh Meteorological Department



Source: Bangladesh Meteorological Department

Figure 12.6 Weather Conditions in Dhaka

12.1.5 Natural Disaster

The record of Natural disasters in Bangladesh has been listed with almost every year for the latest 10 years shown in the table below. However, the most of them have occurred in the southeast district; Chittagong, and Cox's Bazar comprising lowland alluviums. Regarding Seismology, Bangladesh is situated in one of the most tectonically active regions in the world. Here three major tectonic plates (the Indian Plate, the Tibet Sub-Plate, and the Burmese Sub-Plate) collide and thrust over each other. Earthquakes occur frequently in the wider region. On the basis of distribution of earthquake epicenters and tectonic behavior of different tectonic blocks, Bangladesh has been classified into four generalized seismic zones as shown in the figure below. The northeastern folded regions of Bangladesh are the most active zones and belong to Zone IV because of closing to Shillong Plateau Dauki fault and Chittagong-Tripura fold belt. Zone II and III consists of the regions of recent uplifts. Southwest Bangladesh is a seismically quiet, with the Project predominately in Zone I which is seismically moderately active areas. From the above information and the below table, no large earthquake has been recorded since 1900 along the Project alignment except for a magnitude 5.8 earthquake in 1935.

Table 12.2 Natural Disaster Record in Bangladesh since 2012

No.	Date	Disaster type	Affected District	Damage
1	Jun 2012	Flood	Southeast: Chittagong, Cox's Bazar, Bandarban, Sylhet, and Sunamganj	Dead: 131 Affected: 44,000
2	Oct 2012	Tropical Depression	Southeast: Noakhali, Bhola, Chittagong	Dead: 36 Missing: 72 Injured: 183 Affected: 103,836
3	Dec 2012	Cold wave	North: Sub-Himalayan regions	Dead: 80
4	Mar 2013	Tornado	East: Brahmanbaria	Dead: 38 Injured: 414 Affected house: 5,745
5	May 2013	Tropical Depression	South: Patuakhali	Dead: 17 Affected house: 23,000

No.	Date	Disaster type	Affected District	Damage
6	Aug 2014	Flood	North along the major rivers	Affected: 340,000 Affected house: 34,000
7	Apr 2015	Violent wind	North: Bogra	Dead: 24
8	Jun 2015	Flood	Southeast: Chittagong, Bandarban & Cox's Bazar	Dead: 23 Affected house: 10,000
9	Jul 2015	Flash Flood	Southeast: Cox's Bazar, Chittagong, Bandarban, Jessore, and Feni	Dead: 12 Affected: Over 20,000
10	Jul 2015	Tropical Cyclone	Southeast: Hatiya and Sandwip	Affected: 320,000
11	May 2016	Tropical Cyclone	Southeast: Chittagong, Noakhali, Lakshmipur, and Chandpur	Dead: 27 Affected: Over 200,000
12	Jul 2016	Flood	North and central along the major rivers	Dead: 42 Injured: 250,000 Affected: 3,200,000 Affected house: 250,000
13	Mar 2017	Flood	Northeast	Affected house: 850,000
14	May 2017	Tropical Cyclone	Southeast: Cox's Bazar and Chittagong	Dead: 5 Affected: 200,000
15	Jun 2017	Landslide	Southeast: Chittagong	Dead: 42 Affected: Over 6,000
16	Aug 2017	Flood	North: Dinajpur and Kurhigram	Dead: 114 Affected: 6,900,000
17	Jun 2018	Flood	Southeast: Cox's Bazar	Affected: Over 4,400
18	May 2019	Tropical Cyclone	South: Barguna, Noakhali and Patuakhali	Dead: 17 Affected house: 13,000
19	Jul 2019	Flood	North, Northeast, and Southeast	Dead: 119 Affected house: 7,300,000
20	Nov 2019	Tropical Cyclone	Southwest: Sundarbans	Dead: 2 Missing: 15 Affected: 2,000,000
21	May 2020	Tropical Cyclone	South: Khulna	Dead: 25 Affected: 10,000,000
22	June 2020	Flood	North: Jamalpur and Rangpur	Dead: 220 Affected: 164,000
23	Jul 2021	Flood	Southeast: Cox's Bazar	Dead: 21 Affected: 191,000
24	May 2022	Heavy Rain, Flood, Landslide	Northeast: Sunamganj and Sylhet	Dead: 21 Affected: 7,200,000

Source: Asian Disaster Reduction Center

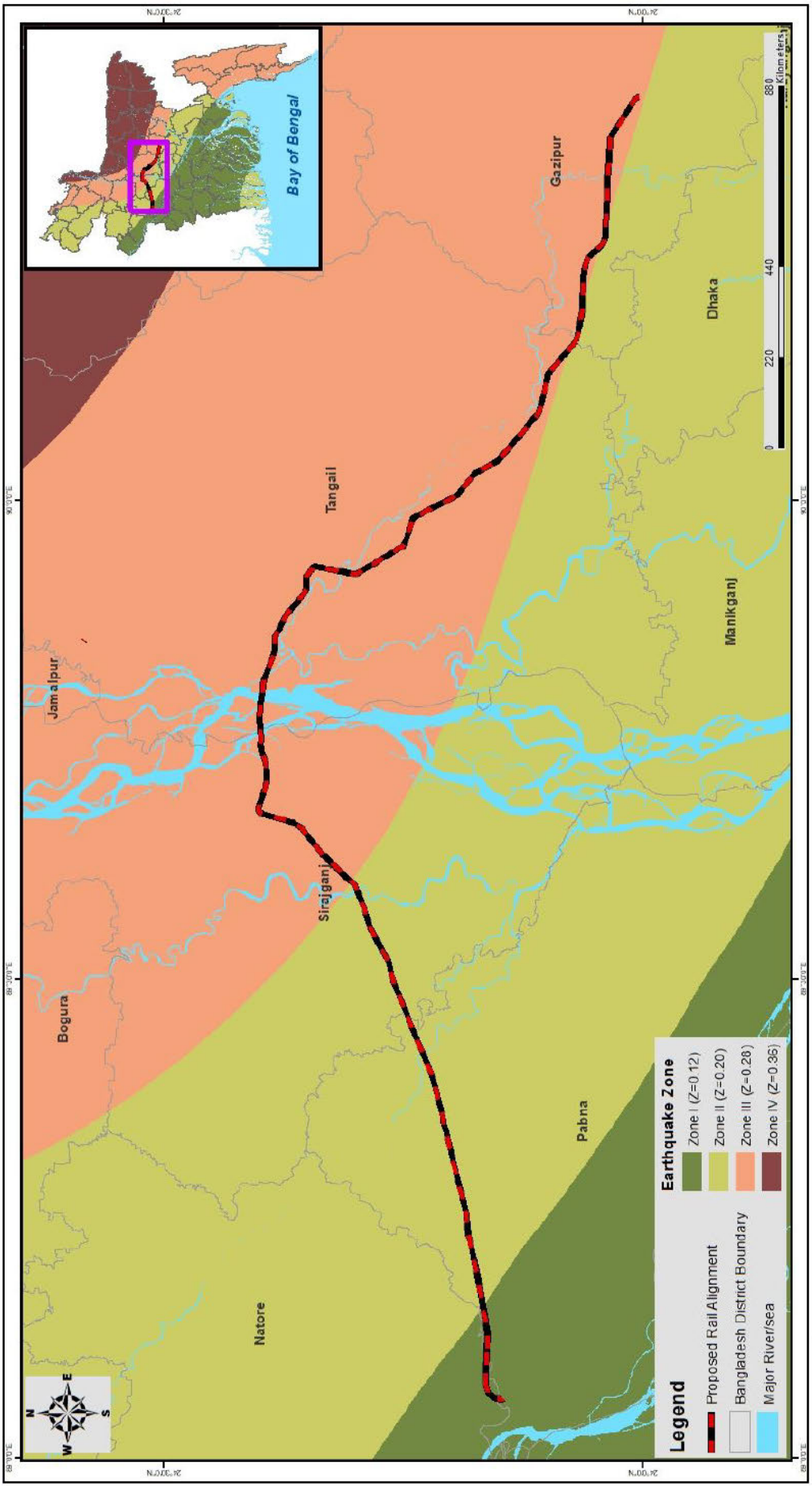
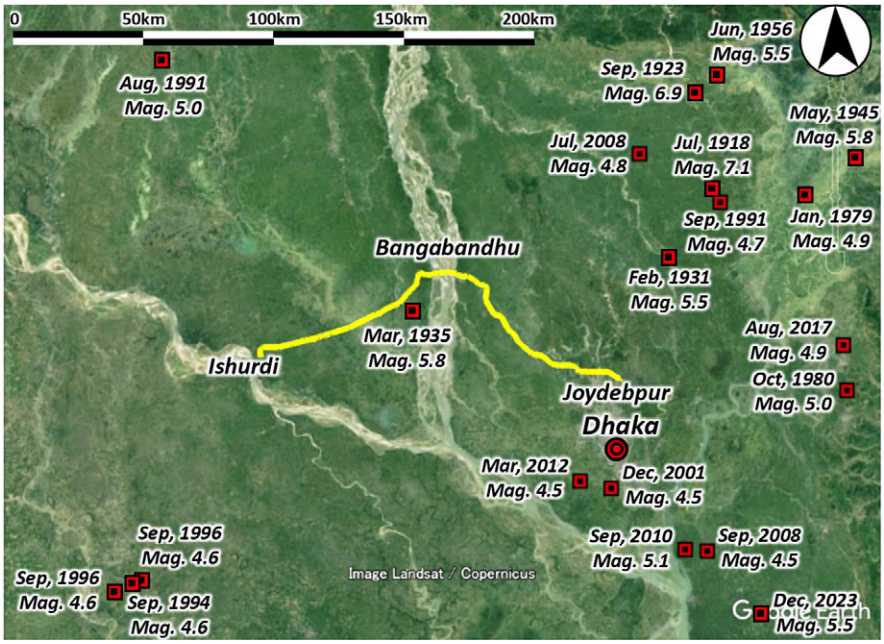


Figure 12.7 Seismic Zones of Bangladesh

Source: Bangladesh National Building Code (BNBC) 2015



Source: JST based on Google Earth, United States Geological Survey

Figure 12.8 Earthquake Record near the Alignment since 1900 (Magnitude 4.5 or Greater)

12.1.6 Environmental Considerations Items

BR had conducted a survey on various impact items for environmental and social considerations and summarized the survey results in the Environmental Impact Assessment study of Construction of Double Line Between Joydebpur and Ishurdi Section of Bangladesh Railway in March 2020 (hereinafter referred to as "EIA report of JIDLP 2020"). Therefore, the results excerpts from EIA report of JIDLP 2020 are mentioned as JST's review. However, the items, mentioned in EIA report of JIDLP 2020, for which data were updated in this Feasibility Study shall be omitted from this report.

(1) Protected Area and National Park

51 protected areas, such as wildlife and bird sanctuaries, national parks and safari parks, have been designated in Bangladesh. The Project alignment passes no protected areas including national parks. Among 51 protected areas, Bhawal National Park designated is the closest one whose southern boundary is located around 0.5 km distance from the alignment. The Park extends to 50.22 km^2 consisting of a core area of 9.4 km^2 and a buffer zone of 40.82 km^2, which is managed by the Bangladesh Forest Department. The core area is located around 3.5 km distance from the railway alignment. The park's map is shown below. The park was established to protect important habitats as well as to provide opportunities for recreation. It has been kept under IUCN Management Category IV, as a habitat or species management area. The most common flora was the unique coppice sal forest, but the Sal trees have been removed almost. In contrast, a large number of exotic trees species have been planted as part of the conservation program, covering 90% of the area. 221 species of plants (24 species of climbers, 27 species of grasses, 3 species of palms, 105 species of herbs, 19 species of

shrubs, and 43 species of trees) was recorded in 2005, which formed a safe habitat for many mammals such as Bengal fox (Vulpes bengalensis), jackal (Canis aureus), small Indian civet (Viverricula indica), wild boar (Sus scrofa), etc., whose category of IUCN are Least Concerned (LC). On the other hand, most of the forest inhabited in the buffer zone has been denuded and is now occupied by forestry companies or displaced people. There are over 150 industries in and around the buffer zone, with thousands of workers from these industries living around the zone. Fuelwood collection, as a significant activity in the zone, is another practice that threats forest biodiversity. Ground fire is a common feature in the zone that destroys vegetation, medicinal herbs and shrubs. Thus, approximately 70% of forest habitats has been damaged as a result of these factors in the last 4-5 decades[17]. Regarding the other protected areas, if information on protected areas for which applications are pending is obtained during the detailed design or construction stages, mitigation measures to reduce the impact shall be considered as much as possible.

Table 12.3 Protected Area along the Railway Alignment

No.	Name	Type	Area (km^2)	Distance from the line (km)
1	Madhupur	National Park	84.36	35.8
2	Kadigarh	National Park	3.44	30.3
3	Bangabandhu Safari Park Gazipur	Safari Park	15.42	12.9
4	Bhawal	National Park	50.22	0.5
5	Silanda-Nagdemra	Dolphin sanctuary	0.24	13.8
6	Nagarbari-Mohonganj	Dolphin Sanctuary	4.08	30.0
7	Nazirganj	Dolphin Sanctuary	1.46	43.7

Source: Protected Planet, JST based on the Google Earth

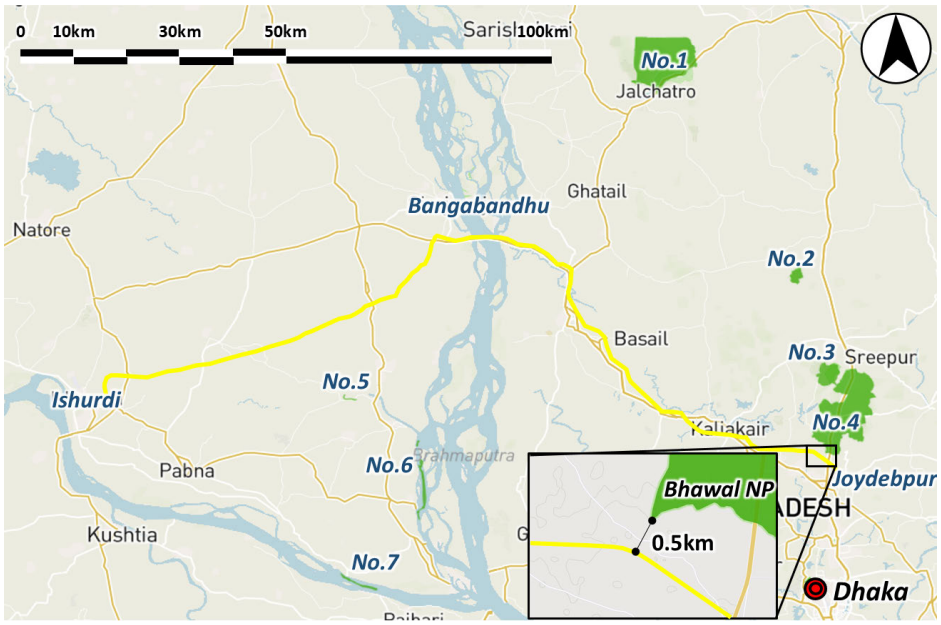
Core zone entrance gate of Bhawal National Park

Buffer zone of Bhawal National Park

Source: JST

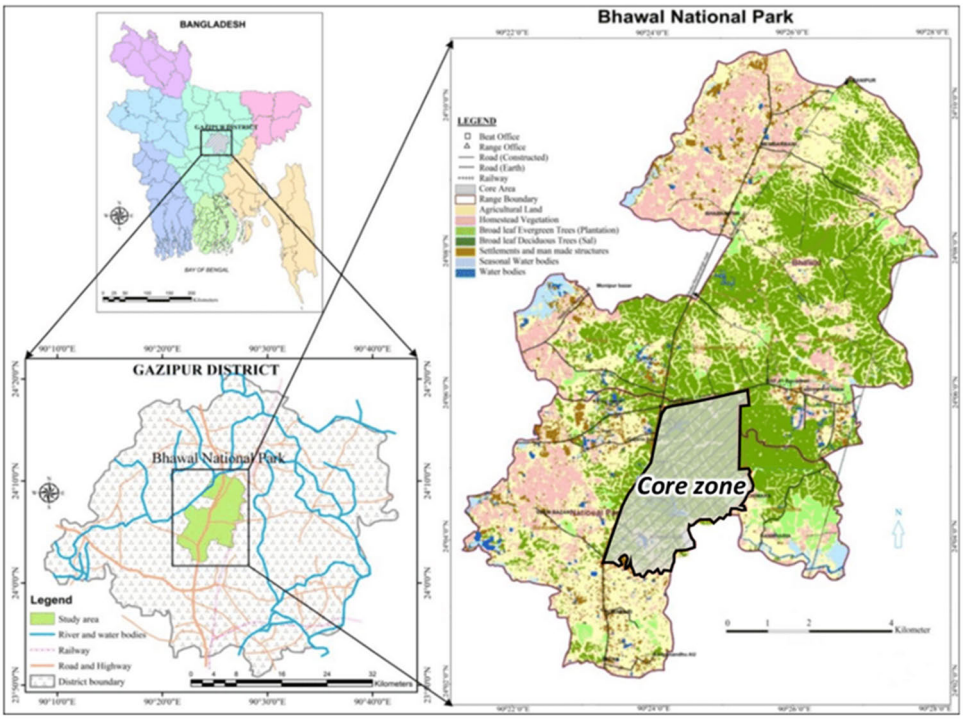
Figure 12.9 Bhawal National Park

[17] Management Strategies for Sustainable Forest Biodiversity Conservation in Protected Areas of Bangladesh: A Study of Bhawal National Park, Gazipur, Md. Alauddin et al.



Source: Protected Planet based on Google Map

Figure 12.10 Protected Area along the Railway Alignment



Source: Management Strategies for Sustainable Forest Biodiversity Conservation in Protected Areas of Bangladesh: A Study of Bhawal National Park, Gazipur, Md. Alauddin et al.

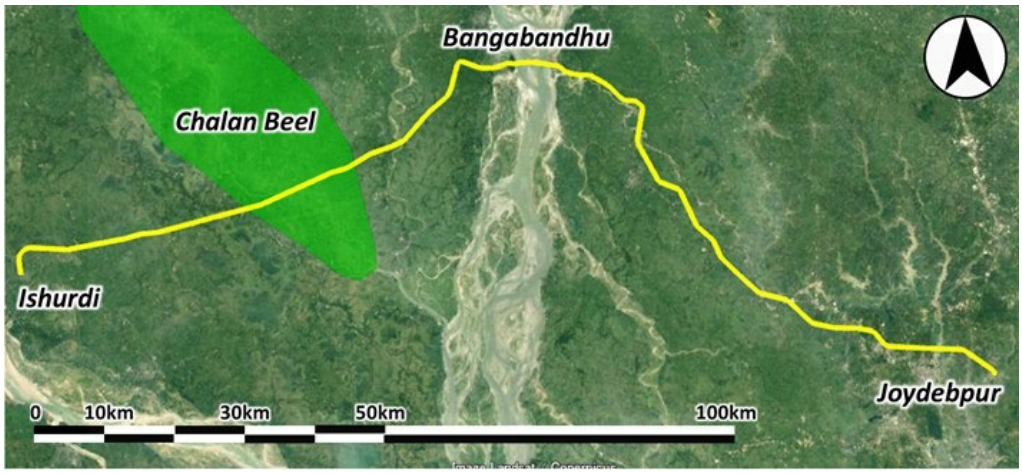
Figure 12.11 Boundary of Bhawal National Park and Core Zone

(2) Ecosystem

The aquatic environment with rivers, canals, water bodies, and ponds is formulated along the railway alignment except for some residential areas in the vicinity of the stations. The agricultural land along the railway alignment is mostly inundated during the monsoon season and dries up in the dry season.

Therefore, it is considered that the ecosystem has different appearances in the rainy season and the dry season.

Although the Chalan Beel is not designated as any types of protected area, it is a permanent water body (wetland) located west of the Jamuna River and crosses approximately 13 km of the Project alignment and is important for a range of activities including fishing, livestock keeping and agriculture. It is one of the largest beel[18] of Bangladesh and comprises a series of beel inter-connected by various channels to form a continuous 375 km^2 water body with dense aquatic vegetation growth during the monsoon. BR has installed bridges or box culverts at intervals of about 1.5 km to facilitate upstream to downstream flow in this area. Based on the above, JST proposed to conduct Ecosystem surveys in the Project area, including the Chalan Beel area, in the rainy season and dry season.



Source: Assessment of Chalan beel Ecosystem Diversity through Remote Sensing and Geographical Information Systems, Md. Abu Sayeed et al, 2014, JST based on Google map

Figure 12.12 Location of Chalan Beel

Source:JST

Figure 12.13 Section in Chalan Beel

[18] A lake-like wetland with static water in a flood plain

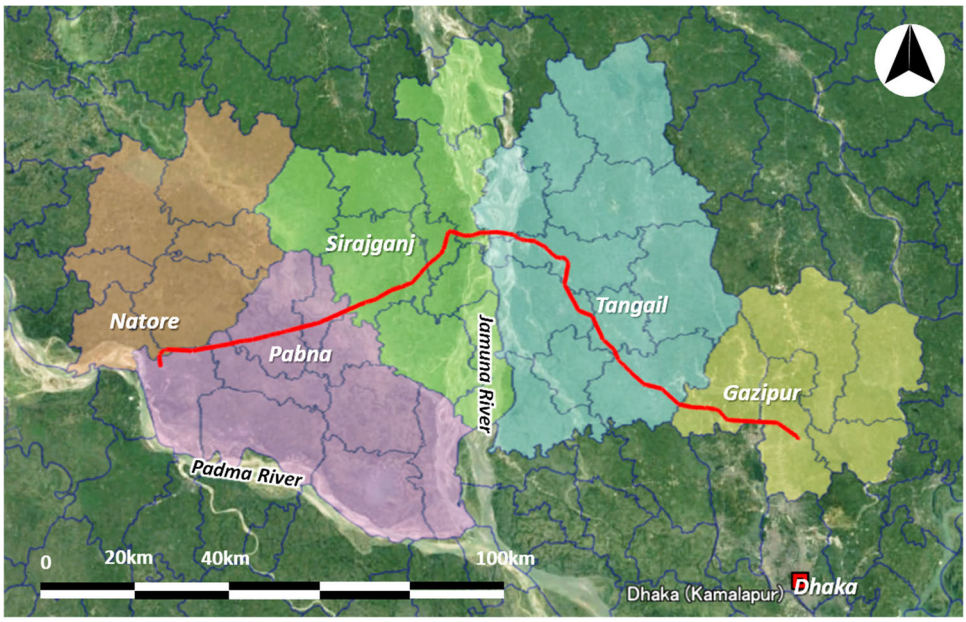
12.1.7 Social Considerations' Items

This section explains the social conditions of target districts by mainly reviewing the national statistics data, the secondary data. The result of the census survey of project affected area conducted in 2022-2023 is included in Chapter 13 Resettlement Action Plan. The updated RAP report prepared in this survey will be submitted to MOR through BR for the approval.

(1) Administrative Boundary

The alignment passes through 2 divisions namely Dhaka and Rajshahi Divisions and 5 districts such as Gazipur, Tangail, Sirajganj, Pabna, and Natore districts. The divisional administrative boundary surrounding the alignment is shown in the figure below.

- Dhaka division: Gazipur District, Tangail District
- Rajshahi division: Sirajganj District, Pabna District, Natore District



Source: JST based on Google map

Figure 12.14 Divisions along the Alignment

(2) Demographic Characteristics

Among target districts, the highest population density is 1,884 people/km^2 in Gazipur district, the closest district to Dhaka, and the lowest one is 898 people/km^2 in Natore district. Each household size of five districts is from 4.01 to 4.31, and all of them are lower than that of the national average (4.44). Male to female ratio is 109 (109 male for every 100 female) in Gazipur districts and the one is 95 in Tangail districts. The ones of other three districts in the Rajshahi division are 100 which is the same as the national average.

Table 12.4 Demographic Characteristics of the Project Area

Division	District	Population (people)	Sex Ratio (M/F)	Household size (people)	Density (people/km^2)
Dhaka	Gazipur	3,403,912	109	4.07	1,884
	Tangail	3,605,083	95	4.10	1,056
Rajshahi	Sirajganj	3,097,489	100	4.31	1,290
	Pabna	2,523,179	100	4.25	1,062
	Natore	1,706,673	100	4.01	898
Bangladesh		144,043,697	100	4.44	976

Source: Population & Housing Census 2011

According to Census of 2011, the majority of the religious groups in the Project area is Muslim as around 93-97% which is higher than the national average (90.4%). Other religious groups in the Project area consist of Hindu (3-7%), and less than 1 % of Christian. In terms of the languages used in the area, Bengali is spoken by 98% of the country's population.

Table 12.5 Population by Religion in the Project Area (%)

Division	Districts	Muslim	Hindu	Christian	Buddhist	Others
Dhaka	Gazipur	94.0	5.2	0.7	0.0	0.1
	Tangail	92.7	6.8	0.4	0.0	0.1
Rajshahi	Sirajganj	95.2	4.8	0.0	0.0	0.0
	Pabna	96.9	2.9	0.1	0.0	0.0
	Natore	93.2	6.1	0.5	0.0	0.2
Bangladesh		90.4	8.5			1.1

Source: Population & Housing Census 2011

(3) Economy

Table below shows that the majority of the male population, between 70-87%, are employed in all districts of the Project area, whereas, the majority of the female population, accounting for 72-83%, are engaged in housework, except for in Gazipur district. The employment rate of females is almost 25% in Gazipur district, while in other districts, the rates are less than 4.5%. The female employment rate of the Gazipur district is much higher than the ones of other districts because of the employment opportunities in garment factories.

Table 12.6 Employment Status of Population 7 Years and above (%)

Division	Districts	Employment		Housework	
		Male	Female	Male	Female
Dhaka	Gazipur	80.9	24.7	2.0	58.4
	Tangail	70.0	4.1	1.1	72.0
Rajshahi	Sirajganj	85.7	3.8	0.9	82.5
	Pabna	85.8	4.4	1.3	81.1
	Natore	87.2	3.7	1.5	83.5

Source: Population & Housing Census 2011

In terms of employment by industrial sectors, the statistics show that as the district goes distant from Dhaka, the rates of employment in industry and service sectors decrease, while the one in agriculture sector increases. The main employment in Gazipur district which is the closest to Dhaka is in the industry sector which accounts for 41% followed by the service and agriculture sectors which are 30% and 29% respectively. Whereas, in Natore district, 84% is employed in the agriculture sector and only 3% is in the industrial sector. The statistics also show that the percentages of female working in the service sector is much higher than the ones of male in all four districts, except for Gazipur district.

Table 12.7 Employment by Industrial Sectors in the Project Area

Division	Districts	Total Population (%)			% of Female		
		Agriculture	Industry	Service	Agriculture	Industry	Service
Dhaka	Gazipur	29	41	30	4	71	25
	Tangail	55	12	33	18	26	56
Rajshahi	Sirajganj	66	19	16	29	32	39
	Pabna	73	9	18	31	18	51
	Natore	84	3	13	48	9	42

Source: Population & Housing Census 2011

The following photos show the current status of the economic activities along the alignment which include farming, fishery, animal grazing, and small shops.

Farming

Fishery

Animal grazing

Shops

Note: Photos were taken on 1st August 2022
Source: JST

Figure 12.15 Current Status of the Economic Activities along the Alignment

(4) Education

The literacy rate of 7 years and above is shown in the table below. The literacy rate of the Gazipur district (62.6%) is higher than the national average (51.8%), while the ones of other four districts are lower than the average. Especially, the literacy rate of the Sirajganj district, 42.1%, is the lowest among the five districts. The female literacy rate is lower than that of the male counterparts in all five districts, and a similar trend is found in national averages. In the Gazipur district, the female literacy rate is 58.9% which is the highest and above the national average, and the Sirajganj district is the lowest which is 39.0%. The table also shows the school attendance rate in the 5-24 year population. The rates in Natore, Tangail, and Pabna districts are higher than the national average whereas the ones in Sirajganj and Gazipur districts are lower than the average. As for the Gazipur district, while the school attendance rate is higher than average between the age of 5 to 14 years, it is much lower for the population between 15 to 24 years who is likely to be employed. Differences between the genders are similar to the literacy rates, thus the school attendance rate of females is lower than that of their males' counterparts.

Table 12.8 Education Level of the Project Area

Division	Districts	Literacy (7 years and above)			School Attendance (5-24 years)		
		Male	Female	Both	Male	Female	Both
Dhaka	Gazipur	66.0	58.9	62.6	45.7	39.4	42.5
	Tangail	50.0	43.8	46.8	59.0	52.1	54.9
Rajshahi	Sirajganj	45.1	39.0	42.1	53.5	47.6	50.5
	Pabna	47.8	45.6	46.7	55.7	51.2	53.4
	Natore	51.9	47.3	49.6	58.4	52.3	55.3
Bangladesh Average		54.1	49.4	51.8	54.6	50.8	52.7

Source: Population & Housing Census 2011

(5) Health

To understand the level of health services in the districts, the population per health facility, bed, and doctor are compared. Natore district has the largest number of people per facility, per bed, and per doctor, which can be understood as the population in Natore district being underserved compared to other districts. After Natore district, Gazipur and Tangail districts have a larger number of people per facility and bed due to the higher population in each district. The rate of childbirth at health facilities in Sirajganj district is 31.2%, which is lower than that of the country average (47.1%). Similarly, under-five-years mortality per 1,000 live births is higher in Sirajganj and Natore districts at 65 and 53, respectively, compared to the country average of 47.

Table 12.9 Health Services of the Project Area

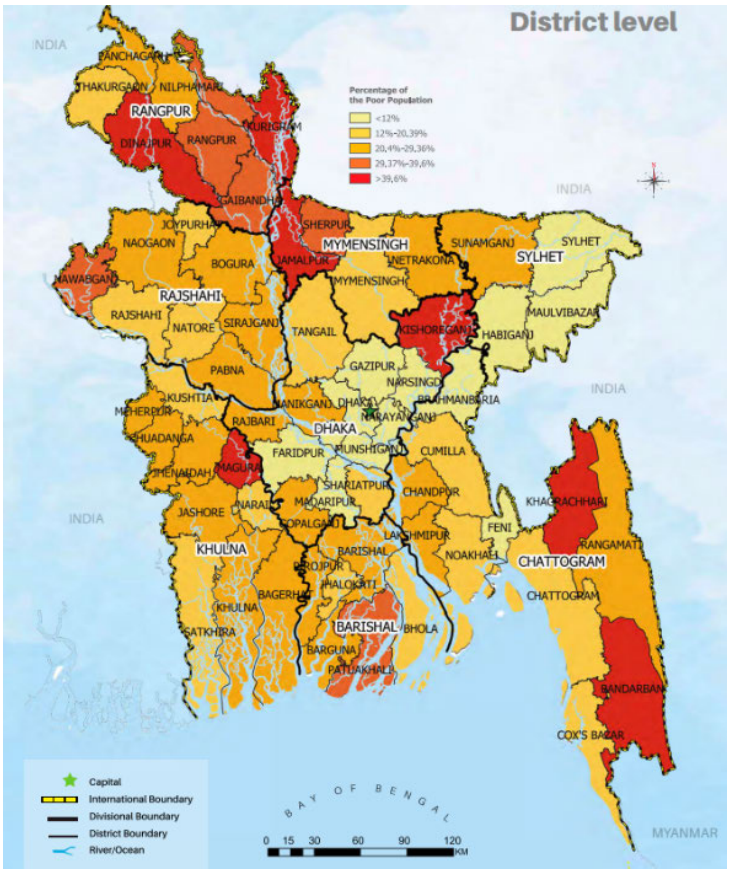
Division	Districts	Population/ Facilities*	Population / Bed*	Population / Doctor*	Birth at health facility**	Under-five mortality**
Dhaka	Gazipur	27,451	2,494	7,181	57.7	44
	Tangail	20,253	2,630	4,979	49.6	37

Division	Districts	Population/ Facilities*	Population / Bed*	Population / Doctor*	Birth at health facility**	Under-five mortality**
Rajshahi	Sirajganj	15,885	1,975	7,783	31.2	65
	Pabna	12,553	1,430	7,009	51.3	41
	Natore	38,788	2,893	10,600	57.8	53
Bangladesh Average		-	-	-	47.1	47

Note: Percentage of live birth at a health facility, Under-five mortality per 1,000 live births
Source: *Population & Housing Census 2011, **Bangladesh Maternal Mortality and Health Care Survey (BMMS) 2016

(6) Poverty

The below figure, poverty map, shows underserved and impoverished areas in the country. According to Household Income and Expenditure Survey (HIES) 2016, the lower poverty line is BDT 103.7/day (US$3.20), and the upper poverty line is BDT 178.2/day (US$5.50) in Bangladesh. Compared to the data of 2011, all districts showed progress in 2016 in terms of a decrease in the population under the poverty line. Among the 5 districts, the percentage of the population upper poverty line of the Gazipur district is 6.9% and the Tangail district is 19.0% which is lower than the national average. On the other hand, Pabna and Sirajganj districts show a higher rate of the population under the upper poverty line, which is 33.0% and 30.5%, respectively.



Source: Household Income and Expenditure Survey (HIES) 2016

Figure 12.16 Poverty Map in Bangladesh

Table 12.10 Poverty Line in the Project Area (%)

Division	Districts	2010*		2016**
		Population under Lower poverty line	Population under Upper poverty line	Population under Upper poverty line
Dhaka	Gazipur	8.2	19.4	6.9
	Tangail	18.0	29.7	19.0
Rajshahi	Sirajganj	22.7	38.7	30.5
	Pabna	16.7	31.5	33.0
	Natore	21.3	35.1	24.0
Bangladesh Average		17.6	31.5	24.3

Note: Lower Poverty Line: BDT103.7 (2016) or US$3.20 (2011 PPP) per day per capita
Upper Poverty Line: BDT178.2 (2016) or US$5.50 (2011 PPP) per day per capita
Source: *Zila level povmap estimates 2010, ** Household Income and Expenditure Survey (HIES) 2016

(7) Vulnerability

According to National Women Development Policy 2011, two-thirds of the population living under the poverty line are women, and female-headed families are greater in number among them. Therefore, widows and female-headed households can be also considered as vulnerable as they may have limited time or opportunities to engage in economic activities. Besides households below the poverty line, a household with elder people or people with disability, there will be additional caretaking tasks. Those households may have low coping ability against possible negative impacts from the Project.

Table 12.11 Vulnerability Status (%)

Division	Districts	Widows	Elder people (Above 60+)	Disability
Dhaka	Gazipur	5.8	5.4	0.9
	Tangail	5.1	9.1	1.4
Rajshahi	Sirajganj	9.1	7.4	1.6
	Pabna	8.1	7.9	1.4
	Natore	9.5	8.0	1.6

Source: Population & Housing Census 2011

12.2 Legal Framework Pertaining to ESC in Bangladesh

12.2.1 Environmental Law and Regulations in Bangladesh

For the protection, conservation, and management of the biophysical and social environment from damaging development pressures, the Government of Bangladesh has developed a complete legal framework, including laws, regulations, decrees, and standards addressing environmental and social safeguards. These are currently under review and materials are being circulated but cannot be applied until they are promulgated. Of the existing documents, those most relevant to this Project are summarized in this chapter.

(1) National Environmental Policy, 1992 (amended in 2018)

The Bangladesh National Environmental Policy, approved in 1992, sets out the basic framework for environmental action together with a set of broad sectorial action guidelines. Key elements of the Policy are:

- Maintaining ecological balance and ensuring sustainable development of the country through protection and conservation of the environment;
- Protecting the country from natural disasters;
- Identifying and regulating all activities that pollute and destroy the environment;
- Ensuring environment-friendly development in all sectors;
- Ensuring sustainable and environmentally sound management of the natural resources; and
- Maintaining active association, as far as possible, with all international initiatives related to the environment.

The Policy seeks to ensure that transport systems, including roads and inland waterways, do not pollute the environment or degrade resources. The Policy states that Environmental Impact Assessments must be conducted before projects are undertaken. In 2018, the policy was amended to envisaged not only environment conservation, pollution control, biodiversity conservation, mentioned in the previous version, but also mitigation of the adverse effect of climate change to ensure sustainable development. For ensuring sustainable development and environmentally sound management of the natural resources and to meet the DoE/GOB regulatory requirement.

(2) National Environmental Management Action Plan (NEMAP), 1995

The National Environmental Management Action Plan (NEMAP) is a wide-ranging and multifaceted plan which builds on and extends the statements set out in the National Environmental Policy. NEMAP was developed to address issues and management requirements during the period 1995 to 2005 and set out of the framework within which the recommendations of the National Environmental Policy were to be implemented. It identified four broad objectives and remains highly relevant today. The four key environmental management directions specified were:

- Identification of key environmental issues affecting Bangladesh;
- Identification of actions necessary to halt or reduce the rate of environmental degradation of the natural environment;
- Sustainable resource use and the conservation of habitats and biodiversity; and
- Improvement of the quality of life of the people.

(3) Environmental Conservation Act, 1995 (amended in 2023)

The Act is applied by the Department of Environment, (DoE), within the Ministry of Environment and Forest. The Act forms the basis of the country's environmental safeguard system. It authorizes the Director General (DG) of DoE to undertake any activity deemed necessary to control, prevent, and

mitigate pollution and to conserve and enhance the quality of environment. It lays out the basic rules on damage to the ecosystem, discharge of wastes, and the agency's power to enter and collect samples as part of any investigation. The Act also defined the powers of DoE to prepare Rules in support of the Act.

(4) Environment Conservation Rules, 1997 (amended 2002)

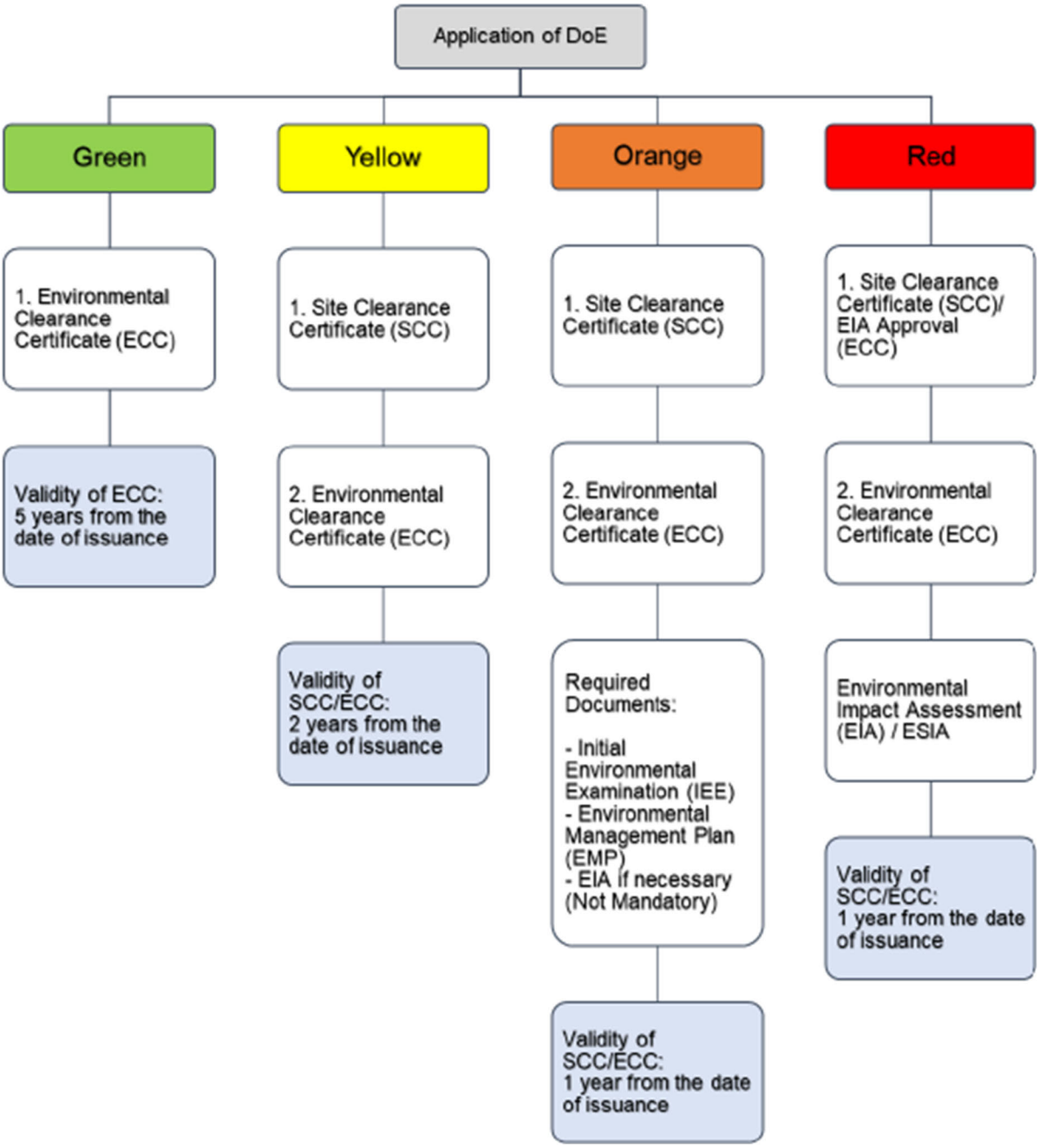
The Environment Conservation Rules, 1997 are the first set of rules promulgated under the Environment Conservation Act, 1995. These Rules provide for, inter alia, the following:

- procedures from planning and completion of EIAs, including the preparation of Environmental Management Plans, document format, and content, as well as and for the provision of environmental clearance;
- National Environmental Quality Standards (EQS) for ambient air, surface water, groundwater, drinking water, industrial effluents, emissions, noise, and vehicular exhaust;
- A listing of industries, development projects, and other activities. Grouped into four environmental assessment categories based on actual (for existing industries/development projects/activities) and anticipated (for proposed industries/development projects/activities) pollutant loading; and
- Procedure for damage-claim by persons affected or likely to be affected due to polluting activities or activities causing hindrance to normal civic life.

Depending on the industry, activity, the Project location, type of work, size and severity of pollution loads, DoE classified 186 activities into four environmental assessment categories. ; (a) Green, (b) Yellow, (c) Orange and (d) Red. According to the Rules, Environmental Clearance Certificate (ECC) is issued to all existing and proposed industrial units and projects, falling in the Green Category without undergoing EIA. However, for category Yellow, Orange and for Red projects, require location clearance certificate and followed by issuing of Environmental Clearance upon the satisfactory submission of the required documents. Green listed industries are considered relatively pollution-free, and therefore do not require site clearance from the DoE. On the other hand, Red listed industries are those that can cause 'significant adverse' environmental impacts and are, therefore, required to submit an EIA report. These industrial projects may obtain an initial Site Clearance on the basis of an IEE based on the DoE's prescribed format, and subsequently submit an EIA report for obtaining Environmental Clearance.

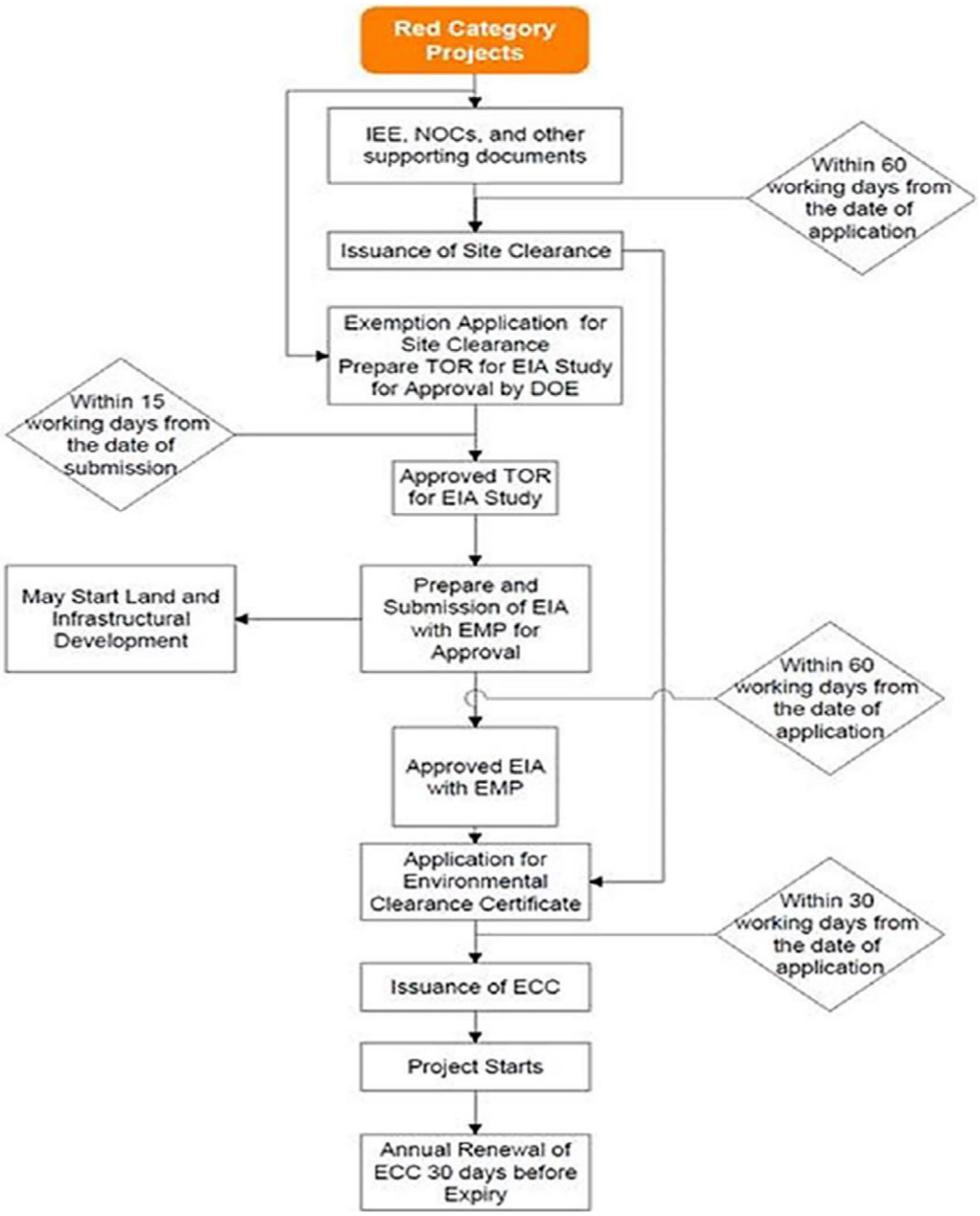
The Project falls under Red Category item 67 of Red Category in Schedule 1 of the ECR. Although rail is not specifically mentioned in the Rules, in practice linear transportation development includes railway lines. Red Category Item 68 also specifies that before construction of bridges with spans ≥100 m, a full EIA must be completed and approved by DoE. This means that any rail line with a bridge having a span of ≥100 m triggers a Red Category or full EIA. The Environmental Assessment process for each category and EIA procedure for Red category in Bangladesh to be followed for obtaining a Site Clearance Certificate (SCC) and an Environmental Clearance Certificate are shown in the Figures

below. The ECC is valid for one year and will be sought for the project, which comes under the Red Category.



Source: Environment Conservation Rules, 1997 (amended in 2023)

Figure 12.17 Environmental Assessment Process in Bangladesh



Source: Environment Conservation Rules, 1997 (amended in 2023)

Figure 12.18 EIA Procedure for Red category project in Bangladesh

(5) EIA Guideline for Industry (2021)

The EIA Guidelines are regarded as guidelines for industries subject to EIA and present 6 steps of the EIA process (screening, scoping, baseline data generation, impact assessment, mitigation of impacts and environmental management plan). These comprehensive guidelines can be followed for the ESIA study of development project. The Guidelines provide a step-by-step methodology for the completion of EIAs, following slightly more general ECR 1997 and its subsequent amendments in 2002, 2003, and 2010.

(6) Secondary Relevant National Legislation

The table below presents an annotated list of the other national legal instruments that have relevance to the proposed Project, addressing both social and environmental project planning and EIA preparation considerations.

Table 12.12 National Legal Instruments Related to Environment

Ordinance/Act/Rules	Responsible Agency/Ministry/Authority	Key Features/Potential Applicability
National Water Policy, 1999	Ministry of Water Resources and Bangladesh Water Development Board (BWDB)	Protection, restoration and enhancement of water resources; Protection of water quality, including strengthening regulations concerning agro-chemicals and industrial effluent; Sanitation and potable water; Fish and fisheries; and participation of local communities in all development activities in the water sector.
Ground Water Management Ordinance 1985	Upazila Parishad	Management of groundwater resources; Tube well shall not be installed in any place without the license granted by Upazila Parishad
Forest Act, 1927 and subsequent amendments in 1982 and 1989	Ministry of Environment and Forest: Forest Department	Reserve Forests; Protected Forests; Village Forests
National Forest Policy, 1979 with an amendment in 1994	Ministry of Environment and Forest; Forest Department	Afforestation of 20% land; Protection of biodiversity of the existing degraded forests; Strengthening of agricultural sector; Control of Global warming, Desertification; Control of trade in wild birds and animals; Prevention illegal occupation of the forestlands, free felling and hunting of wild animals.
Private Forests Act, 1959	Forest Department; Regional Forest Officer.	Conservation of private forests; Afforestation on wastelands.
Bangladesh Wildlife (Preservation) Act, 1974	Ministry of Environment and Forest: Bangladesh Wildlife Advisory Board	Preservation of wildlife sanctuaries, parks and reserves.
National Biodiversity Strategy and Action Plan (2016)	Ministry of Environment and Forest; Bangladesh Wildlife Advisory Board	Conservation and restoration of the biodiversity of the country for well-being of the present and future generations;
Biodiversity Act (2017)	Ministry of Environment, Forest and Climate Change	To fulfill the commitment of Bangladesh towards implementing the three objectives of Convention on Biological Diversity: conservation of biodiversity, the sustainable use of its components and fair and equitable sharing of benefits arising out of the utilization of genetic resources.

Source: JST

12.2.2 Screening

(1) Bangladesh

In October 2013, the Department of Environment (DoE), Ministry of Environment and Forests, Government of Bangladesh classified the Project as a Red Category, signifying a full EIA, but agreed that DoE requirements would be adhered to. Therefore, the EIA report of JIDLP 2020 was prepared according to DoE formatting to meet the requirements of DoE, and no need to revise or resubmit the report in this Feasibility Study.

(2) JICA

The Project is classified as "Category A" in the JICA guidelines for ESC published in April 2010 because it falls into the railway sector.

12.2.3 Permit

(1) Environmental Clearance Certificate (ECC)

On 29th June 2020, the Department of Environment (DoE) issued the Project's ECC. On the top of that, BR has submitted the application to DoE to renew the ECC since 2021 because ECC shall be expired within 1 year since issued. As of June 2024, the latest ECC has been issued in October 2023, BR will fill a renewal application in June 2024, and the ECC is expected to be reapproved in October 2024.

(2) Other environment-related permits

Other environment-related permits shall be required as follows. The application period for the permits is mainly at the stage of pre-construction.

Table 12.13 Other Environment-related Permits

Item	Acts/Rules	Concerned Agency	Stage
Removal of trees	Forest Act 1927 amended in 2000	Forest Department	Pre-Construction
River dredging	—	Bangladesh Inland Water Transport Authority (BIWTA), and Deputy Commissioner (DC)	Pre-Construction

Source: JST

12.2.4 EIA Survey Policy of the Project

The project is classified as "Red Category" in Bangladesh and is classified as "Category A" in the JICA guidelines for ESC. Therefore, EIA should be based on the EIA approval process in the JICA guidelines for ESC, if there are any gaps between the two. The following table shows the comparison of Bangladesh procedure and the JICA guidelines for ESC.

Table 12.14 Gap between EIA Procedure in Bangladesh and JICA Guidelines for ESC

JICA guidelines for ESC (April 2010)	ECR 2023	GAP	Policy of this survey
Underlying Principles			
Environmental impacts that may be caused by projects must be assessed and examined in the earliest possible planning stage. Alternatives or mitigation measures to avoid or minimize adverse impacts must be examined and incorporated into the project plan.	ECA (1995) and ECR (2023) do not explicitly ask for identification and assessment of alternatives.	Exist, however BR has already analyzed the 3 alternatives including the option without project in EIA report of JIDLP 2020.	JST reviewed and update the proposed alternatives through this feasibility study.
Information Disclosure			
• EIA reports (which may be referred to differently in different systems) must be written in the official language or in a language widely used in the country in which the project is to be implemented. When explaining projects to local residents, written materials must be provided in a language and form understandable to them • EIA reports are required to be made available to the local residents of the country in which the project is to be implemented. The EIA reports are required to be available at all times for perusal by project stakeholders such as local residents and copying must be permitted	There is no regulation for the time of EIA report disclosure and the written language.	Exist	To follow JICA guidelines for ESC (To recommend BR to set up the time of EIA disclosure can guarantee people to access to the report written in a language widely used in the country.)
Stakeholder meeting			
• For projects with a potentially large environmental impact, sufficient consultations with local stakeholders, such as local residents, must be conducted via disclosure of information at an early stage, at which time alternatives for project plans may be examined. The outcome of such consultations must be incorporated into the contents of project plans. • In preparing EIA reports, consultations with stakeholders, such as local residents, must take place after sufficient information has been disclosed. Records of such consultations must be prepared • Consultations with relevant stakeholders, such as local residents, should take place, if necessary, throughout the preparation and implementation stages of a project. Holding consultations is highly desirable,	No public disclosure is required as per ECR. Although there are descriptions recommending public participation in EIA, any detailed regulations for local consultation are not laid down.	Exist. However, BR has already implemented the stakeholder meeting at 5 locations in 2014 and at 4 locations in 2019 when BR prepared the EIA report of JIDLP 2020.	To follow JICA guidelines for ESC. (To implement public consultation accordingly throughout the preparation and implementation stages of the Project. 1st consultation was implemented at scoping stage including the explanation of analysis of alternatives, the content of the survey, and its schedule, and 2nd consultation was implemented when the DFR for this feasibility study is prepared.)

JICA guidelines for ESC (April 2010)	ECR 2023	GAP	Policy of this survey
especially when the items to be considered in the EIA are being selected, and when the report is being prepared.			
Assessment Items			
• The impacts to be assessed with regard to environmental and social considerations include impacts on human health and safety, as well as on the natural environment, that are transmitted through air, water, soil, waste, accidents, water usage, climate change, ecosystems, fauna and flora, including trans-boundary or global scale impacts. These also include social impacts, including migration of population and involuntary resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety. • In addition to the direct and immediate impacts of projects, their derivative, secondary, and cumulative impacts as well as the impacts of projects that are indivisible from the project are also to be examined and assessed to a reasonable extent. It is also desirable that the impacts that can occur at any time throughout the project cycle should be considered throughout the life cycle of the project.	No mention regarding the assessment of specified environmental and social items, the derivative, secondary, and cumulative impacts as well as the impacts of projects that are indivisible from the project, and the impacts that can occur at any time throughout the project cycle.	Exist, however BR included the assessment of main impact items such as Air pollution, Noise, Water, and Ecosystem etc. in the EIA report of JIDLP 2020.	To follow JICA guidelines for ESC (JST reviewed the assessment results through the survey. On the top of that, the additional survey results were inserted in the DFR for this feasibility study)
Monitoring, Grievance Redress Mechanism			
• Project proponents etc. should make efforts to make the results of the monitoring process available to local project stakeholders. • When third parties point out, in concrete terms, that environmental and social considerations are not being fully undertaken, forums for discussion and examination of	No mention regarding the preparation of results of the monitoring process available to local project stakeholders, and the establishment of forums.	Exist. However, BR included the chapter of Environmental Grievance Redress Mechanism in the EIA report of JIDLP 2020.	To follow JICA guidelines for ESC. (JST reviewed and update the proposed Grievance Redress Mechanism through this feasibility study.)

JICA guidelines for ESC (April 2010)	ECR 2023	GAP	Policy of this survey
countermeasures are established based on sufficient information disclosure, including stakeholders' participation in relevant projects. Project proponents etc. should make efforts to reach an agreement on procedures to be adopted with a view to resolving problems.			
Ecosystem and Biota			
Projects must not involve significant conversion or significant degradation of critical natural habitats and critical forests.	Project proponent shall identify Ecologically Critical Area overlapped on the project site.	No GAP	To follow JICA guidelines for ESC. (JST reviewed the EIA report of JIDLP 2020 and added Ecosystem survey through this feasibility study.)
Indigenous Peoples			
Any adverse impacts that a project may have on indigenous peoples are to be avoided when feasible by exploring all viable alternatives. When, after such an examination, avoidance is proved unfeasible, effective measures must be taken to minimize impacts and to compensate indigenous peoples for their losses.	No mention regarding a consideration for indigenous peoples.	Exist.	To follow JICA guidelines for ESC. (If JST identify the indigenous people through this feasibility study, Indigenous people's plan shall be prepared.)

Source: JST

12.3 Scoping Pertaining to ESC

This section summarizes the scoping for the prioritized alternative concluded in the preceding section, assuming positive and negative environmental and social impacts based on the information obtained from site reconnaissance and existing literature.

12.3.1 Scoping

The scopes of Environmental and Social considerations (ESC) are the construction of the main structure including civil works of double line with approx. 170 km, construction of approx. 200 bridges and 3 new stations, and renovation and reconstruction of 23 existing stations. The tables below show the affected environmental and social items for railway and bridges respectively, the so-called scoping results. The other table also shows the scoping result for the related facilities such as borrow-pit, quarry, and construction yard. However, the scoping result at the operation stage for the related facilities should be omitted because they are for use only during the construction. Based on the detailed design prepared by BR, the contractor will formulate a construction plan including the details of the related facilities at the construction stage and will commence using the facilities after approval of the Government of Bangladesh. Basically, sand will be obtained by river dredging, as any establishments of borrow-pits are prohibited by "Balumohal and Soil Management Act, 2010". As shown in the Table 12.15, the river dredging requires a permit from BIWTA and DC. Regarding the use of quarries, since

JST is considering importing quarry material from overseas as an option, the location cannot be identified at this time. As for construction yards, since the location cannot be also identified at this time, a general evaluation for these sites shall be prepared.

Table 12.15 Scoping for Railway with Reasons Evaluated

No.	Impact item	Evaluation		Reason for evaluation
		Pre-CS CS	OS	
Pollution				
1	Air pollution	✔	✔	**CS:** Emission gas (NOx, SOx) and dust (SPM) are caused temporarily by some heavy machines and dump trucks. **OS:** Positive impact will be offered by modal sift from dump truck to freight train along the railway line. However, emission gas (NOx, SOx) and dust (SPM) are also caused by increasing number of running train.
2	Water pollution	✔	✔	**CS:** - Turbid water will be generated in surface water and ground water along the railway line due to civil works. - There is a possibility of being discharged with organic wastewater at an installed base campsite. **OS:** There is a possibility of discharged organic wastewater from the toilet installed in the train and at every station.
3	Waste	✔	✔	**CS:** - It is predicted that construction waste such as soil and deforestation trees are generated. - General waste and excreta will be generated from the base campsite. **OS:** General waste and excreta will be generated from running train and every station.
4	Soil contamination	✔	✔	**CS:** Minor impact of soil contamination will be generated by oil leaks of heavy machines and dump track. **OS:** Soil contamination may be generated on the railway line due to oil leaks of running train.
5	Noise and vibration	✔	✔	**CS:** Noise and vibration will be generated by construction heavy machines, dump trucks. **OS:** Double line can reduce traffic noise and vibration depending on road traffic volume reduction, but increased number of running train issues additional noise and vibration by itself, which has negative impact on the nearby communities.
6	Ground subsidence	✔	✔	**CS/OS:** Construction activities that have a negative impact on underground water such as large-scale digging and water pumping are not scheduled in this project. But there is still a possibility of ground subsidence in case of the soft foundation under the railway line.
7	Offensive odor	✔	✔	**CS:** Offensive odor may be issued depending on the volume of general waste, etc. from basecamp sites. **OS:** Offensive odor may be issued depending on the volume of general waste etc. from every station.
8	Bottom Sediment	✔	✔	**CS:** - Turbid water will be generated in surface water and ground water along the railway line due to civil works. - Minor impact of bottom sediment will be generated by oil leaks of heavy machines and dump track. **OS:** Bottom sediment contamination may be generated on the railway line due to oil leaks of running train.
Natural Environment				
9	Protected Area			**CS/OS:** Although the railway line passes at 0.5km south from Bhawal National Park, designated as a protected area. It can be said that negligible impact on the Park is expected.

No.	Impact item	Evaluation		Reason for evaluation
		Pre-CS CS	OS	
10	Ecosystem	✔	✔	**CS:** - There is a negative impact on the ecosystem through deforestation of trees due to the double line construction. - Since a partial section pass through Chalan Beel, the impact on ecosystem is expected, especially on aquatic species due to generation of turbid water and change in water flow. **OS:** Since a partial section pass through Chalan Beel, the impact on ecosystem is expected especially on aquatic species due to change in water flow.
11	Hydrology			**CS/OS:** Construction/Operation activities that have a negative impact on underground water such as large-scale digging and water pumping are not scheduled in the Project.
12	Geography and topography	✔		**CS:** There may be some unique geography and topography along the alignment identified in field survey. **OS:** There is no geographical and topographical modification.
Social Environment				
13	Land acquisition/ Resettlement	✔		**Pre-CS:** It is predicted that there are land acquisition and resettlement along the railway line. **OS:** Since land acquisition and resettlement support will be completed before the operation phase, no impact is expected during this stage.
14	Poverty	✔		**CS:** The impact on poverty is evaluated based on characteristics of local society along the railway line. **OS:** Since land acquisition and resettlement support will be completed before the operation phase, no impact is expected during this stage.
15	Indigenous and ethnic people	✔		**CS:** No indigenous and ethnic people are identified in the Prior F/S. However, if JST identify the indigenous people through this preparatory survey, Indigenous people's plan shall be prepared. **OS:** Since there is no land acquisition and resettlement, operation activities that have a negative impact on indigenous and ethnic people are not expected.
16	Local economy such as employment and livelihood, etc.	✔		**Pre-CS/CS:** A negative impact on the livelihood of PAPs may be generated depending on land acquisition and resettlement. **OS:** A positive impact can be expected by reducing the congestion and improving the flow of goods and people. In addition, increased railway passengers will bring more business opportunities for local transport operators and shop owners surrounding stations.
17	Land use and utilization of local resources	✔		**CS:** There may be a negative impact on land acquisition for agricultural land along the railway line. **OS:** There is no land acquisition and resettlement in the operation phase.
18	Water Usage and its rights	✔		**CS:** Land acquisition and construction work may affect drinking water sources such as wells. **OS:** There is no impact on water use because of no land acquisition, and there is no additional impact on water use and its rights because Irrigation facilities and drinking water facilities such as waterworks and wells located in the Project area can be transferred as necessary.
19	Existing social infrastructure and services	✔		**CS:** - A negative impact on sensitive facilities such as schools, hospitals, and community centers may be occurred depending on land acquisition and traffic issues such as congestion and accidents. - The impact of the relocation of underground facilities is expected due to the construction work. **OS:** Improvement of accessibility by installing BR stations and by increasing number of trains is expected, by which there is a possibility of a positive impact on the use of social infrastructure such as school, hospital, etc., and on inter-city migration.

No.	Impact item	Evaluation		Reason for evaluation
		Pre-CS CS	OS	
20	Social institutions such as social infrastructure and local decision-making institutions	✔		**CS:** -A negative impact on sensitive facilities such as schools, hospitals, and community centers may be occurred depending on land acquisition and traffic issues such as congestion and accidents. -The impact of the relocation of underground facilities is expected due to the construction work. **OS:** Improvement of accessibility by installing BR stations and by increasing number of trains is expected, by which there is a possibility of a positive impact on the use of social infrastructure such as school, hospital, etc., and on inter-city migration.
21	Maldistribution of benefits and damages	✔		**CS:** Depending on the construction area, there may be a maldistribution of benefit and damage such as the prohibition of railway crossing and setting of the detour route. **OS:** There is no impact on maldistribution of benefits and damages because a doubletrack will be installed on the entire railway line, which is the same condition on all sections.
22	Local conflict of interest	✔		**CS:** Local people and Union councils may demand that construction contractor should supply employment opportunities equally as construction workers. **OS:** It is predicted that there is no local conflict of interest because the railway services are supplied for local communities evenly in principle.
23	Cultural heritage	✔	✔	**Pre-CS/CS:** It is predicted that there is no impact on religious and historical buildings such as temple under the current proposed alignment. But the existence of the impact should be confirmed to be sure after finalizing the alignment, if the buildings are located along the alignment. **OS:** There is no impact on religious and historical buildings because of no-additional land acquisition at the operation stage. But Existence of vibration impact by double-tracked operation should be confirmed, if the buildings are located along the alignment.
24	Landscape			**CS/OS:** There is no landscape conservation area designated by law and regulation along the alignment.
25	Gender	✔	✔	**CS:** There may be a gender gap regarding wage, salary, and treatment as construction workers. **OS:** Female passengers' personal safety and security may be a concern during congestion. Specific gender issues will be investigated during the survey.
26	Children's right	✔		**CS:** Negative impact on Children's rights is not estimated by the Project, but the impact possibility should be evaluated based on the information collected by the field survey. **OS:** There is no impact on children's rights by BR operation.
27	Health (Infectious diseases such as HIV/AIDS, etc.)	✔	✔	**CS:** Infectious diseases such as STD etc. may be spread by the inflow of construction workers. Additionally, Land use changes by soil cutting and soil filling may create new habitats for mosquitoes that can mediate dengue fever. **OS:** There is a possibility that STD and other infectious diseases spread by increasing the number of settlers and travelers after BR double-tracked operation.
28	Labor environment including labor safety	✔	✔	**CS:** It is necessary to improve the labor environment for construction workers following related laws and regulations. **OS:** - The appropriate labor environment for BR staff needs to be secured following related laws and regulations.

No.	Impact item	Evaluation		Reason for evaluation
		Pre-CS CS	OS	
Others				
29	Accidents	✔	✔	**CS:** Since construction-related vehicles use arterial roads, there is a possibility of increasing traffic accidents. **OS:** It is estimated that the risk of train accidents for local people and their livestock will be increased due to increasing number of running train.
30	Cross border impact and climate change	✔	✔	**CS:** Greenhouse gas emissions will increase slightly by reducing the absorbed amount of greenhouse gas by cutting trees along the alignment, operation of construction heavy machinery, and construction of structures. **OS:** Positive impact will be offered by modal sift from private cars, buses and dump truck to passenger train and freight train along the railway line. However, greenhouse gas emission is also caused by increasing number of running train.

Note: ✔: Items to be assessed, Pre-CS: Pre-Construction Stage, CS: Construction Stage, OS: Operation Stage
Source: JST

Table 12.16 Scoping for Bridges with Reasons Evaluated

No.	Impact Item	Evaluation		Reason for evaluation
		Pre-CS CS	OS	
Pollution				
1	Air pollution	✔		**CS:** Emission gas (NOx, SOx) and dust (SPM) will have a temporary negative impact on the air quality by construction heavy machines, dump trucks. **OS:** No notable impact is expected because of no emission.
2	Water pollution	✔		**CS:** Turbid water will be generated at bridge construction sites due to civil and excavation work. **OS:** No notable impact is expected because of no digging etc.
3	Waste	✔		**CS:** It is predicted that construction waste such as excavated soil is generated. **OS:** No notable impact is expected because of no digging etc.
4	Soil contamination	✔		**CS:** Leakage of oil from the heavy machine and dump track may contaminate the soil. **OS:** No notable impact is expected because of no digging etc.
5	Noise and vibration	✔	✔	**CS:** Noise and vibration from excavation works, construction heavy machines, dump trucks, and pile driving work may be generated. **OS:** BR's double-tracked operation issues additional noise and vibration by itself.
6	Ground subsidence	✔	✔	**CS/OS:** Construction activities that have a negative impact on underground water such as large-scale digging and water pumping are not scheduled in the Project. But there is still a possibility of ground subsidence in case of a soft foundation under the bridge section.
7	Offensive odor			**CS:** No notable impact is expected because of no campsite etc. **OS:** It is predicted that there is no impact on offensive odor
8	Bottom Sediment	✔		**CS:** Excavated soil at the construction site may be contaminated. **OS:** Operation activities on the bottom of water that have a negative impact on bottom sediment are not scheduled in the Project.

No.	Impact Item	Evaluation		Reason for evaluation
		Pre-CS CS	OS	
Natural Environment				
9	Protected area			**CS/OS:** There is no protected area along the bridge construction sites.
10	Ecosystem	✔		**CS:** There may be a negative impact on the aquatic ecosystem due to excavation works and discharge of waste from the bridge construction sites. **OS:** No notable impact is expected because of no digging etc.
11	Hydrology	✔		**CS:** River flow condition may be disturbed due to the construction. **OS:** River flow condition might be constant because the bridge piers should be installed in the same position as the existing bridges.
12	Geology and Topography			**CS/OS:** There is no specified and valuable geology and topography in and around the bridge.
Social Environment				
13	Land acquisition/ Resettlement			**CS/OS:** There is no land acquisition and resettlement at the bridge construction sites.
14	Poverty			**CS/OS:** There is no impact on Poverty due to no land acquisition or resettlement at the bridge construction sites.
15	Indigenous and ethnic people			**CS/OS:** There is no impact on Indigenous and ethnic people due to no land acquisition or resettlement at the bridge construction sites.
16	Local economy such as employment and livelihood, etc.	✔		**Pre-CS:** - There may be a negative impact on the livelihood of fishery operators and other relevant persons because of bridge construction. - There is a positive impact on local people economically as employment opportunities by the bridge construction for construction workers. **OS:** There is no land acquisition and resettlement in the operation phase.
17	Land use and utilization of local resources			**CS/OS:** There is no impact on Land use and utilization of local resources due to no land acquisition at the bridge construction sites.
18	Water use and its rights	✔	✔	**CS:** A negative impact on well water quality for drinking may be issued depending on the construction activities. Route of water vehicles (e.g. fishery boats and ships) passing may change due to the bridge construction. **OS:** There may be a negative impact on fishery rights due to the existence of bridge piers.
19	Existing social infrastructure and services	✔		**Pre-CS/CS:** If there is a service of fishery boat at the bridge construction sites. A negative impact on the service may be issued depending on the construction activities. **OS:** No notable impact is expected because of no obstacles etc.
20	Social institutions such as social infrastructure and local decision - making institutions			**CS/OS:** There is no community severance along the railway bridge area.
21	Maldistribution of benefit and damage	✔		**CS:** Depending on the construction activities, there may be a maldistribution of benefit and damage such as relocation of fishing area and hindering of their economy due to bridge construction. **OS:** No notable impact is expected because of no obstacles etc.
22	Local conflict of interest	✔		**CS:** Residents may complain about entering construction workers and the safety of their neighborhood. **OS:** There is no possible impact on local conflict of interest by the completion of the bridges.

No.	Impact Item	Evaluation		Reason for evaluation
		Pre-CS CS	OS	
23	Cultural Heritage			**CS/OS:** There is no impact on religious and historical buildings around the bridge construction sites.
24	Landscape			**CS/OS:** There is no landscape conservation area designated by law and regulation around the bridge construction sites.
25	Gender	✔		**CS:** There may be a gender gap regarding wage, salary, and treatment as construction workers. **OS:** There is no impact on Gender by the completion of the bridges.
26	Children's right	✔		**CS:** There is a possibility that children's compulsory education rights may be hindered because of customary child labor in the communities around the bridge construction sites. **OS:** There is no impact on children's rights by the completion of the bridges.
27	Health (Infectious diseases such as HIV/AIDS, etc.)	✔		**CS:** Infectious diseases such as HIV/AIDS, etc. may be spread by the inflow of construction workers. Additionally, Land use changes by soil cutting and soil filling may create new habitats for mosquitoes that can mediate dengue fever. **OS:** There is no impact on Health diseases by the completion of the bridges.
28	Labor environment including labor safety	✔		**CS:** It is necessary to improve the labor environment for construction workers following related laws and regulations. **OS:** There is no big change in the labor environment for residents by the completion of the bridges.
Others				
29	Accidents	✔	✔	**CS:** Since construction-related vehicles use arterial roads, there is a possibility of increasing traffic accidents. **OS:** It is estimated that the risk of train accidents by local people and their livestock will be increased due to increasing number of running train.
30	Cross border impact and climate change			**CS:** Gas emission from construction vehicles is not significant. No activities that will affect global warming are expected. **OS:** No notable impact is expected because of no emission.

Note: ✔: Items to be assessed, Pre-CS: Pre-Construction Stage, CS: Construction Stage, OS: Operation Stage

Source: JST

Table 12.17 Scoping for Related Facilities (Quarry and Construction Yard) with Reasons Evaluated

No.	Impact item	Evaluation	Reason for evaluation
		CS	
Pollution			
1	Air pollution	✔	Emission gas (NOx, SOx) and dust (SPM) are caused by some machines and dump trucks temporarily.
2	Water Pollution	✔	If the drainage is undeveloped, it may affect the surrounding water sources during rainfall.
3	Waste		No activity that will generate waste is expected.
4	Soil contamination	✔	Temporary soil contamination due to oil leakage that may be caused by using fuel for heavy machines and vehicles.
5	Noise and vibration	✔	Noise and vibration are caused by heavy machinery and dump trucks.

No.	Impact item	Evaluation	Reason for evaluation
		CS	
6	Ground subsidence		No activity that will cause land subsidence is expected.
7	Offensive odor		No activity that will cause offensive odor is expected.
8	Bottom Sediment	✔	- If the drainage is undeveloped, it may affect the surrounding water sources during rainfall. - Temporary soil contamination due to oil leakage that may be caused by using fuel for heavy machines and vehicles.
Natural Environment			
9	Protected area		As a basic policy, the registered site by the local government should be prohibited near protected area, so there will be no impact on the area.
10	Ecosystem	✔	If the amount of soil and crushed stones exceeds the expectations, the excavation range may be expanded, and the ecosystem may be affected. There is also a possibility of logging trees.
11	Hydrology		No activity that will cause hydrology is expected.
12	Geography and topography	✔	If the valuable geography and topography exist in the vicinity of the related facilities, it may affect geography and topography.
Social Environment			
13	Land acquisition/ Resettlement		As a basic policy, the registered site by the local government should be utilized, so there will be no land acquisition or resettlement.
14	Poverty		There is no impact on poverty due to no land acquisition or resettlement at the bridge construction sites.
15	Indigenous and ethnic people		There is no impact on Indigenous and ethnic people due to no land acquisition or resettlement at the bridge construction sites.
16	Local economy such as employment and livelihood, etc.		No activity that will impact on local economy and livelihood is expected.
17	Land use and utilization of local resources	✔	If the amount of soil and crushed stones exceeds the expectations, the excavation range may be expanded, and land use and utilization of local resources may be affected.
18	Water use and its rights	✔	If the amount of soil and crushed stones exceeds the expectations, the excavation range may be expanded, and Water use, and its rights may be affected.
19	Existing social infrastructure and services	✔	A negative impact on sensitive facilities such as existing roads, schools, hospitals, and community centers will be temporarily affected due to frequent dump truck traffic.
20	Social institutions such as social infrastructure and local decision - making institutions		No activity that will impact on social institutions is expected.
21	Maldistribution of benefit and damage		No activity that will impact on maldistribution of benefit and damage is expected.
22	Local conflict of interest	✔	If the amount of soil and crushed stones exceeds the expectations, the excavation range may be expanded, and Local conflict may occur between the owner and residents.
23	Cultural Heritage	✔	Some negative impacts may occur if there is a cultural heritage near the Project area.
24	Landscape	✔	If the amount of soil and crushed stones exceeds the expectations, the excavation range may be expanded, and the Landscape may be affected.
25	Gender		No activity that will impact on gender is expected.
26	Children's right		No activity that will impact on children's rights is expected.

No.	Impact item	Evaluation	Reason for evaluation
		CS	
27	Health (Infectious diseases such as HIV/AIDS, etc.)		No activity that will impact on health is expected.
28	Labor environment including labor safety	✔	It is necessary to secure an appropriate working environment following relevant laws.
Others			
29	Accidents	✔	Traffic accidents may increase because construction vehicles utilize the main road to the construction site.
30	Cross border impact and climate change		No activity that will impact on cross-border impact and climate change is expected.

Note: ✔: Items to be assessed by the contractors, CS: Construction Stage

Source: JST

12.4 TOR for ESC Surveys

Terms of Reference (TOR) of the Environmental and Social Consideration Survey (ESC Survey) and the survey points and area are shown below.

Table 12.18 Content of ESC Survey

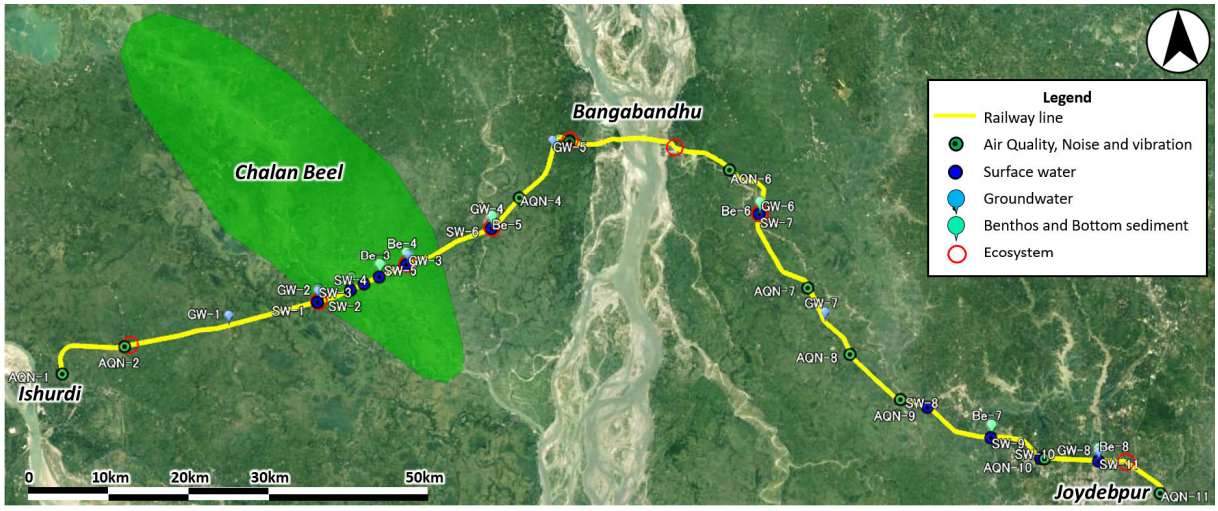
No.	Impacted Item	Sampling/Site Measurement Survey	Analysis and Method
Pollution			
1	Air Quality	I. Field survey (1) 11 points (Ishurdi St, Mooladuli St., Boral Bridge St., Ullapara St., Shahid M. Mansur Ali St., Mosjid St., Mirzapur St., Dherua Rail Overpass, Near Mouhak St., Near crossing point with N3 Rd., Joydebpur St.) (2) Item: SO_2, CO, NO_2, O_3, PM_{10}, $PM_{2.5}$, Temperature, Moisture, Precipitation, Wind direction and speed From 6:00 to 21:00 (3) Frequency: Once (Dry season) II. Impact during construction	I. Comparison of survey results with existing survey results and standard values. II. Confirm the contents of construction, method, period, area, type of construction machine, its operating position and period, number of construction vehicles, its period, and running route.
2	Water Quality	I. Field survey **Surface Water** (1) 11 points (1 point near Boral Bridge St., 2 points between Sharantnagar St. and Dilpashar St., 2 points between Dilpashar St and Lahirimohanpur St., 1 point between Ullapara St. and Salop St., 1 point between Elenga St. and Tangail St., 2 points between Mirzapur St. and High-Tech City St., 1 point near Mouchak St., 1 point between Mouchak St. and Joydebpur St.) (2) Item: Water temperature, pH, Turbidity, TOC, BOD, COD, T-N, T-P, Oil and grease, TSS, DO, Total coliform bacteria. (3) Frequency: Twice (Rainy season and Dry season) **Ground Water** (1) 8 points (1 point near Chatmohar St., 1 point at Boral Bridge St., 1 point near Lahirimohanpur St., 1 point between Ullapara St. and Salop St., 1 point between Jamtoil St. and Shahid M. Mansur Ali St., 1 point between Elenga St. and Tangail St., 1 point between Mosjid St. and Mohera St., 1 point between Mouchak St. and Joydebpur St.) (2) Item: pH, TDS, As, Fe, Mn, Chloride	I. Comparison of survey results with existing survey results and standard values. II. Confirm the contents of construction, method, period, area, type of construction machine, its operating position and period, number of construction vehicles, its period, and running route.

No.	Impacted Item	Sampling/Site Measurement Survey	Analysis and Method
		(3) Frequency: Twice (Rainy season and Dry season) II. Impact during construction	
3	Waste and hazardous materials	(1) Site measurement - Registered final disposal sites as proposal adjacent to the Project alignment (2) Item: Basic information and photo for the disposal site (e.g.: Total capacity, remaining capacity, established year, accepted types of waste, owner etc.) (3) Frequency: One times	- Information collection on registered construction waste disposal sites along the alignment. - Quantitative prediction
4	Noise and Vibration	I. Field survey (1) 11 same points as the ones of Air Quality **Add the sampling points adjacent to the sensitive buildings such as school, hospital and heritage, if existed in and around the Project site.** Note) In the selection of the measurement location have to give priority to the sensitive facilities of noise impact, such as schools, hospitals, residential area, so on. (2) Item: Noise: L_{Amax}, L_{Amin}, L_{Aeq}, From 6:00 to 21:00 Vibration: La: Vibration as accretion, Lv: Vibration as velocity (3) Frequency: Once (Dry season) II. Noise/vibration level during construction and operation at the representative section III.Impact during construction	I. Comparison of survey results with existing survey results and standard values. II. Noise: Quantitative prediction (Railway noise on the CROW and at sensitive points if any/ LAeq dB(A)) Vibration: Quantitative prediction (Railway vibration on the CROW and at sensitive points if any / Lv dB) III.Confirm the contents of construction, method, period, area, type of construction machine, its operating position and period, number of construction vehicles, its period, and running route.
5	Bottom Sediment	I. Field survey (1) 8 points (Boral Bridge St., 1 point between Sharantnagar St. and Dilpashar St., 2 points between Dilpashar St and Lahirimohanpur St., 1 point between Ullapara St. and Salop St., 1 point between Elenga St. and Tangail St., 1 point between Mirzapur St. and High-Tech City St., 1 point between Mouchak St. and Joydebpur St.) (2) Item: Cd, Pb, Cr, Cr6+, As (4) Frequency: One time (Dry season) II. Impact during construction	I. Comparison of survey results with standard values. II. Confirm the contents of construction, method, period, area, type of construction machine, its operating position and period, number of construction vehicles, its period, and running route.
Natural environment			
6	Ecosystem	**I. Identification** (1) Site measurement: 8 areas (1 km radius from the point) (Mooladuli St., Boral Bridge St., 1 area near Lahirimohanpur St., 1 area between Ullapara St. and Salop St., Shahid M. Mansur Ali St., Bangabandhu Setu East St., 1 area between Elenga St. and Tangail St., 1 area between Mouchak St. and Joydebpur St.) Data collection: Map and location of Natural conservation area in and around the Project alignment. (2) Target: Affected flora and fauna by the Project (3) Item Terrestrial and aquatic flora: Species name, Scientific name and Distribution including categorization of IUCN Red list Terrestrial and aquatic fauna: Vertebrate and Invertebrate including Mammals, Amphibia, Reptile, Aves, Rhopalocera,	Information collection through existing literature survey and field survey

No.	Impacted Item	Sampling/Site Measurement Survey	Analysis and Method
		Insects and Fishes with categorization of IUCN Red list (4) Frequency: Twice (Rainy season and Dry season) (5) Secondary data including the IUCN red category of fauna and flora identified in Chalan Beel and Bhawal National Park **II. Tree counting** (1) Site measurement: North side from the existing railway with 30 m width (2) Target: Affected tree by the Project (3) Item: Number and species of all affected trees, Coordinate data of affected endangered trees (Especially, Dipterocarpus turbinatus, Swietenia mahagoni, and Aegle marmelos)	
7	Benthos	(1) Site measurement: 8 points (Same as the points for Bottom Sediment survey) (2) Target: Affected species by the construction (3) Item: Species name and Scientific name (4) Frequency: One time (Dry season)	Information collection through existing literature survey and field survey
8	Climate inventory and analysis	Secondary data collection	Estimation result of future traffic volume, JICA Climate FIT
9	General topography and geology	Substitution of topographic and geological survey result	-
10	Hydrological situation	Secondary data collection, if any	-
Social Environment			
11	Socio-economic profile	Census data, Secondary data collection	-
12	Land use	Secondary data collection, site survey	-
13	Land use and utilization of local resources	Secondary data collection, site survey	-
14	Existing social infrastructures and services	Secondary data collection, site survey	-
15	Local economy and livelihood	Secondary data collection, site survey	-
16	Cultural and historical heritage, religious facilities, other sensitive facilities	Secondary data collection, site survey	-
17	Public health (sanitation and infectious diseases such as HIV/AIDS)	Secondary data collection	-
18	Occupational health and safety	Secondary data collection	-
Others			
19	Accidents	Collection of traffic accident data from police station, if any	-
20	Flood and other natural disaster risk	Literature survey such as disaster record owned by related authority	-

No.	Impacted Item	Sampling/Site Measurement Survey	Analysis and Method
21	Borrow-pit and soil disposal	(1) Site measurement Registered Borrow-pits and Soil disposal sites as proposal adjacent to the Project alignment (2) Item: - Basic information and photo for the sites (e.g.: Total capacity, remaining capacity, registered year, owner etc.) - Administrative procedure including license name, responsible agency (3) Frequency: One times	-

Source: JST



Source: JST

Figure 12.19 Survey Points and Areas

12.5 Survey Results

12.5.1 Air Pollution

(1) Survey

The air quality survey in 2018 was conducted by WHO in Gazipur, which is set as the end point of the project, and especially the value was ranked 12th (95.33 μg/m^3) for $PM_{2.5}$ and 19th (156.08 μg/m^3) for PM_{10} respectively from the bottom among 3,000 cities in the world. Therefore, it can be said that the air quality in Gazipur has an extremely poor condition[19]. The air quality survey for the project was conducted in March 2023 during the dry season, and the result is as follows. All other items are below environmental standards at all sites except for the values of $PM_{2.5}$ at almost points, and the values of $PM_{2.5}$ and NO_2 at Joydebpur (Gazipur), therefore it can be said that the air quality along the alignment is still not good. Main factors of air pollution include rapid population growth in Bangladesh, traditional cooking styles, and soot/smoke due to brick production. There could be large-scale pollution source facility such as emission from industrial factories and vehicles running on main roads along or across the alignment in some sections.

[19] Air quality database 2022, WHO

Table 12.19 Survey Results

Location	Coordinate	Time	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	CO (mg/m^3)	NO_2 ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	O_3 ($\mu g/m^3$)
AQN1. Ishwardi Junction area	24°7' 57.3810"N 89°3' 48.7938"E	Day	62.21	**91.15**	1.42	21.37	73.33	74.20
		Night	58.53	**87.69**	0.90	19.87	64.31	73.97
AQN2. Mooladuli station area	24° 9' 49.8744"N 89° 8' 28.0104"E	Day	108.32	**138.27**	0.88	81.08	138.75	64.32
		Night	123.98	**122.52**	0.89	64.76	109.96	73.97
AQN3. Boral Bridge Station	24°12'53.5386"N 89°22'47.1246"E	Day	82.44	**79.24**	0.88	63.99	67.77	43.35
		Night	111.54	63.86	0.91	54.45	34.75	72
AQN4. Dherula (Jotibari) rail crossing	24°20' 0.6612"N 89°37'42.7506"E	Day	90.65	49.69	0.88	14.40	24.57	51.22
		Night	80.25	43.58	0.91	12.64	19.97	43.11
AQN5. Shahid M. Mansur Ali Station	24°23'50.8842"N 89°41' 26.2824"E	Day	83.88	63.88	0.61	66.56	103.32	89.09
		Night	105.62	**75.62**	0.85	53.94	87.27	62.90
AQN6. Analia Bari crossing (Crossing point N3 road) area	24°21' 54.9102"N 89°53' 20.8458"E	Day	76.72	**76.66**	0.46	71.85	106.60	62.52
		Night	106.32	**101.98**	0.75	68.99	86.63	69.44
AQN7. Kashil Railway Crossing	24°13' 52.5714"N 89°59' 8.5236"E	Day	62.14	**67.40**	0.46	32.74	19.86	62.52
		Night	50.36	57.11	0.75	19.32	17.83	69.44
AQN8. Mohera Railway Station	24°9' 22.1718"N 90°2' 15.7842"E	Day	112.22	**94.44**	0.41	27.37	102.28	16.63
		Night	74.37	**77.47**	0.83	22.22	100.97	52.32
AQN9. Mirzapur Railway Station	24°6'12.5562"N 90°5' 37.8702"E	Day	84.56	**65.61**	1.05	86.49	113.47	82.38
		Night	94.90	62.76	0.92	79.97	106.80	74.61
AQN10. Ratanpur Railway Station	24°2' 21.2634" N 90°16'38.2332"E	Day	105.68	**82.63**	0.47	64.07	108.59	10.85
		Night	101.87	**71.57**	0.31	57.43	99.31	19.59
AQN11. Joydebpur Railway Station	23° 59' 58.434"N 90°25' 13.2594"E	Day	**167.26**	**103.48**	1.55	**101.58**	187.87	112.97
		Night	111.97	**99.32**	1.84	89.72	112.66	72.06
DoE			150	65	10	100	365	235
IFC			150	75	-	200	125	100

Note: Measurement values that exceed the NEQ Guideline values are shown in a boldfaced word.

Source: JST, Statutory Rules and Order No. 220, 2005, Government of Bangladesh/ Environmental, Health, and Safety Guidelines (2007), IFC

(2) Prediction

A quantitative prediction was expected, but a confident evaluation of the prediction result could not be made due to underdevelopment of general environmental data in Bangladesh, including wind direction and speed, a flux of insolation, atmospheric radiant quantity, cloudiness, and atmospheric stability. Therefore, a qualitative prediction was implemented.

1) Construction phase

Based on the current status of air quality along the alignment, the construction heavy machines and dump trucks may cause further traffic congestion and deterioration of atmospheric environment. However, this impact is not severe because of the following reasons:

- Most of the earthworks is limited only to banking construction along the alignment

- Since most sections do not overlap with arterial roads, traffic congestion due to heavy equipment operation does not occur.
- Proper work schedules will be developed so that the construction equipment will not be concentrated at a certain point for a long time.

2) Operation phase

Although the project alignment intersects with a trunk road with heavy traffic at many points, the project section running parallel to the trunk road is only approx. 12 km in the east-west section, which sandwiches the Bangabandhu Bridge, out of the total project length of 168 km. Additionally, the parallel trunk road is located on the south side of the alignment in the all sections, so the impact of road traffic on the study, which targets the north side of the alignment, is considered to be minor. Therefore, the number of trains shall be considered in the impact assessment of the project without considering the future road traffic volume because diesel trains themselves also emit air pollutants. The number of trains is planned to increase from the current 25 trains per day to 68 trains per day, which is only a slight increase of 1.04 to 2.83 trains per hour. Therefore, the impact on the surrounding environment is expected to be negligible.

12.5.2 Water Pollution

(1) Survey

Water quality survey along the alignment, was carried out in August 2022 during the rainy season, and in November and December 2022 during dry season. The location of water quality sampling and a summary of the results are shown in the below table. Regarding groundwater quality, the values of Iron and Manganese exceeded the environmental standard of Bangladesh at some points during both seasons, in particular, those values in the dry season are higher than those in the rainy season. But the groundwater quality environment cannot be said to be poor because standard values for iron and manganese in drinking water are set not from a health standpoint, but rather as "items related to daily life problems" such as coloration of drinking water and poor taste according to the Waterworks Act, Japan[20].

For surface water quality measurement, in comparing against the Bangladesh standards values, values of Total Coliforms were higher than the standard value at some points in the rainy season as agricultural lands are nearby; because use of organic fertilizers (e.g. cow dung etc.) is a common practice in rural areas of Bangladesh. And there are several small textile factories near SW10, which indicates much higher BOD, COD, coliform values than the other locations.

(2) Prediction

Regarding the treatment of domestic wastewater and industrial-related drainage along the alignment, it is discharged untreated into rivers and lakes. In the rainy season, the rainwater mixed with sewage

[20] http://www.jagh.jp/jp/g/activities/torikichi/faq/77.html, Japan Association of Groundwater Hydrology

overflows into the rivers and lakes resulting in the deterioration of the sanitary environment. Additionally, turbid water may be generated from the bridge construction work, so further deterioration of water quality may occur. However, this impact is not severe because of the following reasons:

- Earthwork is limited to excavation for construction of bridge piers.
- Temporary cofferdam construction method using sheet piles, which is used in general construction projects shall be adopted during construction of bridge piers to keep water quality.

Adding to the above, mitigation measures such as the installation of settle basins at every construction site and the wastewater treatment system at the construction yard should be installed not to deteriorate the water quality. In the operation phase, there is a possibility of discharged organic wastewater from the toilet installed at every station, but the wastewater treatment system at every station should be also installed to keep the water quality.

Table 12.20 Result of Ground Water Quality in Rainy Season

No.	Location	Arsenic	Chloride	Iron	Manganese	pH	TDS
Unit		mg/L	mg/L	mg/L	mg/L	-	mg/L
GW1	Chatmohor railway Station, Mulgram, Chatmohar, Pabna	0.001	35	0.62	**0.48**	7.5	302
GW2	Chala Bazar, Jhawail, Kamarkhanda, Sirajganj	0.001	20	**3.66**	**0.81**	7.9	140
GW3	Boral Bridge, Bhangura Paurashava, Bhangura, Pabna	0.001	30	0.13	**0.80**	7.8	282
GW4	Lahiri Mohonpur Station Road, Bara Pangashi, Ullah Para, Sirajganj	0.004	15	0.57	0.03	8.0	44
GW5	Ghaitna Shahjahanpur Railway Bridge, Ullah Para Paurashava, Ullah Para, Sirajganj	0.008	30	**2.11**	**1.34**	7.7	122
GW6	24 Fatikjani Govt Primary School, Elenga, Kalihati, Tangail	0.021	40	**1.43**	**0.99**	7.8	260
GW7	Patkhaguri Rail Crossing, Habla, Basail	0.001	20	0.52	**0.28**	7.8	127
GW8	Mirergao Railway Bridge, Konabari, Gazipur Sadar	0.001	20	0.05	0.03	7.9	120
Bangladesh Standards for drinking water		0.05	150 - 600	0.3 – 1.0	0.1	6.5 - 8.5	1000
WHO		0.01	-	0.3	0.1	-	-

Note: Bolded values exceed standard values, TDS (Total Dissolved Solid), Samling date is from 14th to 18th Aug 2022.

Source: JST, The Environment Conservation Rules, 1997, Department of Environment/ Guidelines for Drinking-water Quality, WHO

Table 12.21 Result of Ground Water Quality in Dry Season

No.	Location	Arsenic	Chloride	Iron	Manganese	pH	TDS
Unit		mg/L	mg/L	mg/L	mg/L	-	mg/L
GW1	Chatmohor railway Station, Mulgram, Chatmohar, Pabna	0.001	30	**2.44**	**0.64**	7.4	340
GW2	Chala Bazar, Jhawail, Kamarkhanda, Sirajganj	0.002	20	**6.53**	**0.92**	7.6	150
GW3	Boral Bridge, Bhangura Paurashava, Bhangura, Pabna	0.001	25	0.56	**0.91**	7.4	280

No.	Location	Arsenic	Chloride	Iron	Manganese	pH	TDS
GW4	Lahiri Mohonpur Station Road, Bara Pangashi, Ullah Para, Sirajganj	0.015	20	**6.55**	**0.89**	7.5	140
GW5	Ghaitna Shahjahanpur Railway Bridge, Ullah Para Paurashava, Ullah Para, Sirajganj	0.007	35	**3.78**	**2.09**	7.4	195
GW6	24 Fatikjani Govt Primary School, Elenga, Kalihati, Tangail	0.023	50	**2.25**	**1.31**	7.5	320
GW7	Patkhaguri Rail Crossing, Habla, Basail	0.002	15	**1.55**	**0.31**	7.8	95
GW8	Mirergao Railway Bridge, Konabari, Gazipur Sadar	0.001	20	0.66	0.03	7.8	126
Bangladesh Standards for drinking water		0.05	150 - 600	0.3 – 1.0	0.1	6.5 - 8.5	1000
WHO		0.01	-	0.3	0.1	-	-

Note: Bolded values exceed standard values, TDS (Total Dissolved Solid), Samling date is from 27th Nov to 3rd Dec 2022.

Source: JST, The Environment Conservation Rules, 1997, Department of Environment/ Guidelines for Drinking-water Quality, WHO

Table 12.22 Result of Surface Water Quality in Rainy Season

No.	Location	BOD	COD	DO	pH	TSS	Turbidity	Oil and Grease	TOC	Total Phosphate	Total Nitrogen	Total Coliforms
Unit		mg/L	mg/L	mg/L	mg/L	-	NTU	mg/L	mg/L	mg/L	mg/L	CFU/100ml
SW1	Boral Bridge, Bhangura Paurashava, Bhangura, Pabna	28	120	3.60	7.2	5	39.8	Less than 2	5.8	Less than 0.5	7.9	**5,000**
SW2	Gumani Bridge, Bhangura, Pabna	27	112	3.25	7.3	12	96.7	Less than 2	6.5	Less than 0.5	12.2	**1,400**
SW3	Baonjan Railway Bridge, Dil Pasar, Bhangura, Pabna	20	84	3.60	7.3	9	76.6	Less than 2	Less than 5	Less than 0.5	Less than 2	400
SW4	Dilpashar Railway Bridge, Dil Pashar, Bhangura, Pabna	28	112	3.70	7.3	8	73.7	Less than 2	Less than 5	Less than 0.5	Less than 2	200
SW5	Lahiri Mohonpur Station Road, Bara Pangashi, Ullah Para, Sirajganj	25	96	4.10	7.4	15	206	Less than 2	Less than 5	Less than 0.5	Less than 2	**1,500**
SW6	Ghaitna Shahjahanpur Railway Bridge, Ullah Para Paurashava, Ullah Para, Sirajganj	27	108	3.17	7.6	6	57	Less than 2	5.9	Less than 0.5	11.05	500
SW7	Tangail Bridge, Elenga, Kalihati, Tangail	24	96	3.30	7.6	27	430	Less than 2	5.5	Less than 0.5	Less than 6.6	600
SW8	Dherua Rail Overpass, Gorai, Mirzapur, Tangail	26	100	2.96	7.4	3	18.5	Less than 2	Less than 5	Less than 0.5	3.9	200
SW9	Kaliakoir Railway bridge, Kaliakoir Paurashava, Kaliakoir, Gazipur	25	96	7.60	7.6	18	260	Less than 2	5.8	Less than 0.5	9.95	**7,400**
SW10	Rail line Bridge, West Chandora, Mouchak, Kaliakoir, Gazipur	**60**	244	2.50	7.7	14	109	Less than 2	15.6	Less than 0.5	42.4	**10,000**
SW11	Mirergao Railway Bridge, Salna, Kayaltia, Gazipur Sadar	30	120	2.65	7.5	21	197	Less than 2	Less than 5	Less than 0.5	Less than 2	**6,600**
Bangladesh Standards for Sewage Discharge		40	-	-	6.5 – 8.5	100	-	-	-	35	250	1,000 or less
IFC		30	125	-	6 - 9	50	-	10	-	2	10	400

Note: Bolded values exceed standard values, BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), DO (Dissolved Oxygen), TSS (Total Suspended Solid), TOC (Total Organic Carbon), Sampling date is from 14th to 18th Aug 2022.

Source: JST, The Environment Conservation Rules, 1997, Department of Environment/ Environmental, Health, and Safety (EHS) Guidelines (2007), IFC

Table 12.23 Result of Surface Water Quality in Dry Season

No.	Location	BOD	COD	DO	pH	TSS	Turbidity	Oil and Grease	TOC	Total Phosphate	Total Nitrogen	Total Coliforms
Unit		mg/L	mg/L	mg/L	mg/L	-	NTU	mg/L	mg/L	mg/L	mg/L	CFU/100ml
SW1	Boral Bridge, Bhangura Paurashava, Bhangura, Pabna	1	4	6.44	8.1	7	29.1	Less than 2	108	0.81	Less than 2	300
SW2	Gumani Bridge, Bhangura, Pabna	2	8	6.15	8.0	8	36.5	Less than 2	103	0.85	Less than 2	130
SW3	Baonjan Railway Bridge, Dil Pasar, Bhangura, Pabna	2	8	6.20	7.8	6	24.4	Less than 2	51	Less than 0.5	Less than 2	12
SW4	Dilpashar Railway Bridge, Dil Pashar, Bhangura, Pabna	2	8	6.16	7.8	5	15.7	Less than 2	84	Less than 0.5	Less than 2	45
SW5	Lahiri Mohonpur Station Road, Bara Pangashi, Ullah Para, Sirajganj	3	12	5.90	7.7	5	19.1	Less than 2	52	0.74	Less than 2	26
SW6	Ghaitna Shahjahanpur Railway Bridge, Ullah Para Paurashava, Ullah Para, Sirajganj	2	8	6.14	7.7	6	20.3	Less than 2	75	0.69	Less than 2	10
SW7	Tangail Bridge, Elenga, Kalihati, Tangail	6	24	5.60	7.8	8	94.5	Less than 2	49	Less than 0.5	Less than 2	97
SW8	Dherua Rail Overpass, Gorai, Mirzapur, Tangail	5	20	5.30	7.7	8	12.6	Less than 2	Less than 5	Less than 0.5	Less than 2	0
SW9	Kaliakoir Railway bridge, Kaliakoir Paurashava, Kaliakoir, Gazipur	6	24	5.20	7.6	12	42.7	Less than 2	14	Less than 0.5	Less than 2	500
SW10	Rail line Bridge, West Chandora, Mouchak, Kaliakoir, Gazipur	45	172	2.40	7.1	23	68.2	Less than 2	17	10.4	41.7	0
SW11	Mirergao Railway Bridge, Salna, Kayaltia, Gazipur Sadar	6	24	5.35	7.5	11	24.6	Less than 2	138	0.64	Less than 2	0
Bangladesh Standards for Sewage Discharge		40	-	-	6.5 – 8.5	100	-	-	-	35	250	1,000 or less
IFC		30	125	-	6 - 9	50	-	10	-	2	10	400

Note: Bolded values exceed standard values, BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), DO (Dissolved Oxygen), TSS (Total Suspended Solid), TOC (Total Organic Carbon), Samling date is from 27th Nov to 3rd Dec 2022.

Source: JST, The Environment Conservation Rules, 1997, Department of Environment/ Environmental, Health, and Safety (EHS) Guidelines (2007), IFC

12.5.3 Waste

(1) General waste

In Bangladesh, waste management services vary significantly between rural and urban areas due to differences in population density, infrastructure, and resources.

1) Rural area

In rural areas, waste management services are often limited or non-existent, and waste is typically disposed of in open spaces or burned. People bury their organic wastes in small holes nearby, while inorganic wastes are often dumped openly near low-lying areas. Dry waste, including plastic, paper, and metal, is also often dumped openly in low-lying areas. However, in some places, recyclable products are sold to recyclers, which can help reduce waste and promote sustainability. The lack of waste management infrastructure and services in rural areas is due to limited resources and funding, as well as a lack of awareness about the importance of proper waste management. Some NGOs and community-based organizations have implemented initiatives to improve waste management in rural areas, such as composting programs, but more efforts are needed to address the challenges.

2) Urban area

In contrast, in the areas under the city corporation, authorities collect organic waste from dustbins which are provided for every 7-8 households. This is a formal waste management practice implemented in some urban areas. The waste collected is then transported to a landfill or composting facility for proper disposal or recycling. However, there are still some challenges in the urban areas, such as inadequate waste collection and disposal infrastructure, which can lead to illegal dumping and littering. Additionally, the recycling industry in Bangladesh is still in its early stages, and more efforts are needed to promote recycling in both rural and urban areas.

Overall, waste management in both rural and urban areas of Bangladesh remain a significant challenge. The government, NGOs, and other stakeholders need to work together to improve waste management infrastructure, increase awareness about the importance of proper waste management, and promote sustainable waste management practices.

(2) Construction generated soil

It is expected that land modification will occur along the alignments, with a total of 3,066,881 m^3 of excavated soil. BR plans to reuse the excavated soil generated at these sites as embankment material for double track section, level raising for local houses, and the other local facilities because local communities will strongly require a large amount of soil due to lowland or wet land.

(3) Logged trees

As a result of the tree counting survey, it is estimated that more than 75,000 affected trees will be generated. In the ongoing Bangabandhu Bridge construction project, the logged trees are placed under the control of the Forest Department, which holds an auction for sale. The landowner and the Forest

Department will share the proceeds of the sale. Therefore, all logged trees are reused and are not disposed of as waste.

(4) Prediction

As a result of the above, most of the construction soil and logged trees will be reused, so little waste is expected to be generated. However, solid waste generated from the worker base campsite will need to be properly disposed of following the regulations and rules stipulated by each district and Upazila.

12.5.4 Soil Contamination

As a result of the field survey, no factories or other facilities handling heavy metals are located adjacent to the alignment, and interviews with nearby communities did not reveal any symptoms attributable to soil contamination; therefore, no negative impacts are expected. On the other hand, since there is concern about the impact of soil contamination due to oil and grease leaks from heavy machinery during construction and from running trains during operation as already mentioned, periodic maintenance should be taken as a mitigation measure.

12.5.5 Noise and Vibration

(1) Survey

1) For surrounding environment

(a) Noise

A noise survey was conducted in March 2023 during dry season at the same points of Air quality survey. Day and night-time-averaged noise levels are shown below and compared with Bangladeshi standards for residential zone, mixed areas and commercial areas respectively. As a result, noise level at all the survey points except for No.6 “Analia Bari crossing area” is within the standard. Regarding No.6, the values in both times have an impact on the road traffic noise. Therefore, it can be said that the noise environment along the alignment is generally satisfied.

Table 12.24 Noise Survey Results

Location name		Unit	Day time				Night time			
			Lmax	Lmin	Leq	Standard	Lmax	Lmin	Leq	Standard
1	Ishwardi Junction area	dB	83.4	41.6	62.5	70	81.3	37.8	55.9	60
2	Mooladuli station area		91.2	42.4	65.6	70	88.7	41.1	52.0	60
3	Boral Bridge Station area		89.7	42.2	58.3	60	91.3	37.4	48.9	50
4	Dherula (Jotibari) rail crossing		98.6	38.1	45.9	55	91.3	34.2	44.2	45
5	Shahid M. Mansur Ali Station		99.4	40.5	55.1	60	101.3	32.5	44.7	50

Location name		Unit	Day time				Night time			
			Lmax	Lmin	Leq	Standard	Lmax	Lmin	Leq	Standard
6	Analia Bari crossing (Crossing point N3 road) area	dB	97.6	45.5	**60.0**	55	98.6	34.9	**50.6**	45
7	Kashil Railway Crossing		96.3	39.2	53.6	55	93.3	31.2	44.8	45
8	Mohera Railway Station area		94.6	39.2	51.4	55	94.5	31.2	43.4	45
9	Mirzapur Railway Station area		94.6	35.9	48.5	60	93.4	34.8	48.3	50
10	Ratanpur Railway Station area		95.4	54.6	62.5	70	95.2	39.4	48.1	60
11	Joydebpur Railway Station area		94.2	56.1	67.1	70	93.4	40.6	50.8	60
GoB Noise standard			Residential Zone			55	Residential Zone			45
			Mixed Area			60	Mixed Area			50
			Commercial Area			70	Commercial Area			60
			Industrial Area			75	Industrial Area			70
IFC standard			Residential; institutional; educational			55	Residential; institutional; educational			45
			Industrial; commercial			70	Industrial; commercial			70

Note: Bolded values exceed standard values, dB, Samling date is from 9th to 19th Mar 2023.

Source: JST, The Environment Conservation Rules, 1997, Department of Environment/ Environmental, Health, and Safety (EHS) Guidelines (2007), IFC

(b) Vibration

A vibration survey was conducted in March 2023 during dry season at the same points of air quality survey and noise survey. Day and night-time-averaged vibration velocity is shown below and compared with Australian standards for Residential zone, Mixed areas and Commercial areas respectively due to non-standard in Bangladesh. As a result, vibration velocity at all the survey points except for No.6 “Analia Bari crossing area” is within the standard. Regarding No.6, the values in both times have an impact on the road traffic vibration. Therefore, it can be said that the vibration environment along the alignment is generally satisfied.

Table 12.25 Vibration Survey Results

Location name		Peak Velocity (mm/s)		Australian Standard (mm/s)	
		Day	Night	Day	Night
1	Ishwardi Junction area	0.73	0.69	2.2	2.2
2	Mooladuli station area	0.77	0.67	2.2	2.2
3	Boral Bridge Station area	0.69	0.56	1.1	1.1
4	Dherula (Jotibari) rail crossing	0.43	0.40	0.56	0.40
5	Shahid M. Mansur Ali Station	0.46	0.42	1.1	1.1
6	Analia Bari crossing (Crossing point N3 road) area	**0.62**	**0.55**	0.56	0.40

Location name		Peak Velocity (mm/s)		Australian Standard (mm/s)	
		Day	Night	Day	Night
7	Kashil Railway Crossing	0.45	0.39	0.56	0.40
8	Mohera Railway Station area	0.41	0.38	0.56	0.40
9	Mirzapur Railway Station area	0.60	0.51	1.1	1.1
10	Ratanpur Railway Station area	0.58	0.55	2.2	2.2
11	Joydebpur Railway Station area	0.60	0.52	2.2	2.2

Note: Bolded values exceed standard values, Samling date is from 9th to 19th Mar 2023.
Source: JST, AS 2670.2–1990, Department of Environment and Conservation, Australia.

2) For running train

Since there is no change in the specifications of the trains that will be added at the prospective operation phase, maximum noise level (LAmax), noise exposure levels (LAE), and equivalent noise level (LAeq) of trains were measured at a distance of 30 m from existing alignment as the table below during the passage of the trains in order to predict the equivalent noise levels along the alignment in the future. All the trains targeted are approx. 70 km/h and their length is about 300 m. No standards have been established for conventional railways in any other countries including Bangladesh and Japan.

Table 12.26 Result of Noise Exposure Levels during Train Passage

Location	LAmax	LAE	LAeq
Kalihati, Tangail	89.0 dB	94.7 dB	76.9 dB
	95.9 dB	99.2 dB	79.1 dB
Tangail, Tangail	89.8 dB	91.4 dB	74.4 dB
	85.2 dB	94.1 dB	73.3 dB
Mirzapur, Tangail	92.1 dB	101.7 dB	80.9 dB
Average	91.8 dB	97.8 dB	77.8 dB

Source: JST, Assay date is from 23rd and 24th Nov 2022.

(2) Prediction

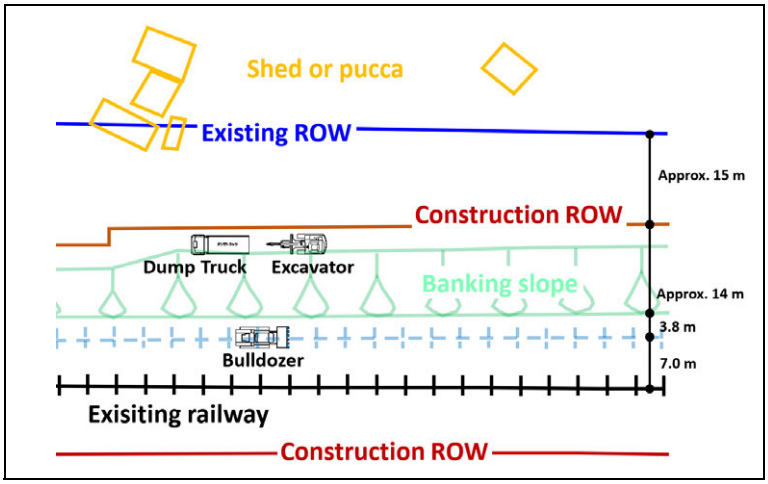
1) Construction phase

Since embankment construction is the construction type that accounts for a large section of the construction project, its noise and vibration levels are the target of the prediction. As described below, noise and vibration levels will not be expected as a significant impact, but the use of low-noise and low-vibration heavy equipment type should be proposed as a mitigation measure. The main heavy equipment commonly used are an excavator (0.7 m^3), a bulldozer (6 t), and a dump truck, and their noise and vibration output levels are shown in the table below. These are assumed to be located north side of the existing line, and noise and vibration levels are predicted on the Construction Right of Way (CROW). Since Bangladesh has no specified standards for noise and vibration during construction, the values set by the Tokyo Metropolitan Government are used as a reference.

Table 12.27 Standards for Regulation of Noise and Vibration Generated by Specific Construction Work

Construction activity	Noise level	Vibration level
Construction work using backhoe and bulldozer	80 dB	70 dB

Source: Tokyo Metropolitan Environmental Security Ordinance, Tokyo Metropolitan Government



Source: JST

Figure 12.20 Typical Construction Yard Arrangement of Embankment Filling

Table 12.28 Noise and Vibration Generated by Construction Machines for Embankment Filling

	Construction machine	Noise power level (1 m from machine side)	Vibration level (7 m from machine side)
1	Excavator (0.7m^3)	105 dB	63 dB
2	Bulldozer (3 ton)	105 dB	66 dB
3	Dump truck	89 dB	62 dB

Source: - ASJ Prediction Model 2007 for Construction Noise, 2007, Acoustical Society of Japan
- Noise and Vibration Countermeasure Handbook for Construction, 2009, Japan Construction Machinery and Construction Association
- Report on the Study and Testing of the Prevention and Elimination of Construction Noise and Vibration, 1979, Public Works Research Institute, Ministry of Construction, Japan

(a) Noise

i) Prediction procedure

The noise level assessment during construction should be considered with the sound level generated by each construction machine located at a different position from the public-private boundary, and the noise attenuation formula (1) should be used in this assessment. After the calculation, the attenuated noise level of each construction machine should be combined following the formula (2).

$$L_p = L_{p0} - 8 - 20log_{10}r \qquad \text{------- (1)}$$

Where

L_{p0} : Noise power level at a distance r_0 from the origin

L_p : Noise power level at a distance r from the origin

r : Distance from the origin at a sound level L_{p0} and L_p $(r_0 = 1m)$

$$L_{CN} = 10 \times \log_{10}\left(\sum_{i=1}^{n} 10^{\left(\frac{Lpi}{10}\right)}\right) \quad \text{-------- (2)}$$

Where

L_{CN} : Combined Noise level

L_{pi} : Noise power level at distance r from the origin of each construction machine

n : Number of Construction machine

ii) Result of noise prediction

According to the result, the maximum noise power level from the construction activity is predicted as 79.1 dB at 1.5m height on the EROW. Then, the current noise level on the railway side at the same height obtained by the survey as a representative point is 65.6 dB in the commercial area, 58.3 dB in the mixed area and 60 dB in the residential zone respectively. Therefore, it means that the predicted level is 79.3 dB in the commercial area, 79.1 dB in the mixed area and residential zone by using the formula (2) above mentioned. As a result, it can be said that the noise levels are below the standard value regulated by the Tokyo Metropolitan Government.

Table 12.29 Result of Noise Prediction

Noise level of Survey	Predicted noise level	Combined noise level	Tokyo, Japan
Commercial area: 65.6 dB	79.1 dB	79.3 dB	80 dB
Mixed area: 58.3 dB		79.1 dB	
Residential zone: 60.0 dB		79.1 dB	

Source: JST, Tokyo Metropolitan Environmental Security Ordinance, Tokyo Metropolitan Government

(b) Vibration

i) Prediction procedure

The vibration level assessment during construction should be considered the same as the case of noise with the level generated by each construction machine located at a different position from the EROW, and the vibration attenuation formula (1) should be used in this assessment. After the calculation, the attenuated vibration level of each construction machine should be combined following the formula (2).

$$VL = VL_0 + 15log_{10}\left(\frac{r_0}{r}\right)^n + 8.68(r_0 - r)\alpha \quad \text{-------- (1)}$$

Where

VL : Vibration level at a distance r from the origin

VL_0 : Vibration level at a distance r_0 from the origin

r_0, r : Distance from the origin at a vibration level VL_0 and VL $(r_0 = 7m)$

n : Geometric attenuation Surface wave: n = 0.5

α : Ground attenuation Clay layer: α = 0.01

$$L_{CV} = 10 \times \log_{10}\left(\sum_{i=1}^{n} 10^{(\frac{VLi}{10})}\right) \quad \text{-------- (2)}$$

Where

L_{CV} : Combined Vibration level

VLi : Vibration level at distance r from the origin of each construction machine

n : Number of Construction machine

ii) Result of vibration prediction

According to the result, the maximum vibration level from the construction activity is predicted as 67.0 dB at ground level on the EROW. Then, the current maximum vibration level on the railway side at ground level obtained by the survey as a representative point is 86.0 dB which was converted from velocity to decibel. It means that the predicted level is 86.1 dB. Therefore, it can be said that the predicted vibration level is extremely low not to affect the value of the vibration level of the survey results.

Table 12.30 Result of Vibration Prediction

Vibration level of Survey	Predicted vibration level	Combined vibration level	Tokyo, Japan
86.0 dB	67.0 dB	86.1 dB	70 dB

Source: JST, Tokyo Metropolitan Environmental Security Ordinance, Tokyo Metropolitan Government

2) Operation phase

As mentioned in "Air pollution" section, the noise impact can be negligible due to the slight increase in the number of trains that will be added in the future. However, since the length of a train will be as long as between 15 and 25 cars, the following noise and vibration forecasts were conducted as a precautionary measure.

(a) Noise

Based on the measured noise exposure levels and the number of trains in the future, the future equivalent noise level shall be calculated following the formula below.

$$L_{Aeq} = 10log_{10}[n \times 10^{L_{AE}/10}/3600]$$

Where

L_{AEi} : Single event noise exposure level of each train passing direction and its number

L_{AE} : Measured as 97.8 dB from the survey

n : Number of the train per hour $(n_1 = 1.08\ (Current), n_2 = 2.83\ (Future)$

From the calculation formula, the assessment shows the equivalent noise level, which is the national standard unit, from train passage without any noise-proof such as noise barrier, trees, and any buildings, etc. Noise prediction results at the representative point along the alignment show as the table below.

Table 12.31 Result of Noise Prediction

Equivalent noise level		Standard	
Current	**Future**	**DoE**	**IFC**
62.6 dB	66.7 dB	Residential: 55 dB Mixed area: 60 dB Commercial: 70 dB	Residential: 55 dB Commercial: 70 dB

Source: JST

(b) Vibration

Since a railway vibration has complicated generation and propagation paths and is affected by rolling stock, tracks, and their structures, etc., no official prediction method has been established so far. Therefore, the prediction of railway vibration was carried out by a model formula, for ballast track on the embankment section, created by analysing the correlation between the train speed and the distance from the vibration source for the existing railway in Japan (1999, West Japan Railway Co., Ltd.).

The model formula for Railway vibration[21]: $VL = 18.6 \times \log_{10} V - 8.2 \log_{10} R + 26.4$

Where V : Train speed (= 70 km/h)

R : Distance from track central point to vibration receiving point (=30 m)

The prediction result shows that the vibration level from a train passage is 48.6 dB at ground. Then, the current vibration level at ground obtained by the survey as a representative point is 86 dB, which was converted from velocity to decibel. It means that the vibration level from a train passage doesn't contributes to the current vibration level at all.

(3) Sensitive receptor

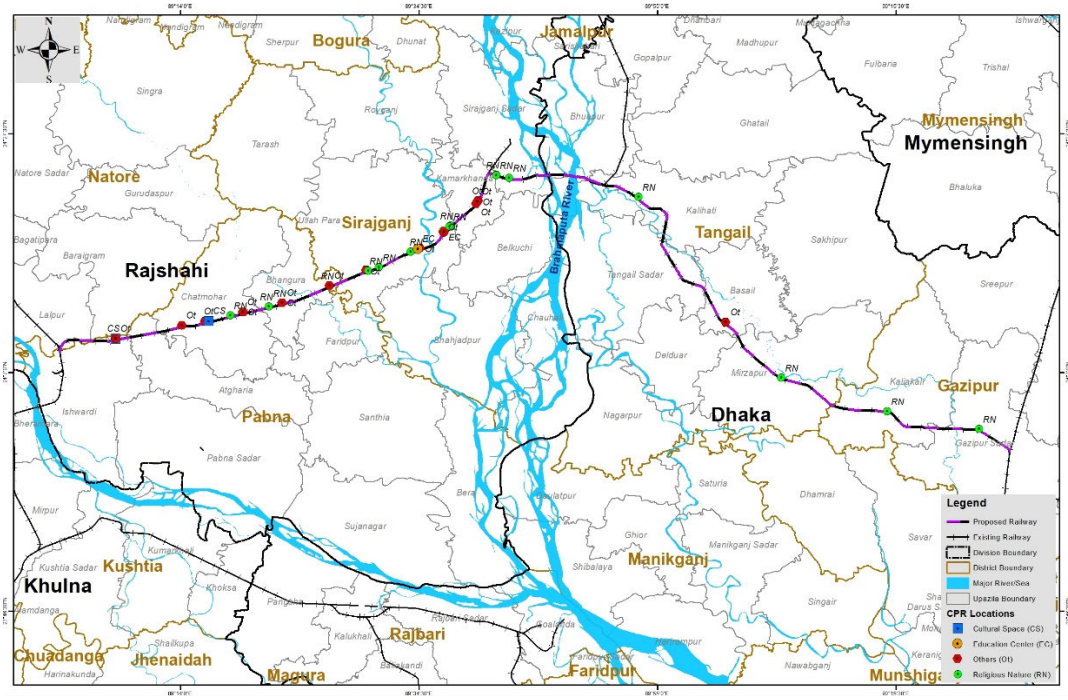
It is found that there are 36 Common/Community Property Resources (CPRs) to be affected due to the project as shown below. Since most CPRs shall be demolished and relocated except for a school in Sirajganj District, it is unnecessary to install any mitigation measure for noise. Regarding the school that is not be relocated, since the school building is separated from the new alignment by more than 70 m, the prediction result was calculated to be 59.3 dB based on the prediction formula (1) considering the distance attenuation of noise mentioned in the noise prediction procedure, which is lower than the Bangladeshi noise standard of 60 dB for mixed area, thus satisfying the standard. However, if there is any request from the school officials, mitigation measures will be considered such as slowing down the trains in the section. For the other nearby CPRs that do not overlap with the ROW, their locations shall be identified during detailed design stage, noise prediction will be conducted as necessary, and mitigation measures shall be considered when the forecast values exceed the standard.

[21] "Environmental Impact Assessment for the Osaka outside loop-line Railway Construction Project" (1999, Osaka Soto-Kanjo Railway Co.,Ltd)

Table 12.32 Affected CPRs

Districts	Education centers	Mosque / Madrasha	Cultural space	Others	Total
Gazipur	0	2	0	0	2
Tangail	0	2	0	1	3
Sirajganj	2	8	0	7	17
Pabna	0	4	2	8	14
Natore	0	0	0	0	0
Total	**2**	**16**	**2**	**16**	**36**

Source: JST



Source: JST

Figure 12.21 Location of Affected CPRs

School building (only the wall will be affected)

Source: JST

Figure 12.22 Affected CPR

12.5.6 Ground Subsidence

According to the natural condition survey result, the clay and silt layers along the alignment are classified as hard clay, even if the thickness of such layer is large, it can be said that serious consolidation settlement will not occur. But the amount of ground settlement and the possibility of circular landslip must be generally considered when examining an embankment. Regarding circular landslip, considering that the existing embankment is stable without any problems, it seems that there will be no problem even if the embankment is widened. However, it is necessary to pay attention to the consolidation settlement directly under the new embankment. When constructing a new embankment by widening the existing embankment, care must be taken to prevent harmful subsidence of the existing embankment and track. According to the result on consolidation settlement, it is assumed that even if a new embankment is constructed, there will be almost no subsidence in the original ground and no track irregularities, however, it is necessary to reconsider at the stage of detailed design.

12.5.7 Offensive Odor

Possible points of offensive odor are related to waste / garbage generation, therefore, construction areas including camping yards during the construction phase and station facilities during the operational phase might be the major locations. This impact depends on not only the collection system but also how to keep waste / garbage until collection at each location generally.

12.5.8 Bottom Sediment

(1) Survey

The samples were taken at 8 points in the rivers crossing the alignment where the scale of bridge construction would be large. The location of the sampling points and results of each sample is shown in the figure and tables below. As there is no guideline for bottom sediment in Bangladesh, the results of all parameters were compared with Environmental Quality Standards for Bottom sediment in Canada. It can be seen that sediment values from each sample under the standard value.

Table 12.33 Sampling Points for Bottom Sediment

No.	Survey Points	Location	
		Latitude	Longitude
Be-1	Boral Bridge, Bhangura Paurashava, Bhangura, Pabna	24°12'52.31"N	89°22'45.18"E
Be-2	Gumani Bridge, Bhangura, Pabna	24°13'41.71"N	89°25'12.75"E
Be-3	Dilpashar Railway Bridge, Dil Pashar, Bhangura, Pabna	24°14'35.16"N	89°27'20.05"E
Be-4	Lahiri Mohonpur Station Road, Bara Pangashi, Ullah Para, Sirajganj	24°15'25.43"N	89°29'20.27"E
Be-5	Ghaitna Shahjahanpur Railway Bridge, Ullah Para Paurashava, Ullah Para, Sirajganj	24°17'56.88"N	89°35'38.72"E
Be-6	Tangail Bridge, Elenga, Kalihati, Tangail	24°18'55.72"N	89°55'31.70"E
Be-7	Kaliakoir Railway bridge, Kaliakoir Paurashava, Kaliakoir, Gazipur	24° 3'47.06"N	90°12'39.90"E
Be-8	Mirergao Railway Bridge, Salna, Kayaltia, Gazipur Sadar	24° 2'10.52"N	90°20'38.81"E

Source: JST

Table 12.34 Results of Bottom Sediment Analysis

No.	Arsenic (mg/kg)	Cadmium (mg/kg)	Chromium Hexavalent (mg/kg)	Chromium (mg/kg)	Lead (mg/kg)
Be-1	1.48	Less than 0.03	Not Detected	12.8	8.74
Be-2	1.41	Less than 0.03	Not Detected	10.5	9.60
Be-3	1.15	Less than 0.03	Not Detected	9.6	6.47
Be-4	2.27	Less than 0.03	Not Detected	11.8	7.73
Be-5	3.65	Less than 0.03	Not Detected	12.0	10.00
Be-6	2.90	Less than 0.03	Not Detected	18.9	6.41
Be-7	2.37	Less than 0.03	Not Detected	14.3	8.77
Be-8	2.30	Less than 0.03	Not Detected	14.4	6.20
Standard in Canada	5.9	0.6	0.94	37.3	35.0

Source: JST, Canadian Sediment Quality Guidelines for the Protection of Aquatic Life, Canadian Council of Ministers of the Environment, 1999, updated 2001, updated 2002

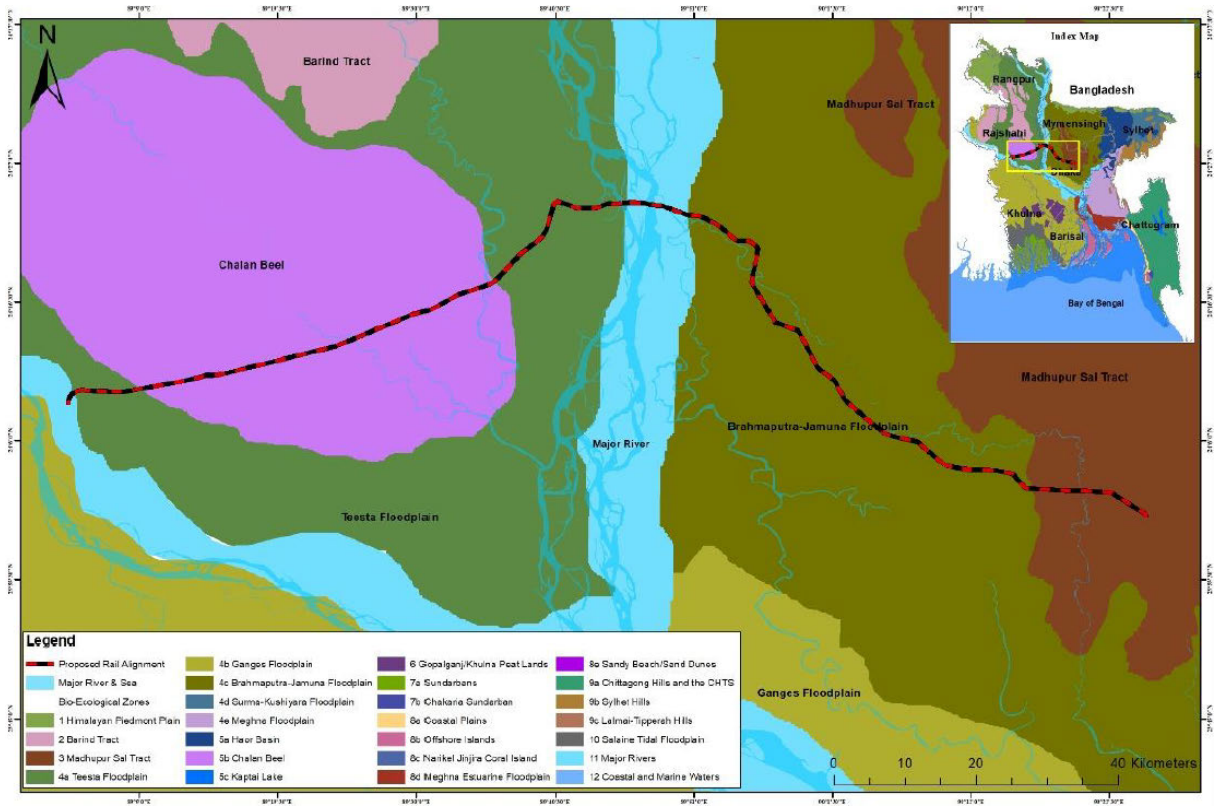
(2) Prediction

Excavated soil at respective bridge construction site will be generated, but a total soil amount might be limited because of minor construction activity. Additionally, since the survey analysis results are satisfied with the standard value, the possibility of reusing the excavated soil for the surrounding embankment section shall also be examined. From the above mentioned, it can be said that the impact of bottom sediment excavation will be minor.

12.5.9 Fauna and Flora

(1) Background

Bangladesh has a wide variety of habitats within a small geographic area. Bangladesh is a low-lying deltaic country, and seasonal variation in water availability is the major feature that creates many ecosystem functions there. Temperature, rainfall, physiographic variations in soil, and different hydrological conditions play vital roles in forming diverse ecosystems in the different geographic areas of Bangladesh. IUCN Bangladesh in 2002 classified the country into twenty-five bio-ecological zones shown in the figure below. The project area falls under five (05) zones: Madhupur Sal Tract (3), Brahmaputtra-Jamuna Floodplain (4c), Major Rivers (11), Teesta Floodplain (4a), and Chalan Beel (5b). Chalan Beel is a wetland in the Sirajganj, Pabna, and Natore districts. It is a large wetland depression, marshy in character with rich fauna and flora. In the winter season, it becomes a pocket of lower depression to retain water, most of the areas are inundated and converted to a big reservoir. In the dry season, local people excavate many small pockets to retain water for fish harvest. In the winter this marshy low land transform to agro crop land like paddy, wheat, maize, mustard, and vegetables. The natural pattern of the water's drainage channels in this area were disrupted by the obstruction caused by the railway construction since railways in these lowlands had to be built on embankment in the British period.



Source: Bioecological zone of Bangladesh, IUCN 2002

Figure 12.23 Bioecological Zones along the Alignment

	
Crop land chalan	Pocket chalan
	
Kua fishing chalan	Canal through chalan

Source: JST

Figure 12.24 Chalan Beel Area

(2) Survey location

8 areas are targeted in total for ecosystem surveys along the alignment as shown in the table below. As the study areas, priority was given to the Chalan Beel area and major rivers where the scale of bridge construction would be large.

Table 12.35 Location and Schedule of the Survey in the Rainy and Dry Season

No.	Location	Rainy	Dry
E1	Muladuli, Gopalpur, Natore and Pabna	From 21st to 27th Aug, 2022	From 28th Nov to 1st Dec, 2022
E2	Boral Bridge, Chaubaria, Bhangura Paurashava, Bhangura, Pabna		
E3	Lahiri Mohonpur Station Road, Bara Pangashi, Ullah Para, Sirajganj		
E4	Ghaitna Shahjahanpur Railway Bridge, Ullah Para Paurashava, Ullah Para, Sirajganj		
E5	Shahid M Monsur Ali Rail Station, Koddar More, Sirajganj		
E6	Bangabandhu Setu East Station, Jamuna Bridge Approach Rd, Tangail		
E7	Tangail Bridge, Elenga, Kalihati, Tangail		
E8	Tekibari salna, Gazipur,		

Source: JST

(3) Survey method

1) Flora

Flora survey's objective was to record the existence of terrestrial and aquatic flora and plants within the project affected area, that is, 1 km radius from the survey point. Lists of plant species were identified inside the area based on primary information obtained from eye observation and discussions with local peoples. Data were provided based on the seasonal appearance (monsoon season and post monsoon season). Local, scientific, and English common names.

2) Fauna

Regarding the wildlife survey, many amphibians, mammalians, reptilians, and birds identified in the area are mysterious species and difficult to find using standard field sampling methods. As such, experience suggests that interviews with local people and showing photographs are very useful methods for collecting information on wildlife. During the field survey period, extensive interviews with local people were conducted to collect information on wildlife (amphibians, reptiles, mammals, birds, and insects), including occurrences, distribution, and seasonal appearance. Discussions with the local people were also used to comprehend nocturnal and unseen animals since they can reveal details about some animals that are difficult to learn from direct observation. To make an inventory of resident wildlife and to determine their conservation status (like common, least common, and rare), the categories of the Red data book of the IUCN (International Union for Conservation of Nature and Natural Resources)-Bangladesh were followed.

3) Fish

Regarding the fisheries field survey, the East and West of the Jamuna River were conducted. The East Bank covers two districts namely Tangail and Gazipur. Fish habitats introduced in the areas are ponds, floodplains, beel, khal, and rivers. On the other hand, the West bank covers Sirajganj Sadr, Belkuci, Shazapur, Kazipur upazilla of the Sirajganj district. Significant drivers of biodiversity were observed in the west bank of the Jamuna River and the Chalan beel area. The consultation and literature review methods were followed for data collection. The consultation was conducted with different government and non-government officials and stakeholders before starting the survey by phone. Also, a literature review of the research works of different scientists in the project areas has been done. Substantial information was also collected from various secondary sources.

(4) Result

1) Flora

The plant species were identified based on observation, the general condition, and local information. Planted trees, natural growing trees, herbs, shrubs, climbers, epiphytes, native and exotic tree species have been seen in roadside and homestead areas. Among the plant species, 90% were terrestrial, and the rest of them were aquatic (10%). From these recorded species, 64% were found as native, and the remaining 37% species were exotic. A total of 142 plant species were identified including *Artocarpus lacucha* which is classified as Vulnerable (VU) by the IUCN Bangladesh. Details of Vulnerable species are reported in the section of Tree counting (12.5.11), and details of all identified species are reported in Appendix 12-3.

Table 12.36 Identified Endangered Species of Flora

Scientific Name	Local Name	English Name	IUCN Category	
			Global	Bangladesh
Artocarpus lacucha	Dewa	Monkey Jack fruit	-	VU

Note: IUCN Category: Vulnerable (VU)
Source: JST, IUCN Red List, IUCN, IUCN Red List of Plants 2023, IUCN Bangladesh

2) Fauna

Regarding wildlife species, a total of 92 species were identified including, *Leptoptilos javanicus* as Vulnerable (VU) in the list of birds, and *Vulpes bengalensis* as VU in the list of mammals. The characteristics of the VU species are shown in the table below. Although the endangered species have been identified by visual observation and interview, the existence of these species were rare as already railway has been developed and no nesting was observed during the survey. Their nesting could not be confirmed during the survey. Details of all identified species are reported in Appendix 12-3.

Table 12.37 Identified Endangered Species of Fauna

Scientific Name	*Leptoptilos javanicus*		*Vulpes bengalensis*	
Local Name	Modon tak		Khek Shial	
English Name	Lesser Adjutant		Bengal Fox	
IUCN Category (Global)	**VU**		LC	
IUCN Category (Bangladesh)	**VU**		**VU**	
Identification source	Visual observation and Interview		Visual observation and Interview	
Preferred habitat zone	Nest on tall trees close to wetlands, well-wooden areas, and grasslands, cultivated field		Semi-arid, flat to undulating ground, scrub, slopes, and grasslands. And avoid dense forest.	
Breeding season	May to August		Mainly January to April	
Habitat period in study area	Dry and Rainy season		Dry and Rainy season (but seen occasionally)	
Habitat area in Bangladesh	Northwest tip of Bangladesh		Northwestern part of Bangladesh	
Identification in the study area	**Dry season**	**Rainy season**	**Dry season**	**Rainy season**
West side of Jamuna river	√	√	√	√
East side of Jamuna river				√

Note: IUCN Category: Vulnerable (VU)
Source: JST, IUCN Red List, IUCN, IUCN Red List of Bangladesh 2015, IUCN Bangladesh

3) Fish

Regarding fish species, a total of 86 species were identified including the endangered species: 2 Critical Endangered (CR) species, 10 Endangered (EN) species, 9 VU species. The characteristics of the endangered species are shown in the table below. The endangered species have been identified across the entire section and throughout the year according to the site observation, literature survey and interview survey with local people. However, no nesting was observed during the survey. Details of all identified species are reported in Appendix 12-3.

Table 12.38 Identified Endangered Species of Fish in Bangladesh

Scientific Name	English Name	IUCN Category		Identification source	Preferred habitat zone	Breeding season	Habitat period in study area	Rainy season				Dry season			
		Global	Bangladesh					West		East		West		East	
								Pres.	Abun.	Pres.	Abun.	Pres.	Abun.	Pres.	Abun.
Notopterus notopterus	Bronze featherback	LC	VU	Interview	River (Horse bend & deeper)	May-Aug	All the year	√	+	√	+	√	+	√	++
Notopterus chitala	Clown knifefish	LC	EN	Interview	River (Horse bend & deeper)	May-Aug	All the year	√	+			√	+	√	+
Gudusia chapra	Indian river shad	LC	VU	VO	River and Beel (surface area)	Jun-Jul	All the Year	√	+	√	+	√	+	√	++
Aspidoparia morar	Morar	LC	VU	LS	River near river bed, and surface	Apr to Jun	All the Year	√	+	√	+	√	+	√	++
Puntius ticto	Ticto barb	LC	VU	VO	Flood plain & Beel	Mar to Jul	All the Year	√	+			√	+		
Botia dario	Bengal loach	LC	EN	Interview	River	Mar to Jul	All the Year	√	+	√	+	√	++	√	+
Botia lohachata	Reticulate loach	LC	EN	Interview	River	Mar to Jul	Dry and Rainy	√	+	√	+	√	+	√	+
Neoeucirrhichthys maydelli	Puiya	LC	CR	LS	River	Apr to Jul	Dry and Rainy			√	+	√	+	√	+
Wallago attu	Freshwater shark	VU	VU	VO	River and Beel	Jul to Aug	Dry and Rainy	√	++	√	+	√	+	√	+
Ompok bimaculatus	Butter catfish	NT	EN	VO	River and Beel	Jun to Aug	Dry and Rainy	√	+					√	+
Ompok pabda	Pabdah catfish	NT	EN	VO	River and Beel	Jun to Aug	Dry and Rainy	√	++	√	+	√	+	√	+
Clupisoma garua	Gaura bachcha	LC	EN	VO	River	Mar to Aug	Dry and Rainy	√	+	√	+	√	+	√	+
Chaca chaca	Squarehead catfish	LC	EN	Interview	River	Jun to Sep	Dry and Rainy			√	+	√	+	√	+
Sperata aor	Long-whiskered catfish	LC	VU	VO	River	Apr to May	Dry and Rainy	√	+	√	+	√	+	√	++
Sperata seenghala	Giant-river catfish	LC	VU	Interview	River	Apr to May	Dry and Rainy	√	+	√	+	√	+	√	+
Rita rita	Rita	LC	EN	VO	River	Jun to Jul	Dry and Rainy	√	+	√	+			√	+
Bagarius bagarius	Dwarf goonch	VU	CR	Interview	River	Apr to Jul	Dry and Rainy	√	+	√		√	+	√	++
Glyptothorax telchitta	Sisorid catfish	LC	VU	LS	River	Apr to Jun	Seasonal (rainy)	√	+	√	+				
Mastacembelus armatus	Zig-zag eel	LC	EN	VO	River, Beel & Flood plain	Mar to Jul	Dry and Rainy	√	+	√	+	√	+	√	+
Monopterus cuchia	Cuchia	LC	VU	LS	River and Beel	Feb to Jun	Seasonal (rainy)	√	+	√	+	√	+	√	+
Channa marulius	Great snakehead	LC	EN	VO	Beel and Floodplain, Mostly in the hidden zone	End of Apr to Aug	Occasional in the River	√	+	√	+			√	+

Note: **IUCN Category**: Critical Endangered (CR), Endangered (EN), Vulnerable (VU), Least Concerned (LC), **Identification source**: Visual Observation(VO), Literature Survey (LS), West: West side of Jamuna river, East: East side of Jamuna river, Pres.: Presence, Abun.: Abundance/ Relative Abundances were analyzed based on the availability of fish during consultation and literature review. Species-wise fish configuration made converted to percentages. Categorized species centered on percentages of abundances rank as single plus (+), more than considered a double plus (++).

Source: JST, IUCN Red List, IUCN, IUCN Red List of Bangladesh 2015, IUCN Bangladesh

(5) Prediction and proposed mitigation measures

1) Flora

Since there are 12 trees designated as Artocarpus lacucha along the alignment, mitigation measures should be taken such as transplantation. Detailed information is reported in the section of Tree counting.

2) Fauna

If the presence of the two endangered species is confirmed prior to construction, the presence of nesting in the vicinity should be confirmed. If confirmed, construction shall be halted and instructions from DoE shall be sought.

3) Fish

Mitigation measures of CR, VU, and EN fish proposed by the ecological expert are as below:

- To establish sanctuaries at the horse bend, and deeper areas in the river with fixation of a branch of jungle tight made of bamboo known as brush shelter.
- To prohibit construction in their breeding season, and to enclose their breeding areas; in case of Hilsa from September to October when tides enter the river, for example.

Regarding the operation stage, a mitigation measure described below will ensure that there are no ecological impacts due to changes in water flow.

- Sizes of openings as a cross section of each river accompanying the construction of new bridges shall be kept at least the current ones to keep river flow.

(6) Implementation of the Project in Critical Habitats

As mentioned above, the endangered species of fish based on the IUCN Red List of Bangladesh have been identified in Chalan Beel, and therefore, the Beel falls under the category of "Critical habitat" under the JICA guidelines. On the other hand, the existing railway line is in harmony with the habitat, as it has been more than 100 years since constructed. Since the project is a double line construction of the existing line, and mitigation measures will be taken to minimize impacts on water quality and hydrology in the critical habitat area as much as possible as mentioned above, the project will be satisfied with the below 3 criteria. Therefore, it can be concluded that the project does NOT involve “Significant conversion” and “Significant degradation” as prohibited in the JICA Guidelines.

- Projects shall not exert significant adverse impacts on biodiversity values existing in “Critical habitats” and key functions of the ecosystems[22]

[22] IFC’s standards note: “Biodiversity values and their supporting ecological processes will be determined on an ecologically relevant scale.”

- Over a reasonable period of time[23], projects shall not cause net reduction in endangered species population[24]
- Long-term and effective mitigation measures and monitoring shall be put in place be performed.

12.5.10 Benthos

(1) Survey method

8 benthic samples, where the scale of bridge construction would be large, at the same points of Bottom sediment survey shown as below were analysed. To begin with, formalin-preserved samples were cleaned and processed with water using a 500-micron mesh-sized sieve net. Organisms were morphologically studied under light compound and stereomicroscopes. The identification and taxonomic assignment were done using existing available literature.

Table 12.39 Sampling Points for Benthos Surveys

No.	Survey Points	Location	
		Latitude	Longitude
Be-1	Boral Bridge, Bhangura Paurashava, Bhangura, Pabna	24°12'52.31"N	89°22'45.18"E
Be-2	Gumani Bridge, Bhangura, Pabna	24°13'41.71"N	89°25'12.75"E
Be-3	Dilpashar Railway Bridge, Dil Pashar, Bhangura, Pabna	24°14'35.16"N	89°27'20.05"E
Be-4	Lahiri Mohonpur Station Road, Bara Pangashi, Ullah Para, Sirajganj	24°15'25.43"N	89°29'20.27"E
Be-5	Ghaitna Shahjahanpur Railway Bridge, Ullah Para Paurashava, Ullah Para, Sirajganj	24°17'56.88"N	89°35'38.72"E
Be-6	Tangail Bridge, Elenga, Kalihati, Tangail	24°18'55.72"N	89°55'31.70"E
Be-7	Kaliakoir Railway bridge, Kaliakoir Paurashava, Kaliakoir, Gazipur	24° 3'47.06"N	90°12'39.90"E
Be-8	Mirergao Railway Bridge, Salna, Kayaltia, Gazipur Sadar	24° 2'10.52"N	90°20'38.81"E

Source: JST

(2) Survey result

Samples consisted of mostly pollution-tolerant macrobenthos including snails (Gastropoda), mussels (Bivalvia), bristle worms (Polychaeta), Oligochaeta and Leeches (Hirudinea). Surprisingly, a few individuals of pollution-sensitive macrobenthos (Trichoptera-Caddisfly) were identified in two samples. The identified benthic organisms including their abundance are presented in the table below. A brief description of different species including their habits, habitat and their responses to environmental alterations are also provided in below section.

[23] Based on experts' advices, etc., the period shall be determined for each project.

[24] IFC's standards note: "Net reduction is a singular or cumulative loss of individuals that impacts on the species' ability to persist at the global and/or regional/national scales for many generations or over a long period of time. The scale (i.e., global and/or regional/national) of the potential net reduction is determined based on the species' listing on either the (global) IUCN Red List and/or on regional/national lists. For species listed on both the (global) IUCN Red List and the national/regional lists, the net reduction will be based on the national/regional population."

Table 12.40 Results of Benthos Surveys

Survey point	Major taxa (group) identified	Genus/ Species Identified	Number of organisms
Be-1	Gastropoda (Mollusca)	Bellamya bengalensis	9
		Melanoides tuberculata	2
		Indoplanorbis sp.	4
	Bivalvia (Mollusca)	Novaculina sp.	1
		Corbicula sp.	2
	Oligochaeta (Annelida)	Lumbriculus sp.	3
	Polychaeta (Annelida)	Neriedae sp. 1	2
		Nereidae sp. 2	1
Be-2	Polychaeta (Annelida)	Neriedae sp. 1	6
		Nereidae sp. 2	5
	Bivalvia (Mollusca)	Corbicula sp.	16
		Lamellidens marginalis	2
	Trichoptera (Insecta)	Cheumatopsyche sp.	2
Be-3	Hirudinea (Annelida)	Pisiciocolidae sp.	4
		Glossophenia sp.	6
		Hemiclepsis sp.	2
	Bivalvia (Mollusca)	Lamellidens corrianus	3
		Lamellidens marginalis	6
		Corbicula sp.	16
	Gastropoda (Mollusca)	Bellamya bengalensis	16
		Bellamya crassaa	3
Be-4	Hirudinea (Annelida)	Hemiclepsis sp.	3
	Gastropoda (Mollusca)	Bellamya bengalensis	9
		Bellamya crassaa	3
		Bethynia sp.	8
	Bivalvia (Mollusca)	Corbicula sp.	6
		Pisidium sp.	13
Be-5	Gastropoda (Mollusca)	Brotia costula	2
		Melanoides tuberculata	2
	Bivalvia (Mollusca)	Corbicula sp.	15
	Polychaeta (Annelida)	Nereidae sp 2	4
	Hirudinea (Annelida)	Hemiclepsis sp.	3
Be-6	Bivalvia (Mollusca)	Corbicula sp.	12
	Trichoptera (Insecta)	Cheumatopsyche sp.	1
	Gastropoda (Mollusca)	Bethynia sp.	3
	Hirudinea (Annelida)	Hemiclepsis sp.	2
Be-7	Bivalvia (Mollusca)	Pisidium sp.	9
		Corbicula sp.	5
	Hirudinea (Annelida)	Hemiclepsis sp.	2
	Polychaeta (Annelida)	Nereidae sp 2	3
Be-8	Hirudinea (Annelida)	Hemiclepsis sp.	2
	Polychaeta (Annelida)	Nereidae sp 2	6
	Bivalvia (Mollusca)	Corbicula sp.	14
		Pisidium sp.	12

Source: JST

(3) Prediction

According to the result, there is no significant impact before and after the construction period was estimated for the project areas. However, there are some minor impacts on biodiversity of proposed sites such as temporary habitat loss on site e.g. land taken up by construction equipment, water pollution from accidental spillages, thawing chemicals, and runoff can lead to adverse changes in aquatic biodiversity as can changes in sediment.

12.5.11 Tree Counting

(1) Survey result

Tree counting survey was conducted along the alignment identifying species, and distance between trees and the alignment. The survey results showed that the number of impacted trees counted as more than 330,000 mentioned in the EIA report of JIDLP 2020 decreased to approximately 80,000. This is because the previous survey covered both sides of the alignment with a width of 50 m, while this survey covered only the north side with a width of 30 m following the result of alternative analysis and a more precise design policy based on the previous similar project experienced in other countries. Among them, there are 12 trees designated as endangered species along the alignment with the location information shown below, mitigation measures should be taken such as transplantation.

Table 12.41 Total number of Affected Trees along the Alignments

District / Type	Gazipur	Tangail	Sirajganj	Pabna	Natore	Type total
Fruit	3,033	4,150	2,520	3,531	440	**13,674**
Banana	4,334	5,470	2,126	1,562	165	**13,657**
Papaya	264	212	37	393	60	**966**
Bamboo	8,393	7,219	4,911	2,973	534	**24,030**
Firewood	528	1,287	161	1,038	323	**3,337**
Medical	823	1,736	517	1,162	109	**4,347**
Ornamental	63	13	2	3	0	**81**
Timber	9,560	5,449	2,449	1,267	425	**19,150**
District total	**26,998**	**25,536**	**12,723**	**11,929**	**2,056**	**79,242**

Source: JST

Table 12.42 Total Number of Endangered affected Trees along the Alignments

District / Local name (English name)	IUCN category	District	Upazila	Height	Placement from alignment	Chainage Start	Chainage End
Dewa (Monkey Jack)	VU	Natore	Lalpur	3 m	Within 15m	209+600	211+300
		Natore	Lalpur	3 m	Within 15m	212+300	213+600
		Natore	Lalpur	3 m	Within 15m	212+300	213+600
		Natore	Lalpur	3 m	Within 15m	212+300	213+600
		Tangail	Kalihati	8 m	From 15m to 30m	308+000	308+300
		Tangail	Tangail Sadar	2 m	Within 15m	321+700	322+000
		Tangail	Mirzapur	3 m	Within 15m	344+500	345+300
		Gazipur	Kaliakoir	4 m	Within 15m	350+100	350+200
		Gazipur	Kaliakoir	4 m	Within 15m	354+500	354+800
		Gazipur	Kaliakoir	3 m	Within 15m	359+900	357+400
		Gazipur	Kaliakoir	3 m	From 15m to 30m	359+800	360+000
		Gazipur	Kaliakoir	3 m	From 15m to 30m	362+000	362+300

Source: JST

(2) Tree Plantation and Replacement Programme (TPRP)

According to the Forest Act 1927 amended in 2000, every tree removal shall be compensated with planting twice the number of removed trees. In Tree Plantation and Replacement Programme (TPRP) of the Project, BR will propose to plant over 237,000 trees, which corresponds with triple the number of proposed affected trees as BR's voluntary mitigation measure. BR will also propose to plant different species in the Project, and that will not only mitigate the temporary loss due to depletion but will also result in enhancing the rail side environment, reducing considerably carbon footprint, and bringing many indirect benefits to local people. Based on the TPRP, BR will bear the planting cost, but the implementation body will be several contractors with BR. Since the best season for planting is from pre-monsoon season to monsoon season: from April to July, the planting period will be from April of the first year to July of the second year at the construction stage. However, in order to ensure thorough management after the planting, the contractors will be paid after two years from the time of planting. Any dead plants, plants that appear extremely weak or plants that do not perform as would be expected will be replaced as soon as possible by the contractor under the responsible judgment of BR.

12.5.12 Hydrology

Temporary cofferdam construction method using sheet piles, which is used in general construction projects shall be adopted during construction of bridge piers to keep water quality. Although temporary water pollution will occur at the time of sheet pile installation, the construction will be basically separated from the river thereafter, so no impact on water quality is expected from the construction work. Additionally, the sizes of openings as a cross section of each river accompanying the construction of new bridges shall be kept at least the current ones. In case an event required to diminish

the sizes of openings occurs during the detailed design stage, a one-dimensional method of non-uniform flow analysis etc. shall be conducted to confirm whether the river flow capability at the estimated high-water level (H.W.L) is met.

12.5.13 Geography and Topography

According to the natural condition survey result, the clay and silt layers along the alignment are classified as hard clay, even if the thickness of such layer is large, it can be said that serious consolidation settlement will not occur.

12.5.14 Land Acquisition/ Resettlement

Details of Land Acquisition and Resettlement are reported in RAP chapter (Chapter 13).

12.5.15 Poverty

Details of Poverty are reported in RAP chapter (Chapter 13).

12.5.16 Indigenous and Ethnic People

Indigenous and ethnic people were not confirmed along the alignment according to the census survey.

12.5.17 Local Economy such as Employment and Livelihood, etc.

Details on the impacts on livelihoods and other modes of transportation are reported in RAP chapter (Chapter 13).

12.5.18 Land Use and Utilization of Local Resources

(1) Land use

Agriculture is the major food supplier for the people of the project area. The major portion of the amazingly fertile agricultural land occurs on the immense floodplains was formed by the deposition of sediments from the rivers- the Ganges, the Brahmaputra and the Meghna. Land use has evolved through natural forces as well as human needs in this project area; different land use types are found along the alignment according to the land use map to identify the land classification within the survey area with a 100 m buffer from the alignment. The affected land use has been presented in the table below.

Table 12.43 Affected Land Use

(Unit: Hectare)

Land type	Agriculture	Homestead	Orchard	High land	Road	Low land	Total
Gazipur	5.01	1.44	1.59	0.00	0.09	0.92	9.05
Tangail	7.62	0.64	1.70	0.00	0.14	1.49	11.59
Sirajganj	0.66	0.05	0.38	0.00	0.02	0.30	1.40
Pabna	0.81	0.41	0.04	0.00	0.01	0.01	1.29
Natore	1.00	0.06	0.02	0.01	0.01	0.00	1.12
Total	15.10	2.60	3.72	0.02	0.27	2.72	24.45

Source: JST

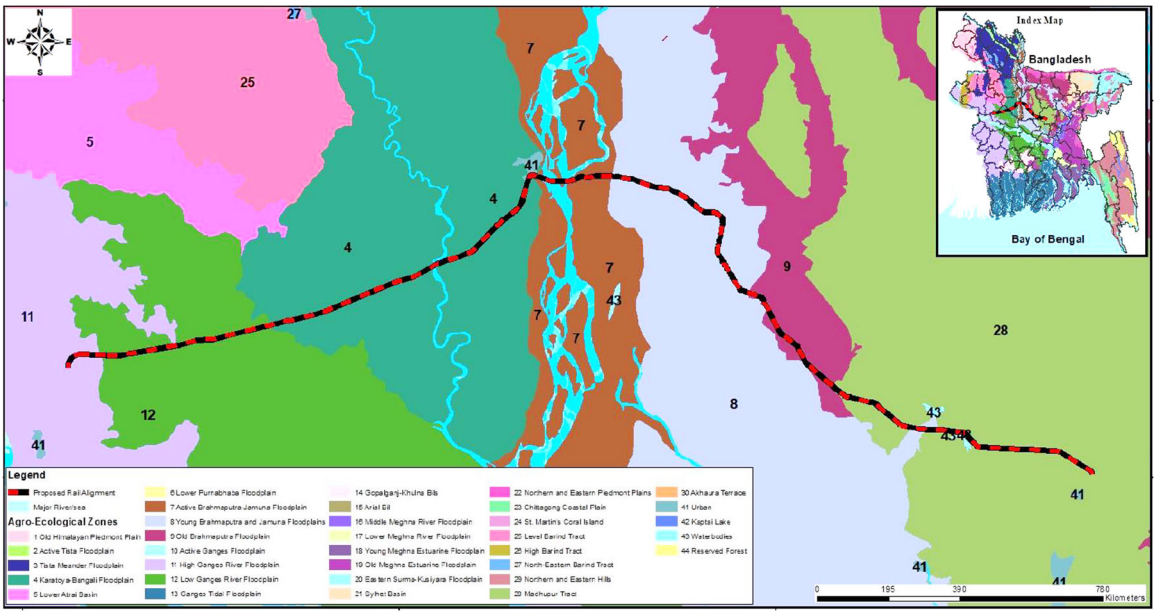
(2) Utilization of local resources

1) Background

Rice is the staple food of Bangladeshi people. Approximately two-thirds of the labor force is employed in agriculture. With irrigation covering around less than 50% of the potentially irrigated area, agriculture is still weather dependent and has grown slower than was earlier expected, particularly because of the predominantly small farmer holdings in Bangladesh. Agricultural environment consists of agricultural land, seeds and crops, chemical inputs, irrigation water, pests, sun light etc. For more production from a unit land area, protection and conservation of agricultural environment is very important.

2) Agro-Ecological Zone

Agro-Ecological Zones of Bangladesh determined on the basis of some definite characteristics, and they are physiography, hydrology, cropping pattern, season, soil types and tidal activity. The land use pattern of the country is influenced by agroecology, soil physiographic and climatic factors. According to the variations of all these factors and agricultural potential, the total land area has been classified into thirty agro-ecological zones, which are grouped into twenty major physiographic units (BBS, 2022). The study area falls under 7 Agro Ecological Zones, named, AEZ-11: High Ganges River Floodplain, AEZ-12: Low Ganges River Floodplain, AEZ-4: Karatoya-Bangali Floodplain, in the west side of the Jamuna River. AEZ-7: Active Brahmaputra-Jamuna Floodplain occurs for both sides along the river bank. And AEZ-8: Young Brahmaputra - Jamuna Floodplain, AEZ-9: Old Brahmaputra Floodplain, AEZ-28: Madhupur Tract in the east side of the Jamuna river.



Source: Bangladesh Agricultural Research Council

Figure 12.25 Agro Ecological Zones along the Project Alignment

3) Cropping

The crop-growing period is divided into three seasons: Kharif-1, Kharif-2 and Rabi. Kharif-1 season starts from March-April and ends in May-June. Kharif-2 season extends from May through October, while the Rabi seasons starts from November and continues up to April. The major characteristics of the cropping seasons of the project area described below:

Kharif-1 Season is characterized by unreliable rainfall and varies in timing, frequency and intensity from year to year, and provides only an intermittent supply of moisture for such crops as Aus[25], groundnut, amaranths etc. During this transition period, soils intermittently become moist and dry. The relative lengths and frequency of such periods depend on the timing and intensity of pre-monsoon rainfall during this season in individual years. With the expansion of irrigation facilities, some of the Kharif-1 crops are now grown under irrigated conditions. These include Aus, maize, jute, amaranths, groundnut, banana, sesame, okura, sweet gourd, white gourd, bitter gourd, ribbed gourd, turmeric etc.

During Kharif-2 the moisture supply from rainfall plus soil storage is enough to support rained or un-irrigated Kharif crops. The crops most extensively cultivated during the Kharif-2 season are transplant Aman, jute, sesame, different kinds of summer vegetables, ginger, turmeric, green chilli, different kinds of aroids, green gram etc. Most Kharif crops are subject to drought and flood in areas without water control.

The Rabi season starts at the end of the humid period and lasts to the Kharif-1 season. The mean length of the Rabi growing period ranges from 140 to 150 days. The mean starting date of the Rabi season ranges from November in this project area. Most common Rabi or winter crops are maize, wheat, mustard, groundnut, sesame, potato, sweet potato, lentil, gram, grass pea, cow pea etc. On lowlands, very lowlands and bottomlands where flooding continues even after the end of rainy season, the Rabi season starts from the date when flooding ends.

(3) Prediction

Assuming that the loss area of agricultural land, orchard, and low land is approx. 21.5 ha according to the survey, there is huge impact on land use and utilization of local resources. However, all the landowner and their employees shall be compensated following ARIPA 2017 and JICA guidelines for ESC including Livelihood Restoration Program. Details of the compensation and the program are reported in RAP chapter (Chapter 13).

12.5.19 Water Usage and its Rights

According to the interview survey, more than 65% of interviewees indicated that they do not routinely use the surrounding water reservoirs. The remaining 35% of interviewees indicated that they use water reservoirs for fishery, fishing, washing, and transportation. However, it can be said that fishing, ferry boat services and washing clothes in the river are not expected to be affected by the construction

[25] Rice sown in summer along with the pre-monsoonal showers and harvested in autumn.

because they can continue a short distance away from the construction site. Regarding loss of pond, details of the compensation and the program for fishery managers or fishery employees are reported in RAP chapter (Chapter 13). At the operation stage, no significant impact is anticipated, as the reduction in fishing area will be limited and fishing can be conducted over a wide range of the other areas according to the interviews with fishermen.

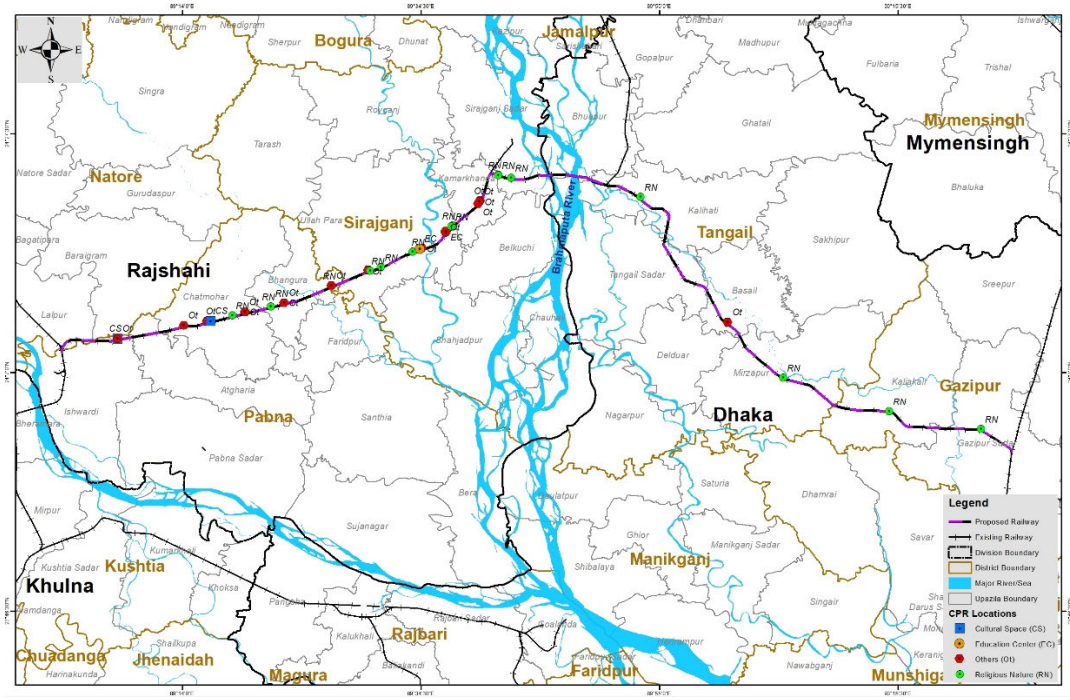
12.5.20 Existing Social Infrastructure and Services

It is found that there are 36 CPRs to be affected due to the project as shown below. Since most CPRs shall be demolished and relocated, the cost for land and relocation with Livelihood Restoration Program shall be compensated. Details of the compensation and the program are reported in RAP chapter (Chapter 13).

Table 12.44 Affected CPRs

Districts	Education centers	Mosque / Madrasha	Cultural space	Others	Total
Gazipur	0	2	0	0	2
Tangail	0	2	0	1	3
Sirajganj	2	8	0	7	17
Pabna	0	4	2	8	14
Natore	0	0	0	0	0
Total	**2**	**16**	**2**	**16**	**36**

Source: JST



Source: JST

Figure 12.26 Location of Affected CPRs

12.5.21 Maldistribution of Benefits and Damages

Local people in rural areas are free to cross any section of the railway line and use the line as an access road although there are concerns about safety issues related to crossing the line at present. Therefore, even during construction phase, the people will be able to freely cross the line except for the construction section, and no impact will be expected. In urban areas, crossing the line will be difficult during construction at level crossings, but construction will be carried out at night when traffic volume is relatively low, thereby mitigating the impact of road congestion as much as possible.

12.5.22 Local Conflict of Interest

Based on the RAP survey, land acquisition and resettlement may lead to unequal distribution of benefits between those who are affected by the project and those who are not. Therefore, sufficient compensation and assistance shall be arranged for affected people to minimize the conflict of interest. Information disclosure to the affected and non-affected people will be important to gain understanding from the residents. Besides, the construction contractor should supply construction employment opportunities equally.

12.5.23 Cultural Heritage

(1) Cultural and historical heritage building

There is no cultural or historical heritage structure along the alignment, but there are 12 cultural properties raised on the interview survey in the table below. According to the Antiquities Act, 1968, it includes the chapter of "Prohibition of destruction, damage etc., of antiquities", however, the chapter does not describe the necessary conditions for the archaeological survey or the approval of the Department of Archaeology. Regarding "Bhangura Central Shaheed Minar" which is historical landmark for the community, since the distance between the landmark and the alignment is only about 30 m, it is highly likely to be affected by the construction. Therefore, BR shall discuss with the manager before implementing the construction work and consider an appropriate construction method that avoids the impact as much as possible. For the other structures, it can be concluded that sufficient separation is maintained. In addition, since the construction work does not include pile driving or boring that involve large vibrations, there will be no impact on these structures.

Table 12.45 Cultural Properties along the Alignments

District	Upazila	Name	Distance from alignment	North Latitude	East Longitude
Pabna	Bhangura	Bhangura Old Upozila Porishad	0.13 km	24°13'7.71"	89°23'29.24"
		Bhangura Central Shaheed Minar	0.03 km	24°12'51.99"	89°22'39.43"
	Chatmohor	Chatmohor Shahi Mosque	3.7 km	24°13'38.66"	89°17'28.65"
Sirajganj	Ullapara	Hatikumrul Noborotno Mondir	12.7 km	24°25'58.57"	89°33'10.86"
Tangail	Mirzapur	Delduwar Jamidar Bari	5.3 km	24° 9'46.66"	89°57'53.93"
		Mohera Jamidar Bari	0.73 km	24° 9'45.65"	90° 2'31.10"

District	Upazila	Name	Distance from alignment	North Latitude	East Longitude
		Pakulla Jamidar Bari	2.5 km	24° 8'28.85"	90° 1'5.66"
		Sree Sree Radha Kalachand Temple	2.6 km	24° 8'26.32"	90° 1'1.97"
	Tangail Sadar	Karatia Jamidar Bari	1.0 km	24°13'24.83"	89°58'43.23"
Gazipur	Gazipur Sadar	Bhawal Rajbari	0.5 km	24° 0'2.51"	90°25'31.77"
		Baliadi Jamidar Bari	1.8 km	24° 2'51.22"	90°11'57.64"
	Kaliakoir	Sreefoltoli court of estate	0.57 km	24° 4'7.63"	90°12'36.23"

Source: JST

(2) Community Property Resources

Details of identified Community Property Resources are reported in RAP chapter (Chapter 13).

12.5.24 Gender

Details are mentioned in the “Consideration on Gender” of RAP chapter (Chapter 13).

12.5.25 Children’s right

(1) Survey

The minimum age for employment regulated by “Children's Act, 2013 (Act No. 24 of 2013)” is age 18. The Act changes the legal definition of a child from being a person under the age of 14 to one under the age of 18. It criminalizes any kind of cruelty inflicted on children while they are working in both the formal and informal sectors. In addition, the Act will prescribe punishments for using or exploiting children in begging, in brothels, and in carrying drugs, arms, or other illegal commodities. On the other hand, some responders of a recent interview survey replied that children between the ages of 10-17 working in shops, factories, construction sites, teashops, restaurants, transport companies, and private households.

(2) Prediction

To ensure that only workers above minimum age are eligible for potential employment opportunities created by the project, the contract agreement with the contractor should include the condition in “Children's Act, 2013 (Act No. 24 of 2013)”.

12.5.26 Health (Infectious diseases such as HIV/AIDS, etc.)

During the study, no cases of sanitation and infectious diseases were reported among the respondents in the study area. However, the most common diseases prevalent in the city are cough, cold, diarrhea, typhoid mainly higher during the rainy season and diabetes. Besides that, risk of HIV/AIDS spread-out shall be considered among construction worker because that is a common social health risk.

12.5.27 Labor Environment including Labor Safety

GoB has ratified all the eight International Labour Organization (ILO) core conventions since the country. Given a progressive agenda, the policymakers have been committed to align the rules and policies with international labor standards. Under these circumstances, there are several laws and regulations on the labor environment in Bangladesh, such as Labour Act in 2006, Labour Rules in 2015, Labour Policy in 2012, and National Child Labour Elimination Policy in 2010. These principal laws and policies shall be respected during the construction phase. The construction of the project includes variety of labor environment such as work at high places, work in the river, work along with roads with traffic, etc. Therefore, different types of risks to labor safety are expected during the construction stages.

12.5.28 Accidents

Accident data was collected along the alignment randomly from each districts mainly from the level crossing, station, and bridge point. The methodology included informal consultations with local people adjacent to each point, people from the shops near the station area, etc. A table below presents a district-wise summary of the consultations on accidents statistics along the alignment. From the collected information on accidents, it can be concluded that accidents used to occur frequently specially before 2018. In 2018 there was a mass recruitment of "gate staff" by BR for the busy level crossings. Since the placements of gate staff, accidents have reduced greatly. However, there are still some level crossings, congested stations and areas where accidents occur once every month or 2-3 month. Therefore, BR's mitigation measures include hiring more gate staff, installing level-crossings at congested points, and station staffing the platforms when trains are approaching.

Table 12.46 Information on Accident on the Level Crossing

District	Location	Location	Remarks on accident
Gazipur	Level Crossing	Bangabandhu High-tech Park	No accident in this crossing had been reported
Gazipur	Level Crossing	Salna Bazar	No accident in recent years, before 2018 accident occurred almost every 5 or 6 months
Gazipur	Station	Ratanpur Railway Station, Mouchak, Kaliakoir.	4-5 person every year
Tangail	Station	Mohera Railway Station, Mirzapur,	3-4 person every year
Tangail	Station	Mirzapur Railway Station, Mirzapur	1-2 person every month, 8-10 person every year
Tangail	Level Crossing	Piuly Bazar, Elenga, Kalihati	No accident in this crossing had been reported
Tangail	Level Crossing	Salla bazar, Kalihati	10-15 accidents every year
Tangail	Bridge	Karail lal Bridge	3-4 person every year, 1-2 cow/goat every month
Tangail	Level Crossing	Bashail, Korotia	2-3 person every year

District	Location	Location	Remarks on accident
Tangail	Level Crossing	Sonalia Rail Crossing, Korotia	1-2 person every year, 3-4 cow/goat every year
Sirajganj	General point	Jotibari, Rasulpur, Kamarkhanda, Sirajganj	3- 4 accidents per year as well as 6-7 cow or goat every year
Sirajganj	Level Crossing	Shodanondopur Rail Crossing (M Monsur Ali Station), Sirajganj Sadar, Saydabad	7-8 accidents per year as well as 20-25 cow or goat every year
Sirajganj	Bridge	Ghaitna Shahjahanpur Railway Bridge, Ullah Para Paurashava	No accident in recent years, before 2018 accident occurred almost every 5 or 6 months
Sirajganj	Station	Lahiri Mohonpur Railway Station, Ullah Para	This is a very busy station; accident occurs every 2 months
Pabna	Bridge	Boral Bridge, Bangura	1- 2 accidents every year
Pabna	Level Crossing	Muladuli crossing. Muladuli, Ishurdi,	Very busy station 12-14 accidents every year

Source: JST

12.5.29 Cross-border Impact and Climate Change

According to the calculation of GHG emission reduction amount using by JICA climate FIT shown in the Chapter "10.4 GHG Emission Reduction Amount Calculated by the JICA Climate FIT", CO_2 emission might be reduced by 185,195 (t-CO_2) in 2028, and by 276,258 (t-CO_2) in 2040, which can be said that the project will make a significant contribution to the reduction of greenhouse gases.

Table 12.47 Estimated GHG Emission Reduction by Passenger and Freight

(Unit: t-CO_2/year)

	2028	2030	2035	2040
1. Passenger				
Emission reduction	113,971	129,440	152,156	178,126
Baseline emission	199,239	220,117	257,675	300,763
Project emission	85,268	90,677	105,519	122,637
2. Freight				
Emission reduction	63,350	67,246	73,787	87,833
Baseline emission	133,391	140,158	154,377	176,081
Project emission	70,041	72,912	80,590	88,248
3. Total				
Emission reduction	**185,195**	**205,639**	**235,896**	**276,258**

Source: JST, JICA climate FIT

12.6 Impact Assessment

This section describes the possible environmental and social impacts during the pre-construction, construction, and operation phase of the project. Predictions of the impacts were conducted based on the results of scoping, analysis of the project components, and the baseline data including field survey results. Scoping for the project was discussed for railway, bridges, and related facilities including

quarry and construction yard, etc. However, the impact assessment for such related facilities shall be omitted because their locations has not been identified at the time of the feasibility study. Therefore, the prediction and evaluation of the environmental assessment for the items will be carried out in the following phases. The result of the environmental and social impact assessment is shown in the table below along with the results of the assessment made earlier at the scoping stage to allow comparisons to be made.

Table 12.48 Results of Assessment for Railway

No.	Impact Item	Evaluation				Reason for evaluation
		Scoping		Based on Survey		
		Pre-CS/CS	OS	Pre-CS/CS	OS	
Pollution						
1	Air pollution	✔	✔	B-	B+	**CS:** Emission gas (NOx, SOx) and dust (PM) will have a temporary negative impact on the air quality by construction machineries and vehicles. (Baseline data showed SPM at some measuring point exceeded the standard.) **OS:** Positive impact will be offered by modal sift from bus and dump truck to passenger train and freight train along the railway line respectively. And The number of trains is planned to increase from the current 25 trains per day to 68 trains per day, which is only a slight increase of 1.04 to 2.83 trains per hour. Therefore, the impact on the surrounding environment is expected to be negligible.
2	Water pollution	✔	✔	B-	B-	**CS:** -Turbid water will be generated in surface and ground water along the alignment due to civil works. - There is a possibility of being discharged with organic wastewater at an installed base campsite. **OS:** There is a possibility of discharged organic wastewater from the toilet installed at every station.
3	Waste	✔	✔	B-	B-	**CS: -** BR plans to reuse the excavated soil generated at these sites as embankment material for double track section, level raising for local houses, and the other local facilities because local communities will strongly require a large amount of soil due to lowland or wet land. - Logged trees are placed under the control of the Forest Department, which holds an auction for sale. The landowner and the Forest department will share the proceeds of the sale. Therefore, all logged trees are reused and are not disposed of as waste. - General waste and excreta will be generated from the base campsite. **OS:** General waste and excreta will be generated from running train and every station.
4	Soil contamination	✔	✔	B-	B-	**CS:** Minor impact of soil contamination will be generated by oil leaks of heavy machines and dump track. **OS:** Soil contamination may be generated on the railway line due to oil leaks of running train.
5	Noise and vibration	✔	✔	B-	B±	**CS:** Noise and vibration will be generated by construction heavy machines, dump trucks. **OS:** Double line can reduce traffic noise and vibration depending on road traffic volume reduction, but increased number of running train issues additional noise and vibration by itself, which has negative impact on the nearby communities.
6	Ground subsidence	✔	✔	B-	B-	**CS/OS:** Clay and silt layers along the alignment are classified as hard clay, even if the thickness of such layer is large, it can be said that serious consolidation settlement will not occur. But the amount of ground settlement and the possibility of circular landslip must be generally considered when examining an embankment. So, it is necessary to pay attention to the consolidation settlement directly under the new embankment.

No.	Impact Item	Evaluation				Reason for evaluation
		Scoping		Based on Survey		
		Pre-CS/CS	OS	Pre-CS/CS	OS	
7	Offensive odor	✔	✔	B-	B-	**CS:** Offensive odor may be issued depending on the volume and management of general waste, etc. from basecamp sites. **OS:** Offensive odor may be issued depending on the volume and management of general waste etc. from every station.
8	Bottom sediment	✔	✔	B-	B-	**CS:** -Turbid water will be generated in surface and ground water along the alignment due to civil works. - Minor impact of soil contamination will be generated by oil leaks of heavy machines and dump track. **OS:** Soil contamination may be generated on the railway line due to oil leaks of running train.
Natural Environment						
9	Ecosystem	✔	✔	B-	B-	**CS:** - There is a negative impact on the flora ecosystem through deforestation of trees due to the double line construction. Especially for Monkey Jack (VU), mitigation measures should be taken such as transplantation. - There is a negative impact on the fauna ecosystem due to the construction. - Since a partial section pass through Chalan Beel, the impact on acquatic ecosystem in rainy season, especially for identified endangered species is expected due to generation of turbid water and change in water flow. **OS:** - Since a partial section pass through Chalan Beel, the impact on aquatic ecosystem is expected especially for identified endangered species due to change in water flow. - Trees planned under Tree Plantation and Replacement Programme (TPRP) may not be planted or grow as scheduled.
10	Geology and Topography	✔		D		**CS:** There is no specified and valuable geology and topography along the alignment.
Social Environment						
11	Land acquisition/ Resettlement	✔		A-		**Pre-CS / CS:** The project requires private land acquisition (60.41 acre (24.4ha)) and total of 2,621 PAHs will be affected out of which 1,601 PAHs will be physically displaced. PAHs are entitled to receive compensation and resettlement assistance regardless of their legal status.
12	Poverty	✔		A-		**Pre-CS:** There are 304 PAHs below the poverty line affected by the project. They may face difficulty adopting to the changes compared to others.
13	Indigenous and ethnic people	✔		D		**Pre-CS and CS:** Indigenous people was not observed in the project affected areas based on a survey on private land by DC as well as past statistical data.
14	Local economy such as employment and livelihood, etc.	✔		B±		**Pre-CS and CS:** Loss of income source due to land acquisition and resettlement are expected to negatively affect the livelihood of PAHs. On the other hand, construction work will have a positive impact on local economy by creating employment and business opportunities in the project area.

No.	Impact Item	Evaluation				Reason for evaluation
		Scoping		Based on Survey		
		Pre-CS/CS	OS	Pre-CS/CS	OS	
15	Land use and utilization of local resources	✔		B-		**CS:** Assuming that the loss area of agricultural land, orchard, and low land is approx. 21.5 ha according to the survey, there is an impact on Land use and utilization of local resources. However, all the landowner and their employees shall be compensated following ARIPA 2017 and JICA guidelines for ESC including Livelihood Restoration Program.
16	Water use and its rights	✔		B-		**CS:** Some local people use water reservoirs for fishery, fishing, washing, and transportation. However, apart from the impact on fishponds, no impact is expected on the existing activities and water use because they can continue in the remaining waterbody. Loss of fishpond shall be compensated following ARIPA 2017 and JICA guidelines for ESC including Livelihood Restoration Program.
17	Existing social infrastructure and services	✔		B-		**Pre-CS and CS:** - A negative impact on sensitive facilities such as schools, and religious facilities may occur due to land acquisition and traffic issues such as congestion and accidents. - There is no underground facility along the alignment.
18	Social institutions such as social infrastructure and local decision making institution	✔		B-		**Pre-CS and CS:** - A negative impact on sensitive facilities such as schools, and religious facilities may occur due to land acquisition and traffic issues such as congestion and accidents.
19	Maldistribution of benefit and damage	✔		B-		**CS:** Local people in rural areas are free to cross any section of the railway line and use the line as an access road. Therefore, even during construction phase, the people will be able to freely cross the line except for the construction section, and no impact will be expected. In urban areas, crossing the line will be difficult during construction at level crossings, but construction will be carried out at night when traffic volume is relatively low, thereby mitigating the impact of road congestion as much as possible.
20	Local conflict of interest	✔		B-		**CS:** Local people and Union councils may demand that construction contractor should supply employment opportunities equally as construction workers.
21	Cultural Heritage	✔	✔	B-	D	**Pre-CS/CS:** Regarding "Bhangura Central Shaheed Minar" which is historical landmark for the community, since the distance between the landmark and the alignment is only about 30 m, it is highly likely to be affected by the construction. **OS:** There is no impact on religious and historical buildings because of no-additional land acquisition at the operation stage.
22	Gender	✔	✔	B-	B-	**CS:** Women-headed households may have limited access to information which shall be considered during consultation process. In addition, there may be a gender gap for wages and treatment as construction workers. **OS:** Employment opportunities for women will be limited in railway operations.

No.	Impact Item	Evaluation				Reason for evaluation
		Scoping		Based on Survey		
		Pre-CS/CS	OS	Pre-CS/CS	OS	
23	Children's right	✔		B-		**CS:** Some responders of the interview survey replied that children between the ages of 10-17 working in shops, factories, construction sites, teashops, restaurants, transport companies, and private households.
24	Health (Infectious diseases such as HIV/AIDS, etc.)	✔	✔	B-	B-	**CS:** Infectious diseases such as STD, etc. may be spread by the inflow of construction workers. Additionally, Land use changes by soil cutting and soil filling may create new habitats for mosquitoes that can mediate dengue fever. **OS:** There is a possibility that STD and other infectious diseases spread by increasing the number of settlers and travelers after BR double-tracked operation.
25	Labor environment including labor safety	✔	✔	B-	B-	**CS:** Occupational injuries / disease may occur with inappropriate labor environment including safety management in the construction sites. **OS:** Occupational injuries / disease may occur with inappropriate labor environment including safety management for BR staffs.
Others						
26	Accidents	✔	✔	B-	B-	**CS:** Since construction-related vehicles use arterial roads, there is a possibility of increasing traffic accidents. **OS:** It is estimated that the risk of train accidents for local people and their livestock will be increased due to increasing number of running train. But from the collected information on accidents in rail crossings, it can be concluded that accidents used to occur frequently specially before 2018. In 2018 there was a mass recruitment of "gate staff" by BR for the busy level crossings. Since the placements of gate staff, accidents have reduced greatly. However, there are still some level crossings, congested stations, and areas where accidents occur once every month or 2-3 month.
27	Cross-border impact and climate change	✔	✔	B-	B+	**CS:** Greenhouse gas emissions will increase slightly by reducing the absorbed amount of greenhouse gas due to cutting trees along the alignment. **CS:** According to the calculation, significant positive impact will be offered by modal sift from private cars, busses and dump truck to passenger train and freight train along the railway line even if greenhouse gas emission is also caused by increasing number of running train.

Pre-CS: Pre-Construction Stage, CS: Construction Stage, OS: Operation Stage

A+/-: Significant positive/negative impact is expected, B+/-: Positive/Negative impact is expected to some extent, D: No impact is expected

Source: JST

Table 12.49 Results of Assessment for Bridge

No.	Impact Item	Evaluation				Reason for evaluation
		Scoping		Based on Survey		
		Pre-CS/CS	OS	Pre-CS/CS	OS	
Pollution						
1	Air pollution	✔		B-		**CS:** Emission gas (NOx, SOx) and dust (SPM) will have a temporary negative impact on the air quality by construction heavy machines, dump trucks.
2	Water pollution	✔		B-		**CS:** Turbid water will be generated at bridge construction sites due to civil and excavation work.
3	Waste	✔		B-		**CS:** It is predicted that construction waste such as excavated soil is generated.
4	Soil contamination	✔		B-		**CS:** Leakage of oil from the heavy machine and dump track may contaminate the soil.
5	Noise and vibration	✔	✔	B-		**CS:** Noise and vibration from excavation works, construction heavy machines, dump trucks, and pile driving work may be generated. **OS:** BR's double-tracked operation issues additional noise and vibration by itself.
6	Ground subsidence	✔	✔	D	D	**CS/OS:** Clay and silt layers along the alignment are classified as hard clay, even if the thickness of such layer is large, it can be said that serious subsidence will not occur.
7	Bottom Sediment	✔		D		**CS:** Survey analysis results are satisfied with the standard value, the possibility of reusing the excavated soil for the surrounding embankment section shall also be examined. From the above mentioned, it can be said that the impact of bottom sediment excavation will be minor.
Natural Environment						
8	Ecosystem	✔		A-		**CS:** At the river crossing section, the impact on aquatic ecosystem, especially for identified endangered species is expected due to generation of turbid water and change in water flow by bridge construction.
9	Hydrology	✔		B-		**CS:** River flow condition may be disturbed due to the construction.
Social Environment						
10	Local economy such as employment and livelihood, etc.	✔		B±		**Pre-CS:** - There may be a negative impact on the livelihood of fishery operators and other relevant persons because of bridge construction. - There is a positive impact on local people economically as employment opportunities by the bridge construction for construction workers.
11	Water use and its rights	✔	✔	B-	D	**CS:** A negative impact on water quality for drinking may be issued depending on the construction activities. **OS:** No significant impact is anticipated, as the reduction in fishing area will be limited and fishing can be conducted over a wide range of other areas.

No.	Impact Item	Evaluation				Reason for evaluation
		Scoping		Based on Survey		
		Pre-CS/CS	OS	Pre-CS/CS	OS	
12	Existing social infrastructure and services	✔		B-		**Pre-CS/CS:** If there is a service of fishery boat at the bridge construction sites. A negative impact on the service may be issued depending on the construction activities.
13	Maldistribution of benefit and damage	✔		B-		**CS:** Depending on the construction activities, there may be a maldistribution of benefit and damage such as relocation of fishing area and hindering of their economy due to bridge construction.
14	Local conflict of interest	✔		B-		**CS:** Residents may complain about entering construction workers and the safety of their neighborhood.
15	Gender	✔		B-		**CS:** There may be a gender gap regarding wage, salary, and treatment as construction workers.
16	Children's right	✔		B-		**CS:** There is a possibility that children's compulsory education rights may be hindered because of customary child labor in the communities around the bridge construction sites.
17	Health (Infectious diseases such as HIV/AIDS, etc.)	✔		B-		**CS:** Infectious diseases such as HIV/AIDS, etc. may be spread by the inflow of construction workers.
18	Labor environment including labor safety	✔		B-		**CS:** Occupational injuries / disease may occur with inappropriate labor environment including safety management in the construction sites.
Others						
19	Accidents	✔	✔	B-	B-	**CS:** Since construction-related vehicles use arterial roads, there is a possibility of increasing traffic accidents. **OS:** It is estimated that the risk of train accidents by local people and their livestock will be increased due to increasing number of running train.

Pre-CS: Pre-Construction Stage, CS: Construction Stage, OS: Operation Stage

A+/-: Significant positive/negative impact is expected, B+/-: Positive/Negative impact is expected to some extent, D: No impact is expected

Source: JST

12.7 Environmental Management Plan

EMP including mitigation measures has been prepared negative or potentially negative impacts mentioned so that it should be examined for respective project stages so that the project can achieve the intended objectives while minimizing accompanied environmental and social negative impacts. The costs, for mitigation measures and their implementation, are also included as follows. The below table shows a preliminary set of mitigation measures for the impact items evaluated "A-" or "B-" in the matrix of results of assessment as above mentioned.

Table 12.50 Proposed Mitigation Measures for Railway at Pre-Construction and Construction Stage

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (BDT)
1-a	Air pollution	Emission gas (NOx, SOx) and dust (PM) will have a temporary negative impact on the air quality by construction machineries and vehicles. (Baseline data showed PMS at some measuring point exceeded the standard.)	Regular preventive maintenance service of construction equipment and machinery should be strictly implemented and should require conducting daily routine equipment and machinery check-ups to ensure that there are in optimum working conditions.	Construction Contractor	PIU	Mentioned in EMoP
1-b			The proper work schedules should be considered not to concentrate the construction equipment at a certain point for a long time.			
1-c			To reduce the dust, the periodic water spray should be taken.			
1-d			The construction site is fenced as high as 2-2.5 m in sections where residences are in proximity.			
2-a	Water pollution	• Turbid water will be generated in surface water and groundwater along the alignment due to civil works. • There is a possibility of being discharged organic wastewater at installed base campsites.	Washing the construction tools in limited areas where there are appropriate facilities for water treatment for discharge.	Construction Contractor	PIU	Mentioned in EMoP
2-b			General waste should be treated at a designated site and disposed of following the instruction of management authority and rules. If the waste must be kept at the construction site, the tarpaulin should be covered on it.			
2-c			In construction works near water bodies, turbid wastewater shall be treated at designated sites and released again.			
2-d			Temporary sanitation facilities with septic tanks such as portable (mobile) toilets and garbage bins will be provided by the contractors to ensure that the domestic wastes to be generated by the construction personals are properly handled and not thrown into the drainage to prevent further pollution.			
3	Waste	General waste and excreta will be generated from the base campsites.	General waste generated from the camp sites should be treated at a designated site and disposed of according to the instructions of management authority and rules. If the waste must be kept at the construction site, the tarpaulin should be covered on it.	Construction Contractor	PIU	Mentioned in EMoP
4	Soil contamination	Minor impact of soil contamination will be generated by oil leaks of heavy machines and dump track.	Daily maintenance of construction equipment and vehicles.	Construction Contractor	PIU	Mentioned in EMoP

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (BDT)
5-a	Noise and vibration	Noise and vibration will be generated by construction heavy machines, dump trucks.	Noise suppressors such as mufflers will be installed whenever deemed necessary to maintain the noise generated by various heavy equipment and other construction machinery within permissible limits.	Construction Contractor	PIU	Mentioned in EMoP
5-b			High noise-generating construction activities will be scheduled during daytime only (8:00 - 20:00) to avoid noise disturbance to adjust residential and commercial areas and other noise-sensitive areas. If nighttime construction is required, it is mandatory to obtain permission from the local authorities to implement the work. In the case of academic facilities, the activities should be considered during the nighttime not to interfere with the class-works.			
5-c			Around the construction site is fenced as high as 2-2.5 m in sections where residences are in proximity.			
5-d			Use low-noise and vibration machinery for construction.			
6	Ground subsidence	Clay and silt layers along the alignment are classified as hard clay, even if the thickness of such layer is large, it can be said that serious consolidation settlement will not occur. But the amount of ground settlement and the possibility of circular landslip must be generally considered when examining an embankment. So, it is necessary to pay attention to the consolidation settlement directly under the new embankment.	Application of appropriate construction measures such as reinforced soil wall to support embankment, and etc.	Construction Contractor	PIU	Mentioned in EMoP
7	Offensive odor	Offensive odor may be issued depending on the volume and management of general waste, etc. from basecamp sites.	Regular cleaning and collection of the general waste from camp sites with appropriate stock places and facilities to prevent offensive odor.	Construction Contractor	PIU	Mentioned in EMoP
8-a	Bottom sediment	Turbid water will be generated in surface and ground water along the alignment due to civil works.	Same as “2-c”			
8-b		Minor impact of soil contamination will be generated by oil leaks of heavy machines and dump track.	Same as “4 Soil contamination”			

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (BDT)
9-a	Ecosystem	• There is a negative impact on the ecosystem through deforestation of trees due to the double line construction. Especially for Monkey Jack (VU), mitigation measures should be taken such as transplantation. • There is a negative impact on the fauna ecosystem due to the construction. • Since a partial section pass through Chalan Beel, the impact on aquatic ecosystem in rainy season, especially for identified endangered species is expected due to generation of turbid water and change in water flow.	Over 237,000 trees need to be planted as compensatory planting to the alternative area following Tree Plantation and Replacement Programme (TPRP) of the Project. Among them, since there are 12 trees designated as endangered species along the alignment, transplantation shall be implemented under instruction of Forestry Department.	PIU	DoF	Mentioned in EMoP
9-b			A preliminary survey should be conducted before the construction commencement, If the presence of the two endangered species of fauna is confirmed, the presence of their nesting in the vicinity should be confirmed. If applicable, construction shall be halted and instructions from DoE shall be sought.	Construction Contractor	PIU/DoE	
9-c			A preliminary survey should be conducted before the construction commencement and during construction to identify the endangered species in Chalan Beel area. If applicable, the below countermeasures should be considered, and the instructions from DoE shall be sought. • To establish Sanctuaries at the horse bend, and deeper areas in the river with fixation of a branch of jungle tight made of bamboo known as brush shelter. • To prohibit construction in their breeding season, and to enclose their breeding areas; it is from Sept to Oct in case of Hilsa when tides enter the river, for example. • Season: Onset of monsoon with thunderstorms along with rainfalls and entering new water during monsoon in Chalan Beel.			
10	Land acquisition/ Resettlement	The project requires private land acquisition (60.41 acre (24.4ha)) and total of 2,621 PAHs will be affected out of which 1,601 PAHs will be physically displaced. PAHs are entitled to receive compensation and resettlement assistance regardless of their legal status.	Resettlement implementation with necessary procedures based on RAP including: - Compensation prior to relocation with full replacement cost - Functioning of the grievance redress mechanism - Livelihood restoration program - Monitoring schemes - Special assistance to vulnerable groups, etc.	PIU	DC/BR	Refer to RAP
11	Poverty	There are 304 PAHs below the poverty line affected by the project. They may face difficulty adopting to the changes compared to others.	Implementation of adequate compensation and assistance based on the entitlement matrix of RAP. Special assistance will be provided for vulnerable groups including households below the poverty line.	PIU	BR	Refer to RAP

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (BDT)
12	Local economy such as employment and livelihood, etc.	Loss of income source due to land acquisition and resettlement are expected to negatively affect the livelihood of PAHs. On the other hand, construction work will have a positive impact on local economy by creating employment and business opportunities in the project area.	Implementation of adequate compensation and assistance based on the entitlement matrix of RAP which includes a livelihood restoration program.	PIU	BR	Refer to RAP
13	Land use and utilization of local resources	Assuming that the loss area of agricultural land, orchard, and low land is approx. 21.5 ha according to the survey, there is an impact on Land use and utilization of local resources. However, all the landowner and their employees shall be compensated following ARIPA 2017 and JICA guidelines for ESC including Livelihood Restoration Program.	Loss of livelihood from the change of agricultural land will be adequately compensated and will be entitled to join a livelihood restoration program based on RAP.	PIU	DC/BR	Refer to RAP
14	Water use and its rights	Some local people use water reservoirs for fishery, fishing, washing, and transportation. However, apart from the impact on fishponds, no impact is expected on the existing activities and water use because they can continue in the remaining waterbody. Loss of fishpond shall be compensated following ARIPA 2017 and JICA guidelines for ESC including Livelihood Restoration Program.	Loss of livelihood for those using fishpond will be adequately compensated and will be entitled to join a livelihood restoration program based on RAP.	PIU	DC/BR	Refer to RAP
15	Existing social infrastructure and services	A negative impact on sensitive facilities such as schools, and religious facilities may occur due to land acquisition and traffic issues such as congestion and accidents.	Resettlement implementation with necessary procedures based on RAP including: - Compensation prior to relocation with full replacement cost - Special assistance for relocation grant	PIU	DC/BR	Refer to RAP

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (BDT)
16	Social institutions such as social infrastructure and local decision making institution	A negative impact on sensitive facilities such as schools, and religious facilities may occur due to land acquisition and traffic issues such as congestion and accidents.	Same as “15 Existing social infrastructure and services”			
17	Maldistribution of benefit and damage	In urban areas, crossing the line will be difficult during construction at level crossings.	Construction shall be carried out at night when traffic volume is relatively low, thereby mitigating the impact of road congestion as much as possible. If nighttime construction is required, it is mandatory to obtain permission from the local authorities to implement the work.	Construction Contractor	PIU	Mentioned in EMoP
18-a	Local conflict of interest	Local people and Union councils may demand that construction contractor should supply employment opportunities equally as construction workers.	Give employment opportunities to residents and Union councils evenly.	Construction Contractor	PIU	Mentioned in EMoP
18-b			If the residents complain about the construction activities, the consultant of the supervision and contractors should deal with them with a sincere response following the Grievance Redress mechanism and should designate staff in charge of public complaints and communications.			
19	Cultural Heritage	Regarding “Bhangura Central Shaheed Minar” which is historical landmark for the community, since the distance between the landmark and the alignment is only about 30 m, it is highly likely to be affected by the construction.	The section adjacent to the said landmark is a normal embankment construction area, so no work with sudden large vibrations will occur. However, prior discussions shall be held with the property owner to explain the details of the work and the area to be constructed, and to acquire their understandings.	Construction Contractor	PIU	Mentioned in EMoP
20-a	Gender	Women-headed households may have limited access to information which shall be considered during consultation process. In addition, there may be a gender gap for wages and treatment as construction workers.	During the process, FGDs for women-headed households shall be held and their opinions shall be reflected in the project.	PIU	DC/BR	Refer to RAP
20-b			There must be care that there is no discrimination between male and female in employment and payment of wages/salaries.	Construction Contractor	PIU	Mentioned in EMoP

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (BDT)
21	Children's right	Some responders of the interview survey replied that children between the ages of 10-17 working in shops, factories, construction sites, teashops, restaurants, transport companies, and private households.	Construction contractor and supervision consultant as well as PIU check and monitor the list or worker and field situation in order to prevent any forms of child labor in the project.	Construction Contractor	PIU	Mentioned in EMoP
22-a	Health (Infectious diseases such as HIV/AIDS, etc.)	Infectious diseases such as STD, etc. may be spread by the inflow of construction workers. Additionally, Land use changes by soil cutting and soil filling may create new habitats for mosquitoes that can mediate dengue fever.	To prevent the spreading of infectious diseases, awareness training to workers shall be provided with the cooperation of the local public health center.	Construction Contractor	PIU	Mentioned in EMoP
22-b			A periodic health check-up program will be conducted.			
22-c			To reduce ponds and puddles, where wrigglers grow, by covering them with a tarpaulin.			
23-a	Labor environment including labor safety	Occupational injuries / disease may occur with inappropriate labor environment including safety management in the construction sites.	Construction personnel will be provided with the necessary safety gear such as a protective hard hat.	Construction Contractor	PIU	Mentioned in EMoP
23-b			First aid stations supervised by the safety health officer of the contractor will be located within the construction site office.			
23-c			Arrange safety training for the worker periodically.			
23-d			Compliance with the related laws and regulations.			
24-a	Accidents	Since construction-related vehicles use arterial roads, there is a possibility of increasing traffic accidents.	Sound traffic management duly approved by the concerned governmental agency will be strictly implemented to minimize traffic congestions and accidents.	Construction Contractor	PIU	Mentioned in EMoP
24-b			Traffic enforcers will be designated along these areas to assist in directing traffic flow.			
25	Cross-border impact and climate change	Greenhouse gas emissions will increase slightly by reducing the absorbed amount of greenhouse gas due to cutting trees along the alignment.	Over 237,000 trees need to be planted as compensatory planting to the alternative area following Tree Plantation and Replacement Programme (TPRP) of the Project.	PIU	DoF	Mentioned in EMoP

Note: PIU: Project Implementation Unit, DC: Deputy Commissioner, BR: Bangladesh Railway, DoF: Department of Forest, EMoP: Environmental Monitoring Plan

Source: JST

Table 12.51 Proposed Mitigation Measures for Railway at Operation Stage

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (BDT)
1	Water pollution	There is a possibility of discharged organic wastewater from the toilet installed at every station.	Periodical maintenance and increasing the frequency of dipping up for relevant facilities such as toilet installed at every station.	BR	MoR	Mentioned in EMoP
2	Waste	General waste and excreta will be generated from running train and every station.	Installation of enough garbage bin at appropriate location in every station and collection rules based on local collection systems, and periodical maintenance and increasing the frequency of dipping up for relevant facilities such as toilet installed at every station.	BR	MoR	Mentioned in EMoP
3	Soil contamination	Soil contamination may be generated on the railway line due to oil leaks of running train.	Necessary facilities and equipment for preventing leaking oil shall be prepared at the depot.	BR	MoR	Mentioned in EMoP
4-a	Noise and vibration	Increased number of running train issues additional noise and vibration by itself, which has negative impact on the nearby communities.	Noise prediction will be conducted as necessary during detailed design stage, and mitigation measures, such as reduction of train speed, shall be implemented if the prediction results exceed the standards.	BR	MoR	Mentioned in EMoP
4-b			If the residents complain about noise and vibration, BR should deal with them with a sincere response following the Grievance Redress mechanism and should designate staff in charge of public complaints and communications.	BR	MoR	Mentioned in EMoP
5	Ground Subsidence	Clay and silt layers along the alignment are classified as hard clay, even if the thickness of such layer is large, it can be said that serious consolidation settlement will not occur. But the amount of ground settlement and the possibility of circular landslip must be generally considered when examining an embankment. So, it is necessary to pay attention to the consolidation settlement directly under the new embankment.	No specific measures but conduct necessary monitoring for "just in case". When measures are need, they are to be discussed to determine the best solution suitable for the conditions.	BR	MoR	Mentioned in EMoP
6-a	Offensive odor	Offensive odor may be issued depending on the volume and management of general waste etc. from every station.	Regular cleaning and collection of the general waste from every station.	BR	MoR	Mentioned in EMoP
6-b			Installation of appropriate garbage bin with cover.			
7	Bottom sediment	Soil contamination may be generated on the railway line due to oil leaks of running train.	Same as “3 Soil contamination”			

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (BDT)
8-a	Ecosystem	Since a partial section pass through Chalan Beel, the impact on aquatic ecosystem is expected especially for identified endangered species due to change in water flow.	If the residents and fisheries raise their complain, BR should deal with them with a sincere response following the Grievance Redress mechanism and should designate staff in charge of public complaints and communications.	BR	MoR	Mentioned in EMoP
8-b		Trees planned under Tree Plantation and Replacement Programme (TPRP) may not be planted or grow as scheduled.	To request BR and DoF to update TPRP from time to time and to ensure that the budget for afforestation is secured before implementation.	BR	DoF	Mentioned in EMoP
9	Gender	Employment opportunities for women will be limited in railway operations.	Active employment of female staff for BR with fair conditions	BR	MoR	Mentioned in EMoP
10	Health (Infectious diseases such as HIV/AIDS, etc.)	There is a possibility that STD and other infectious diseases spread by increasing the number of settlers and travelers after BR double-tracked operation.	A periodic awareness program and health check-up for BR officials	BR	MoR	Mentioned in EMoP
11-a	Labor environment including labor safety	Occupational injuries / disease may occur with inappropriate labor environment including safety management for BR staffs.	Arrange safety training for the BR staff periodically.	BR	MoR	Mentioned in EMoP
11-b			Compliance with the related laws and regulations.			
12	Accidents	It is estimated that the risk of train accidents for local people and their livestock will be increased due to increasing number of running train. But from the collected information on accidents in rail crossings, it can be concluded that accidents used to occur frequently specially before 2018. In 2018 there was a mass recruitment of “gate staff” by BR for the busy level crossings. Since the placements of gate staff, accidents have reduced greatly. However, there are still some level crossings, congested stations and areas where accidents occur once every month or 2-3 month.	Continue to reduce the number of train accidents by hiring further gate staffs, installing level-crossings at congested points, and station staffing the congested station platforms when trains are approaching.	BR	MoR	Mentioned in EMoP

Note: BR: Bangladesh Railway, DoF: Department of Forest, MoR: Ministry of Railway, EMoP: Environmental Monitoring Plan

Source: JST

Table 12.52 Proposed Mitigation Measures for Bridge at Pre-Construction and Construction Stage

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (BDT)
1-a	Air pollution	Emission gas (NOx, SOx) and dust (SPM) will have a temporary negative impact on the air quality by construction heavy machines, dump trucks.	Regular preventive maintenance service of construction equipment and machinery should be strictly implemented and should require conducting daily routine equipment and machinery check-ups to ensure that there are in optimum working conditions.	Construction Contractor	PIU	Mentioned in EMoP
1-b			The proper work schedules should be considered not to concentrate the construction equipment at a certain point for a long time.			
2	Water pollution	Turbid water will be generated at bridge construction sites due to civil and excavation work.	Temporary cofferdam construction method using sheet piles, which is used in general construction projects shall be adopted during construction of bridge piers to keep water quality.	Construction Contractor	PIU	Mentioned in EMoP
3	Waste	It is predicted that construction waste such as excavated soil is generated.	Construction waste generated from the construction should be treated at a designated site and could be utilized for other purpose such as land filling depending upon the suitability.	Construction Contractor	PIU	Mentioned in EMoP
4	Soil contamination	Leakage of oil from the heavy machine and dump track may contaminate the soil.	Daily maintenance of construction equipment and vehicles.	Construction Contractor	PIU	Mentioned in EMoP
5-a	Noise and vibration	Noise and vibration from excavation works, construction heavy machines, dump trucks may be generated.	Noise suppressors such as mufflers will be installed whenever deemed necessary to maintain the noise generated by various heavy equipment and other construction machinery within permissible limits.	Construction Contractor	PIU	Mentioned in EMoP
5-b			High noise-generating construction activities will be scheduled during daytime only (8:00 - 20:00) to avoid noise disturbance to adjust residential and commercial areas and other noise-sensitive areas. If nighttime construction is required, it is mandatory to obtain permission from the local authorities to implement the work.			
5-c			Use low-noise and vibration machinery for construction.			

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (BDT)
6	Ecosystem	At the river crossing section, the impact on aquatic ecosystem, especially for identified endangered species is expected due to generation of turbid water and change in water flow by bridge construction.	A preliminary survey should be conducted before the construction commencement and during construction in order to identification of endangered species in the river. If applicable, the below countermeasures should be considered. • To establish Sanctuaries at the horse bend, and deeper areas in the river with fixation of a branch of jungle tight made of bamboo known as brush shelter. • To prohibit construction in their breeding season, and to enclose their breeding areas; it is from Sept to Oct in case of Hilsa when tides enter the river, for example. • Season: Onset of monsoon with thunderstorms along with rainfalls in the river.	Construction Contractor	PIU	Mentioned in EMoP
7	Hydrology	River flow condition may be disturbed due to the construction.	Sizes of openings as a cross section of each river accompanying the construction of new bridges shall be kept at least the current ones to keep river flow.	Construction Contractor	PIU	Mentioned in EMoP
8	Local economy such as employment and livelihood, etc.	There may be a negative impact on the livelihood of fishery operators and other relevant persons because of bridge construction.	Implementation of adequate compensation and assistance based on the entitlement matrix of RAP which includes a livelihood restoration program.	PIU	DC/BR	Refer to RAP
9	Water use and its rights	A negative impact on water quality for drinking may be issued depending on the construction activities.	Temporary cofferdam construction method using sheet piles, which is used in general construction projects shall be adopted during construction of bridge piers to keep water quality.	Construction Contractor	PIU	Mentioned in EMoP
10	Existing social infrastructure and services	If there is a service of fishery boat at the bridge construction sites. A negative impact on the service may be issued depending on the construction activities.	Loss of livelihood from losing access to water body will be adequately compensated and will be entitled to join a livelihood restoration program based on RAP.	PIU	DC/BR	Refer to RAP
11	Maldistribution of benefit and damage	Depending on the construction activities, there may be a maldistribution of benefit and damage such as relocation of fishing area and hindering of their economy due to bridge construction.	Loss of livelihood from losing access to water body will be adequately compensated and will be entitled to join a livelihood restoration program based on RAP.	PIU	DC/BR	Refer to RAP

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (BDT)
12	Local conflict of interest	Residents may complain about entering construction workers and the safety of their neighborhood.	If the residents raise their complain, the consultant of the supervision and contractors should deal with them with a sincere response following the Grievance Redress mechanism and should designate staff in charge of public complaints and communications.	Construction Contractor	PIU	Mentioned in EMoP
13	Gender	There may be a gender gap regarding wage, salary, and treatment as construction workers.	There must be care that there is no discrimination between male and female in employment and payment of wages/salaries.	Construction Contractor	PIU	Mentioned in EMoP
14	Children's right	There is a possibility that children's compulsory education rights may be hindered because of customary child labor in the communities around the bridge construction sites.	Construction contractor and supervision consultant as well as PIU check and monitor the list or worker and field situation in order to prevent any forms of child labor in the project.	Construction Contractor	PIU	Mentioned in EMoP
15-a	Health (Infectious diseases such as HIV/AIDS, etc.)	Infectious diseases such as HIV/AIDS, etc. may be spread by the inflow of construction workers.	To prevent the spreading of infectious diseases, awareness training to workers shall be provided with the cooperation of the local public health center.	Construction Contractor	PIU	Mentioned in EMoP
15-b			A periodic health check-up program will be conducted.			
16-a	Labor environment including labor safety	Occupational injuries / disease may occur with inappropriate labor environment including safety management in the construction sites.	Construction personnel will be provided with the necessary safety gear such as a protective hard hat and safety belt.	Construction Contractor	PIU	Mentioned in EMoP
16-b			First aid stations supervised by the safety health officer of the contractor will be located within the construction site office.			
16-c			Arrange safety training for the worker periodically.			
16-d			Compliance with the related laws and regulations.			
17-a	Accidents	Since construction-related vehicles use arterial roads, there is a possibility of increasing traffic accidents.	Sound traffic management duly approved by the concerned governmental agency will be strictly implemented to minimize traffic congestions and accidents.	Construction Contractor	PIU	Mentioned in EMoP
17-b			Traffic enforcers will be designated along these areas to assist in directing traffic flow.			

Note: PIU: Project Implementation Unit, DC: Deputy Commissioner, BR: Bangladesh Railway, EMoP: Environmental Monitoring Plan

Source: JST

Table 12.53 Proposed Mitigation Measures for Bridge at Operation Stage

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (BDT)
1	Accidents	It is estimated that the risk of train accidents by local people and their livestock will be increased due to increasing number of running train.	Provide space for emergency evacuation that also serves as a pathway for bridge repair.	BR	MoR	Mentioned in EMoP

Note: BR: Bangladesh Railway, MoR: Ministry of Railway, EMoP: Environmental Monitoring Plan

Source: JST

12.8 Environmental Monitoring Plan

Regarding the environmental and social consideration items for which the mitigation measures are set for construction work, EMoPs to inspect the effect of the measures are shown as below. The monitoring form is included in Appendix 12-1.

Table 12.54 Proposed Environmental Monitoring Plan for Railway at Pre-construction and Construction Stage

No.	Impact Item	Mitigation Measure	Method / Survey Item	Implementation Body	Responsible Body	Location	Frequency	Cost (BDT)
1-a	Air pollution	Regular preventive maintenance service of construction equipment and machinery should be strictly implemented and should require conducting daily routine equipment and machinery check-ups to ensure that there are in the optimum working conditions.	Sampling survey using the same methods as the baseline survey for SO_2, NO_2, PM_{10}, $PM_{2.5}$, CO, Ozone, and any other necessary items	Construction Contractor	PIU	Measured points during the baseline surveys	Monthly during the construction period	14,500/point
1-b		The proper work schedules should be considered not to concentrate the construction equipment at a certain point for a long time.	Construction plan / schedule	Construction Contractor	PIU	Every section under construction		Included in construction cost
1-c		To reduce the dust, the periodical water spray should be taken.	Record of sprinkler truck operation	Construction Contractor	PIU	Every section under construction		
1-d		The construction site is fenced as high as 2-2.5 m in sections where residences are in proximity.	Visual confirmation of installation of fences	Construction Contractor	PIU	Every section under construction	Before commencement of construction	
2-a	Water pollution	Washing the construction tools limited areas where there are appropriate facilities for water treatment for discharge	Visual confirmation of appropriate operation of washing activities	Construction Contractor	PIU	Washing areas	Monthly during the construction period	Included in construction cost
2-b		General waste should be treated at a designated site and disposed of following the instruction of management authority and rules. If the waste must be kept at the construction site, the tarpaulin should be covered on it.	Record of disposal / Visual confirmation	Construction Contractor	PIU	Designated sites		
2-c		In construction works near water bodies, turbid waste water shall be treated at designated sites and released again.	Visual confirmation of appropriate operation of wastewater	Construction Contractor	PIU	Every section under construction		Included in construction cost
2-d		Temporary sanitation facilities with septic tanks such as portable (mobile) toilets and garbage bins will be provided by the contractors to ensure that the domestic wastes to be generated by the construction personals are properly handled and not thrown into the drainage to prevent further pollution.		Construction Contractor	PIU	Every section under construction		

No.	Impact Item	Mitigation Measure	Method / Survey Item	Implementation Body	Responsible Body	Location	Frequency	Cost (BDT)
3	Waste	General waste generated from the camp sites should be treated at a designated site and disposed of according to the instructions of management authority and rules. If the waste must be kept at the construction site, the tarpaulin should be covered on it.	• The volume of waste including soil, vegetation, and garbage • The condition of storage and transportation for the generated waste • Voices and complaints from the local community	Construction Contractor	PIU	Every section under construction and labor camps	Monthly and when complaints are heard in this regard	Included in construction cost
4	Soil contamination	Daily maintenance of construction equipment and vehicles.	• Visual observation of installation of necessary facilities • Record of using machinery	Construction Contractor	PIU	Every section under construction	Monthly during the construction period	Included in construction cost
5-a	Noise and vibration	Noise suppressors such as mufflers will be installed whenever deemed necessary to maintain the noise generated by various heavy equipment and other construction machinery within permissible limits.	• Visual observation of installation of necessary facilities	Construction Contractor	PIU	Every section under construction Measured points during the baseline surveys	Monthly during the construction period	Included in construction cost
5-b		High noise-generating construction activities will be scheduled during daytime only (8:00 - 20:00) to avoid noise disturbance to adjust residential and commercial areas and other noise-sensitive areas. If nighttime construction is required, it is mandatory to obtain permission from the local authorities to implement the work. In the case of academic facilities, the activities should be considered during the nighttime not to interfere with the class-works.	• Record of construction work (operation time) • Record of using machinery • Same methods as the baseline survey On weekday [Noise] LAeq [Vibration] Lv					Noise and vibration: 2,000/point
5-c		Around the construction site is fenced as high as 2-2.5 m in sections where residences are in proximity.						Included in construction cost
5-d		Use low-noise and vibration machinery for construction.						

No.	Impact Item	Mitigation Measure	Method / Survey Item	Implementation Body	Responsible Body	Location	Frequency	Cost (BDT)
6	Ground subsidence	Application of appropriate construction measures such as reinforced soil wall to support embankment, and etc.	Measurement of control points Ground subsidence level by subsidence plate	Construction Contractor	PIU	Every section under construction	Monthly during the construction period	Included in construction cost
7	Offensive odor	Regular cleaning and collection of the general waste from camp sites with appropriate stock places and facilities to prevent offensive odor.	• Record and Site observation • Confirmation of voices and complaints	Construction Contractor	PIU	Camp sites and the surrounding area	Monthly and when complaints are heard in this regard	Included in construction cost
8-a	Bottom sediment	Same as "2-c"						
8-b		Same as "4 Soil contamination"						
9-a	Ecosystem	Over 237,000 trees need to be planted as compensatory planting to the alternative area following Tree Plantation and Replacement Programme (TPRP) of the Project. Among them, since there are 12 trees designated as endangered species along the alignment, transplantation shall be implemented under instruction of Forestry Department.	Status of planting following TPRP	PIU	DoF	Alternative area for compensatory planting	Before construction and monthly during the construction period	BR's Budget
9-b		A preliminary survey should be conducted before the construction commencement, If the presence of the two endangered species of fauna is confirmed, the presence of their nesting in the vicinity should be confirmed. If applicable, construction shall be halted and instructions from DoE shall be sought.	Site inspection focusing on implementation status of proposed mitigation measures	Construction Contractor	PIU/DoE	Every section under construction	Before construction and monthly during the construction period and their breeding season	60,000/time
9-c		A preliminary survey should be conducted before the construction commencement and during construction to identify the endangered species in Chalan Beel area. If applicable, the below countermeasures should be considered, and the instructions from DoE shall be sought. • To establish Sanctuaries at the horse bend, and deeper areas in the area with	Site inspection focusing on implementation status of proposed mitigation measures	Construction Contractor	PIU/DoE	Every section under construction in Chalan Beel area in monsoon season	Before construction and monthly during the construction period and their breeding season	60,000/time

No.	Impact Item	Mitigation Measure	Method / Survey Item	Implementation Body	Responsible Body	Location	Frequency	Cost (BDT)
		fixation of a branch of jungle tight made of bamboo known as brush shelter. • To prohibit construction in their breeding season, and to enclose their breeding areas; it is from Sept to Oct in case of Hilsa when tides enter the area, for example. • Season: Onset of monsoon with thunderstorms along with rainfalls and entering new water during monsoon in Chalan Beel.						
10	Land acquisition/ Resettlement	Resettlement implementation with necessary procedures based on RAP including: - Compensation prior to relocation with full replacement cost - Functioning of the grievance redress mechanism - Livelihood restoration program - Monitoring schemes - Special assistance to vulnerable groups, etc.	Internal/external monitoring of RAP progress including followings using the monitoring format attached to SIA Chapter. • Consultation meeting and other communications with the PAPs • Confirmation of records of payment • Confirmation of progress of compensation and resettlement assistance • Level of income and livelihood restoration of the PAPs Voices and complaints from the PAPs	PIU	DC/BR	Project affected area and locations PAHs are relocated	Internal monitoring of the progress of RAP implementation : Monthly, up to the final payment and relocation. Eternal monitoring of the RAP implementation : At preparation, relocation, rehabilitation stages.	Refer to RAP
11	Poverty	Implementation of adequate compensation and assistance based on the entitlement matrix of RAP. Special assistance will be provided for vulnerable groups including households below the poverty line.	Same as “10. Land acquisition/ Resettlement”		BR	Same as “10. Land acquisition/ Resettlement”		

No.	Impact Item	Mitigation Measure	Method / Survey Item	Implementation Body	Responsible Body	Location	Frequency	Cost (BDT)
12	Local economy such as employment and livelihood, etc.	Implementation of adequate compensation and assistance based on the entitlement matrix of RAP which includes a livelihood restoration program.	Internal/external monitoring of RAP progress including followings using the monitoring format attached to RAP Chapter. • Level of income and livelihood restoration of the PAPs Voices and complaints from the PAPs	PIU	BR	Same as "10. Land acquisition/ Resettlement"		
13	Land use and utilization of local resources	Loss of livelihood from the change of agricultural land will be adequately compensated and will be entitled to join a livelihood restoration program based on RAP.	Same as "12. Local economy such as employment and livelihood, etc."	PIU	DC/BR	Same as "10. Land acquisition/ Resettlement"		
14	Water use and its rights	Loss of livelihood for those using fishpond will be adequately compensated and will be entitled to join a livelihood restoration program based on RAP.	Same as "12. Local economy such as employment and livelihood, etc."	PIU	DC/BR	Same as "10. Land acquisition/ Resettlement"		
15	Existing social infrastructure and services	Resettlement implementation with necessary procedures based on RAP including: - Compensation prior to relocation with full replacement cost - Special assistance for relocation grant	Internal/external monitoring of RAP progress including followings using the monitoring format attached to RAP Chapter. • Consultation meeting and other communication with the PAPs • Confirmation of records of payment • Confirmation of progress of compensation and resettlement assistance Voices and complaints from the PAPs	PIU	DC/BR	Same as "10. Land acquisition/ Resettlement"		

No.	Impact Item	Mitigation Measure	Method / Survey Item	Implementation Body	Responsible Body	Location	Frequency	Cost (BDT)
16	Social institutions such as social infrastructure and local decision-making institution	Same as "15 Existing social infrastructure and services"						
17	Maldistribution of benefit and damage	Construction shall be carried out at night when traffic volume is relatively low, thereby mitigating the impact of road congestion as much as possible. If nighttime construction is required, it is mandatory to obtain permission from the local authorities to implement the work.	• Record and site observation • Voices and complaints from the local community	Construction Contractor with relevant local authorities	PIU	At level crossings during construction	Monthly and when complaints are heard in this regard	Included in construction cost
18-a	Local conflict of interest	Give employment opportunities to residents and Union councils evenly.	• Verification of employment status • Voices and complaints from the local community	Construction Contractor	PIU	Project affected area	When complaints are heard in this regard	Included in construction cost
18-b		If the residents complain about the construction activities, the consultant of the supervision and contractors should deal with them with a sincere response following the Grievance Redress mechanism and should designate staff in charge of public complaints and communications.	Confirmation of voices and complaints from the residents.			Every section under construction		
19	Cultural Heritage	The section adjacent to the Bhangura Central Shaheed Minar is a normal embankment construction area, so no work with sudden large vibrations will occur. However, prior discussions shall be held with the property owner to explain the details of the work and the area to be constructed, and to acquire their understandings.	Minutes of discussion or NOC from the landowner	Construction Contractor	PIU	At the section adjacent to "Bhangura Central Shaheed Minar"	Before construction Commencement, and when complaints are heard in this regard	Included in construction cost

No.	Impact Item	Mitigation Measure	Method / Survey Item	Implementation Body	Responsible Body	Location	Frequency	Cost (BDT)
20-a	Gender	During the process, FGDs for women-headed households shall be held and their opinions shall be reflected in the project.	Internal/external monitoring of RAP progress including followings using the monitoring format attached to SIA Chapter. • Consultation meeting and other communication with the PAPs • Confirmation of records of payment • Confirmation of progress of compensation and resettlement assistance • Level of income and livelihood restoration of the PAPs • Wage gap of the workers at the construction stage Voices and complaints from the PAPs	PIU	DC/BR	Same as "10. Land acquisition/ Resettlement"		
20-b		There must be care that there is no discrimination between male and female in employment and payment of wages/salaries.	Confirmation of equal pay for equal work based on the employment agreements. (If inadequate documents are identified, provide guidance to the contractor and require improvements.)	Construction Contractor	PIU	Every section under construction	Before construction commencement and at the time of employment	Included in construction cost

No.	Impact Item	Mitigation Measure	Method / Survey Item	Implementation Body	Responsible Body	Location	Frequency	Cost (BDT)
21	Children's right	Construction contractor and supervision consultant as well as PIU check and monitor the list or worker and field situation in order to prevent any forms of child labor in the project.	• Voices and complaints from the local community and the construction workers Existence of child labor • Confirmation of the construction contract • Site observation	Construction Contractor	PIU	Every section under construction	Before construction commencement and at the time of employment	Included in construction cost
22-a	Health (Infectious diseases such as HIV/AIDS, etc.)	To prevent the spreading of infectious diseases, awareness training to workers shall be provided with the cooperation of the local public health center.	• Confirmation of health checklist of the workers and preferably of the local community • Interviews with concerned organizations • Visual observation • Confirmation of voices and complaint	Construction Contractor	PIU	Every section under construction	Monthly during the construction period	Included in construction cost
22-b		A periodic health check-up program will be conducted.		Construction Contractor	PIU	Every section under construction	Monthly and when complaints are heard in this regard	Included in construction cost
22-c		To reduce ponds and puddles, where wrigglers grow, by covering them with a tarpaulin.						
23-a	Labor environment including labor safety	Construction personnel will be provided with the necessary safety gear such as a protective hard hat.	• Confirmation of accidents records • Confirmation of health checklist of workers • Medical checkup of workers • Number of cases that suffered from heat strokes and other occupational health problems • Voice and complaints from the workers • Confirmation of the construction contract	Construction Contractor	PIU	Every section under construction	Monthly and when complaints are heard in this regard	Included in construction cost
23-b		First aid stations supervised by the safety health officer of the contractor will be located within the construction site office.						
23-c		Arrange safety training for the worker periodically.						
23-d		Compliance with the related laws and regulations.					Before construction commencement and at the time of employment	

No.	Impact Item	Mitigation Measure	Method / Survey Item	Implementation Body	Responsible Body	Location	Frequency	Cost (BDT)
24-a	Accidents	Sound traffic management duly approved by the concerned governmental agency will be strictly implemented to minimize traffic congestions and accidents.	• Confirmation of accidents record • Record and site inspection • Interview with concerned organizations • Voices and complaints from the local community	Construction Contractor	PIU	Every section under construction	Monthly and when complaints are heard in this regard	Included in construction cost
24-b		Traffic enforcers will be designated along these areas to assist in directing traffic flow.						
25	Cross-border impact and climate change	Over 237,000 trees need to be planted as compensatory planting to the alternative area following Tree Plantation and Replacement Programme (TPRP) of the Project.	Same as “9-a”					

Note: PIU: Project Implementation Unit, DC: Deputy Commissioner, BR: Bangladesh Railway, DoE: Department of Environment, DoF: Department of Forest

Source: JST

Table 12.55 Proposed Environmental Monitoring Plan for Railway at Operation Stage

No.	Impact Item	Mitigation Measure	Method / Survey Item	Implementation Body	Responsible Body	Location	Frequency	Cost (BDT)
1	Water pollution	Periodical maintenance and increasing the frequency of dipping up for relevant facilities such as toilet installed at every station.	Visual confirmation of appropriate operation of relevant facilities.	BR	MoR	Every station	Twice a year for the first three year (Once in the dry season and once in the rainy season)	Included the BR budget
2	Waste	Installation of enough garbage bin at appropriate location in every station and collection rules based on local collection systems, and periodical maintenance and increasing the frequency of dipping up for relevant facilities such as toilet installed at every station.	• Confirmation of waste disposal forms • Confirmation of voices and complaints Waste management condition • Voices and complaints from the local community and passenger • Visual confirmation of appropriate operation of relevant facilities.	BR	MoR	Every station	Twice a year for the first three year	Included the BR budget
3	Soil contamination	Necessary facilities and equipment for preventing leaking oil shall be prepared at the depot.	Visual confirmation of appropriate operation of facilities and equipment.	BR	MoR	At Depot	Twice a year for the first three year (Once in the dry season and once in the rainy season)	Included the BR budget
4-a	Noise and vibration	Noise prediction will be conducted as necessary during detailed design stage, and mitigation measures, such as reduction of train speed, shall be implemented if the prediction results exceed the standards.	If the mitigation measures have been applied, confirm their implementation	BR	MoR	Along the BR line	Twice a year for the first three year	Included the BR budget
4-b		If the residents complain about noise and vibration, BR should deal with them with a sincere response following the Grievance Redress mechanism and should designate staff in charge of public complaints and communications.	Voices and complaints from the local community	BR	MoR	Along the BR line	Whenever complaints are heard in this regard	Included the BR budget

No.	Impact Item	Mitigation Measure	Method / Survey Item	Implementation Body	Responsible Body	Location	Frequency	Cost (BDT)
5	Ground subsidence	No specific measures but conduct necessary monitoring for "just in case". When measures are need, they are to be discussed to determine the best solution suitable for the conditions.	Measurement of control points Ground subsidence level	BR	MoR	Representative points along the BR line	Twice a year for the first three year	Included the BR budget
6-a	Offensive odor	Regular cleaning and collection of the general waste from every station.	• Record and Site observation • Confirmation of voices and complaints Odor	BR	MoR	Every station	Twice a year for the first three year	Included the BR budget
6-b		Installation of appropriate garbage bin with cover.						
7	Bottom sediment	Same as “3 Soil contamination”						
8-a	Ecosystem	If the residents and fisheries raise their complain, BR should deal with them with a sincere response following the Grievance Redress mechanism and should designate staff in charge of public complaints and communications.	Voices and complaints from the residents and fisheries	BR	MoR	Along the BR line	Whenever complaints are heard in this regard	Included the BR budget
8-b		To request BR and DoF to update TPRP from time to time and to ensure that the budget for afforestation is secured before implementation.	Status of planting and growth conditions following TPRP	BR	DoF	Alternative area for compensatory planting	Twice a year for the first three year	Included the BR budget
9	Gender	Active employment of female staff for BR with fair conditions	• Confirmation of employment record • Confirmation of voices and complaints from female staff of BR	BR	MoR	HQ of BR	Twice a year for the first three year	Included the BR budget
10	Health (Infectious diseases such as HIV/AIDS, etc.)	A periodic awareness program and health check-up for BR officials	• Confirmation of health checklist of the officials • Interview with concerned organizations	BR	MoR	Every station and HQ	Twice a year for the first three year	Included the BR budget
11-a	Labor environment including labor safety	Arrange safety training for the BR staff periodically.	• Medical checkup of the staff • Voice and complaints from the staff	BR	MoR	Every station and HQ	Twice a year for the first three year	Included the BR budget
11-b		Compliance with the related laws and regulations.						

No.	Impact Item	Mitigation Measure	Method / Survey Item	Implementation Body	Responsible Body	Location	Frequency	Cost (BDT)
12	Accidents	Continue to reduce the number of train accidents by hiring further gate staffs, installing level-crossings at congested points, and station staffing the congested station platforms when trains are approaching.	• Confirmation of gate-staff employment record • Confirmation of voices and complaints from gate-staff • Station staffing at congested stations	BR	MoR	At congested station and level crossing where the staff has been installed.	Twice a year for the first three year	Included the BR budget

Note: BR: Bangladesh Railway, MoR: Ministry of Railway

Source: JST

Table 12.56 Proposed Environmental Monitoring Plan for Bridge at Pre-construction and Construction Stage

No.	Impact Item	Mitigation Measure	Method / Survey Item	Implementation Body	Responsible Body	Location	Frequency	Cost (BDT)
1-a	Air pollution	Regular preventive maintenance service of construction equipment and machinery should be strictly implemented and should require conducting daily routine equipment and machinery check-ups to ensure that there are in the optimum working conditions.	Sampling survey using the same methods as the baseline survey for SO_2, NO_2, PM_{10}, $PM_{2.5}$, CO, Ozone and any other necessary items	Construction Contractor	PIU	Measured points during the baseline surveys	Monthly during the construction period	14,500/point
1-b		The proper work schedules should be considered not to concentrate the construction equipment at a certain point for a long time.	Construction plan / schedule	Construction Contractor	PIU	Every section under construction		Included in construction cost
2	Water pollution	Temporary cofferdam construction method using sheet piles, which is used in general construction projects shall be adopted during construction of bridge piers to keep water quality.	Sampling survey using the same methods as the baseline survey: [Surface water] BOD, COD, DO, Color, Odor, pH, Turbidity, Temperature, etc.	Construction Contractor	PIU	Bridge construction area	Monthly during the construction period	13,500/point
3	Waste	Construction waste generated from the construction should be treated at a designated site and could be utilized for other purpose such as land filling depending upon the suitability.	• The volume of waste including soil, vegetation, and garbage • The condition of storage and transportation for the generated waste • Voices and complaints from the local community	Construction Contractor	PIU	Bridge construction area	Monthly and when complaints are heard in this regard	Included in construction cost
4	Soil contamination	Daily maintenance of construction equipment and vehicles.	• Visual observation of installation of necessary facilities • Record of using machinery	Construction Contractor	PIU	Bridge construction area	Monthly during the construction period	Included in construction cost
5-a	Noise and vibration	Noise suppressors such as mufflers will be installed whenever deemed necessary to maintain the noise generated by various heavy equipment and other construction machinery within permissible limits.	• Visual observation of installation of necessary facilities • Record of construction work (operation time) • Record of using machinery	Construction Contractor	PIU	Bridge construction area	Monthly during the construction period	Included in construction cost Noise and vibration:

No.	Impact Item	Mitigation Measure	Method / Survey Item	Implementation Body	Responsible Body	Location	Frequency	Cost (BDT)
5-b		High noise-generating construction activities will be scheduled during daytime only (8:00 - 20:00) to avoid noise disturbance to adjust residential and commercial areas and other noise-sensitive areas. If nighttime construction is required, it is mandatory to obtain permission from the local authorities to implement the work.	• Same methods as the baseline survey On weekday [Noise] LAeq [Vibration] Lv					2,000/point
5-c		Use low-noise and vibration machinery for construction.						
6	Ecosystem	A preliminary survey should be conducted before the construction commencement and during construction to identify of endangered species in the river. If applicable, the below countermeasures should be considered. • To establish Sanctuaries at the horse bend, and deeper areas in the river with fixation of a branch of jungle tight made of bamboo known as brush shelter. • To prohibit construction in their breeding season, and to enclose their breeding areas; it is from Sept to Oct in case of Hilsa when tides enter the river, for example. • Season: Onset of monsoon with thunderstorms along with rainfalls in the river.	Site inspection focusing on implementation status of proposed mitigation measures	Construction Contractor	PIU	Every bridge section under construction	Before construction and monthly during the construction period and their breeding season	60,000/time
7	Hydrology	Sizes of openings as a cross section of each river accompanying the construction of new bridges shall be kept at least the current ones to keep river flow.	• Confirmation of bridge design drawings • Confirmation of river flow by site visit	Construction Contractor	PIU	Bridge construction area	Before construction and monthly during the construction period	Included in construction cost

No.	Impact Item	Mitigation Measure	Method / Survey Item	Implementation Body	Responsible Body	Location	Frequency	Cost (BDT)
8	Local economy such as employment and livelihood, etc.	Implementation of adequate compensation and assistance based on the entitlement matrix of RAP which includes a livelihood restoration program.	Internal/external monitoring of RAP progress including followings using the monitoring format attached to SIA Chapter. • Consultation meeting and other communications with the PAPs • Confirmation of records of payment • Confirmation of progress of compensation and resettlement assistance • Level of income and livelihood restoration of the PAPs Voices and complaints from the PAPs	PIU	BR	Project affected area and locations PAHs are relocated	Internal monitoring of the progress of RAP implementation : Monthly, up to the final payment and relocation. External monitoring of the RAP implementation : At preparation, relocation, rehabilitation stages.	Refer to RAP
9	Water use and its rights	Temporary cofferdam construction method using sheet piles, which is used in general construction projects shall be adopted during construction of bridge piers to keep water quality.	Same as “2. Water pollution”					
10	Existing social infrastructure and services	Same as “8. Local economy such as employment and livelihood, etc.”		PIU	DC/BR	Same as “8. Local economy such as employment and livelihood, etc.”		
11	Maldistribution of benefit and damage	Same as “8. Local economy such as employment and livelihood, etc.”		PIU	DC/BR	Same as “8. Local economy such as employment and livelihood, etc.”		
12	Local conflict of interest	If the residents raise their complain, the consultant of the supervision and contractors should deal with them with a sincere response following the Grievance Redress mechanism and should designate staff in charge of public complaints and communications.	Voices and complaints from the local community	Construction Contractor	PIU	Along the BR line	When complaints are heard in this regard	Included in construction cost

No.	Impact Item	Mitigation Measure	Method / Survey Item	Implementation Body	Responsible Body	Location	Frequency	Cost (BDT)
13	Gender	There must be care that there is no discrimination between male and female in employment and payment of wages/salaries.	Confirmation of equal pay for equal work based on the employment agreements. (If inadequate documents are identified, provide guidance to the contractor and require improvements.)	Construction Contractor	PIU	Bridge construction area	Before construction commencement and at the time of employment	Included in construction cost
19	Children's right	Construction contractor and supervision consultant as well as PIU check and monitor the list or worker and field situation in order to prevent any forms of child labor in the project.	• Voices and complaints from the local community and the construction workers Existence of child labor • Confirmation of the construction contract • Site observation	Construction Contractor	PIU	Bridge construction area	Before construction commencement and at the time of employment	Included in construction cost
20-a	Health (Infectious diseases such as HIV/AIDS, etc.)	To prevent the spreading of infectious diseases, awareness training to workers shall be provided with the cooperation of the local public health center.	• Confirmation of health checklist of the workers and preferably of the local community • Interviews with concerned organizations • Visual observation • Confirmation of voices and complaint	Construction Contractor	PIU	Bridge construction area	Monthly and when complaints are heard in this regard	Included in construction cost
20-b		A periodic health check-up program will be conducted.						
21-a	Labor environment including labor safety	Construction personnel will be provided with the necessary safety gear such as a protective hard hat and safety belt.	• Confirmation of accidents records • Confirmation of health checklist of workers • Medical checkup of workers • Number of cases that suffered from heat strokes and other occupational health problems • Voice and complaints from the workers • Confirmation of the construction contract	Construction Contractor	PIU	Bridge construction area	Monthly and when complaints are heard in this regard	Included in construction cost
21-b		First aid stations supervised by the safety health officer of the contractor will be located within the construction site office.						
21-c		Arrange safety training for the worker periodically.						
21-d		Compliance with the related laws and regulations.					Before construction commencement and at the time of employment	

No.	Impact Item	Mitigation Measure	Method / Survey Item	Implementation Body	Responsible Body	Location	Frequency	Cost (BDT)
22-a	Accidents	Sound traffic management duly approved by the concerned governmental agency will be strictly implemented to minimize traffic congestions and accidents.	• Confirmation of accidents record • Record and site inspection • Interview with concerned organizations • Voices and complaints from the local community	Construction Contractor	PIU	Bridge construction area	Monthly and when complaints are heard in this regard	Included in construction cost
22-b		Traffic enforcers will be designated along these areas to assist in directing traffic flow.						

Note: PIU: Project Implementation Unit, DC: Deputy Commissioner, BR: Bangladesh Railway,

Source: JST

Table 12.57 Proposed Environmental Monitoring Plan for Bridge at Operation Stage

No.	Impact Item	Mitigation Measure	Method / Survey Item	Implementation Body	Responsible Body	Location	Frequency	Cost (BDT)
1	Accidents	Provide space for emergency evacuation that also serves as a pathway for bridge repair.	• Confirmation of evacuation space	BR	MoR	Bridge section	Completion of construction	Included the BR budget

Note: BR: Bangladesh Railway, MoR: Ministry of Railway

Source: JST

12.9 Project Implementation System

Undisclosed

Undisclosed

Chapter 13 Resettlement Action Plan

13.1 The Necessity of Land Acquisition and Resettlement

13.1.1 Affected Project Component and Project Area

Although BR has the Right of Way (ROW) on both sides of the existing railway line, the project requires private land to accommodate additional railway lines. The widening of the existing embankment, new bridges, and extending and building of new stations are also the components that require additional land. In addition, the existing ROW is currently being used and occupied by informal settlers, businesses, and shops that will be affected by the project. The project components incurring land acquisition and resettlement are shown below.

Table 13.1 Affected Project Component

Items	Project Components	Total land required	Private land
Doubling the line	Track work of approx. 170 km	Approx. 1,702 acres (689 ha)	72.12 acre (29.2 ha)
Station	Renewal of 26 existing stations		
Bridge	Construction of approx. 200 bridges		

Source: JST

13.1.2 Efforts to Avoid or Minimize the Impact

(1) Alternative alignment options

In the previous F/S report, BR analyzed two alternatives, 1) double track to the north and 2) double track to the south. Based on the multiple environmental and social indicators, including impact on settlements, sensitive facilities, and land acquisition, 1) double track to the north was selected as having fewer negative impacts. Furthermore, this study considered without case and sectional and partial double-tracking options from the viewpoints of economy, technology, safety, environmental degradation, social impacts, and community disruption. The details are described in Chapter 3 Consideration of Alternative Plans.

(2) Setting Construction ROW

While considering the alignment and setting Construction ROW (CROW), BR carefully drew boundaries based on the local condition to minimize the area. The followings are the key strategies undertaken to reduce the acquisition of land.

- The additional track was confined as much as possible within the available existing BR land

- The additional track was adjusted and realigned to save several major factories in the Bangabandhu Setu East to Joydebpur Section
- The CROW was adjusted to avoid sensitive structures such as Common Property Resources (CPRs) and densely populated areas
- In some cases, discussed and negotiated with property owners to minimize the amount of land acquisition.

(3) Reduce impact on Common Property Resources

According to the information from BR, the impact on CPR including education centers and religious structures was minimized as much as possible by adjusting the CROW to a minimum. For those structures that are not avoidable, BR will consult with structure owners and relevant communities in advance and provide cash compensation and relocation support.

Avoided the mosque near the Joydebpur station

Avoided temples near the Joydebpur station

Source: JST

Figure 13.1 Example of Avoided CPRs

13.2 Legal Framework

13.2.1 Laws and Regulations of Bangladesh

(1) Laws and Regulations related to Land Acquisition

The principal legal instrument governing land acquisition in Bangladesh is the Acquisition and Requisition of Immovable Property Act, 2017 (ARIPA 2017). It repealed the long-lasting Acquisition and Requisition of Immovable Property Ordinance, of 1982.

It provides that compensation will be calculated based on the market price for (i) land and assets permanently acquired (including standing crops, trees, and houses); and (ii) any other damages caused by such acquisition. However, eligibility is limited to titleholders, and there is no provision for the compensation of non-title holders. The detail of gaps between Bangladesh legislation and JICA guidelines for ESC is described in Table 13.2.

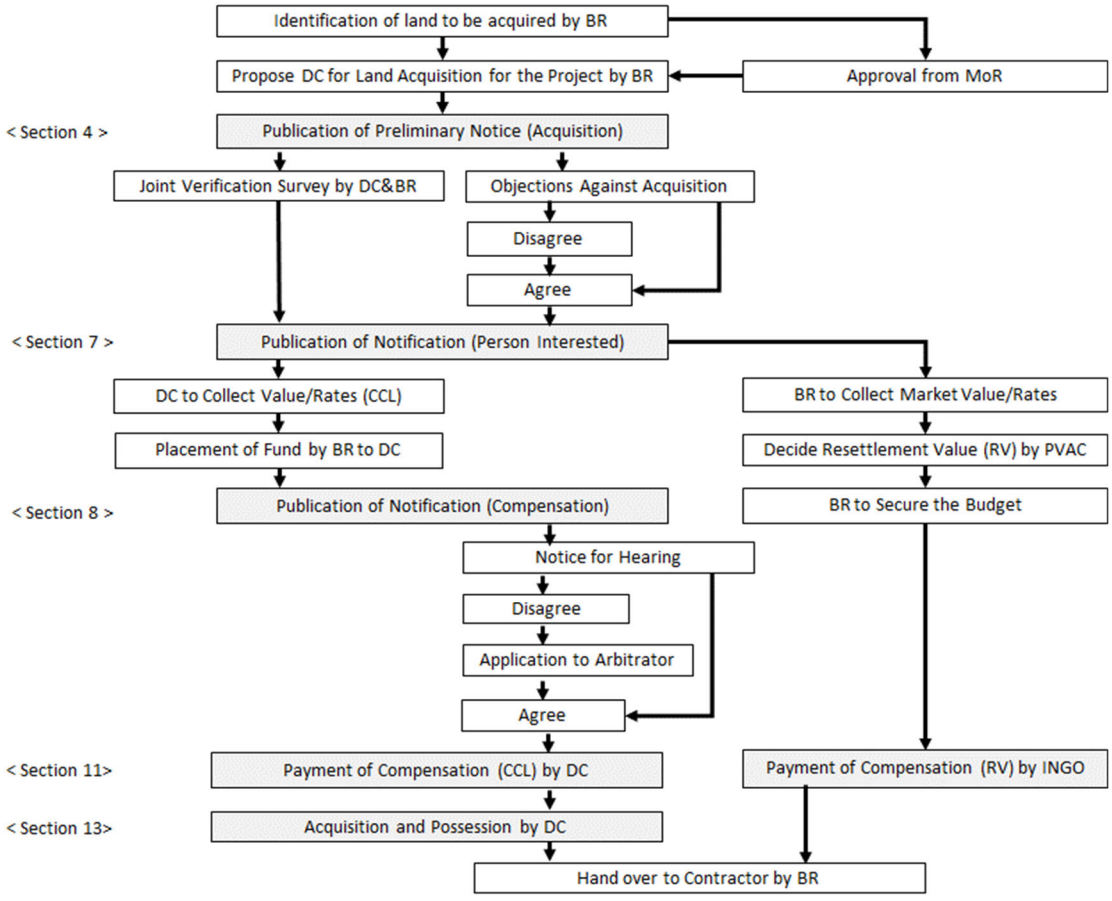
(2) Land Acquisition and Compensation Procedure

1) Procedure for title holders

The land acquisition and compensation procedure stipulated in the ARIPA 2017 is shown in the figure below.

The first step of land acquisition is for BR to submit the land acquisition proposal to the Deputy Commissioner (DC). Upon approval from the DC, DC publishes a preliminary notice to the recorded owner of the affected property under Section 4 of ARIPA 2017. After that, DC and BR conduct a joint verification survey to identify the details of the affected properties. Based on the survey, DC collects prices of land, structures, trees, and crops from relevant authorities as per government rules, which is called Cash Compensation under Law (CCL). Upon placement of funds by BR, the DC publishes a notice to the titled PAPs under Section 7 for receiving CCL.

In parallel, BR conducts Current Market Price (CMP) survey, and the Replacement Cost (RC) will be determined by Property Valuation Advisory Committee (PVAC). The difference between the CCL and RC will be arranged by BR and distributed through RAP implementing NGO/Firm to Project Affected People (PAP).



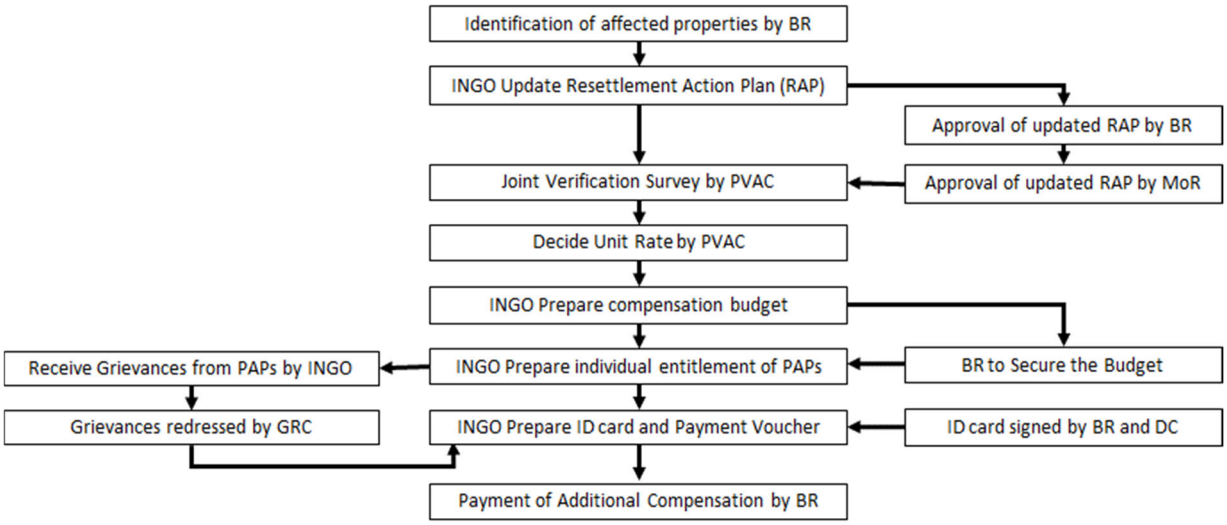
Source: JST based on Acquisition and Requisition of Immovable Property Act, 2017

Figure 13.2 Land Acquisition and Compensation Payment to Title Holders

2) Procedure for non-title holders

As mentioned earlier, Bangladesh legislation does not recognize non-title holders as PAP. Therefore, to meet the requirement of the JICA guidelines for ESC, the following activities will be carried out for this Project. The non-titled PAPs i.e., those who have no legal ownership of the affected property but are socially recognized and enlisted during the census survey, will be compensated by a separate procedure.

As shown in the figure below, after the identification of affected properties by BR, RAP will be updated with the support of the RAP implementing NGO/Firm. Upon approval of the updated RAP by BR and the Ministry of Railway (MOR), a joint verification survey will be carried out and the unit rate will be decided by PVAC, and then the final list of PAPs will be prepared by the NGO/Firm. The ID card will be jointly signed by the BR and NGO/Firm and will be attested by the DCs concerned and additional compensation will be paid by BR.



Source: JST based on past experiences/projects in Bangladesh

Figure 13.3 Land Acquisition and Compensation Payment to Nontitle Holders

13.2.2 JICA Guidelines for ESC Policy

The key principles of JICA guidelines for ESC policies on involuntary resettlement are summarized below.

I. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.

II. When population displacement is unavoidable, effective measures to minimize the impact and compensate for losses should be taken.

III. People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported so that they can improve or at least restore their standard of living, income opportunities, and production levels to pre-project levels.

IV. Compensation must be based on the full replacement cost[26] as much as possible.

V. Compensation and other kinds of assistance must be provided before displacement.

VI. For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. The resettlement action plan should include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.

VII. In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that is understandable to the affected people.

VIII. Appropriate participation of affected people must be promoted in the planning, implementation, and monitoring of resettlement action plans.

IX. Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

The above principles are complemented by World Bank OP 4.12 since it is stated in JICA guidelines for ESC that "JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies". An additional key principle based on World Bank OP 4.12 is as follows.

X. Affected people are to be identified and recorded as early as possible to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits.

XI. Eligibility of Benefits includes the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying.

XII. Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based

XIII. Provide support for the transition period (between displacement and livelihood restoration.

[26] Description of "replacement cost" is as follows.

Land	Agricultural Land	The pre-project or pre-displacement, whichever is higher, market value of land of equal productive potential or use located in the vicinity of the affected land, plus the cost of preparing the land to levels similar to those of the affected land, plus the cost of any registration and transfer taxes.
	Land in Urban Areas	The pre-displacement market value of land of equal size and use, with similar or improved public infrastructure facilities and services and located in the vicinity of the affected land, plus the cost of any registration and transfer taxes.
Structure	Houses and Other Structures	The market cost of the materials to build a replacement structure with an area and quality similar or better than those of the affected structure, or to repair a partially affected structure, plus the cost of transporting building materials to the construction site, plus the cost of any labor and contractors' fees, plus the cost of any registration and transfer taxes.

XIV. Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities, etc.

XV. For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, an abbreviated resettlement plan is to be prepared.

In addition to the above core principles on the JICA policy, it also emphasized a detailed resettlement policy inclusive of all the above points; a project-specific resettlement plan; an institutional framework for implementation; a monitoring and evaluation mechanism; the schedule for implementation; and, a detailed Financial Plan, etc.

13.2.3 The Gap between JICA Guidelines for ESC and Bangladesh Legislation

The main provisional gaps between the Acquisition and Requisition of Immovable Property Act, 2017 (ARIPA 2017) and the JICA guidelines for ESC are listed below.

- There is no provision in ARIPA 2017 for the compensation of non-title holders. The Act also does not provide for resettlement assistance and livelihood restoration support during the transition period.
- Due to the absence of a cut-off date (COD) for non-title holders, the existing act cannot prevent a further influx of occupants to the areas declared. Therefore, gap-filling measures include recording potentially affected structures and setting COD for those PAPs.
- ARIPA 2017 does not specify the application of replacement costs for compensation. Thus, the compensation policy will be prepared in the form of an entitlement matrix based on international practice. Compliance during the implementation will be monitored by internal and external monitoring mechanisms.
- The process of hearing objections in ARIPA 2017 is at the DC level. Therefore, a grievance redress mechanism will be arranged to include a local-level administration and support from RAP implementing NGO/Firm so that it is easily accessible from PAPs.

The details of gaps between Bangladesh Legislation (ARIPA 2017) and JICA guidelines for ESC and necessary gap-filling measures are indicated below.

Table 13.2 Gap between Bangladesh ARIPA 2017 and JICA guidelines for ESC 2010

No.	JICA Guidelines (2010)	ARIPA (2017)	Gaps	Measures
1	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	N/A	No regulation requires to avoid or minimize involuntary resettlement and loss of livelihood	Consider alternatives to minimize involuntary resettlements
2	When population displacement is unavoidable, effective measures to minimize impact and compensate for losses should be taken. (JICA GL)	Compensation includes movable, immovable assets, standing crops, trees, and earnings (Ch.2, Section 9)	No description of employing effective measures to minimize the impact.	Include measures to minimize the impact and appropriate livelihood restoration policy in RAP

No.	JICA Guidelines (2010)	ARIPA (2017)	Gaps	Measures
3	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported so that they can improve or at least restore their standard of living, income opportunities, and production levels to pre-project levels. (JICA GL)	Compensation includes income loss, expenses incidental to change residence or place of business (Ch.2, Section 9)	No clear provision to improve or at least restore the standard of living, and income opportunities to pre-project.	Consider support to improve and restore the livelihoods of PAPs.
4	Compensation must be based on the full replacement cost as much as possible. (JICA GL) Valuation and compensation for losses shall be determined by the replacement cost. (WB OP4.12 Para 10)	Compensation will be calculated as 200% of the market value for a government person, and 300% of the market value for a non-government person (Ch.2, Section 9)	No provision stipulates that the compensation amount should be at full replacement cost.	The amount of compensation shall be determined based on the full replacement cost identified by the market value survey.
5	Compensation and other kinds of assistance must be provided before displacement. (JICA GL)	When the compensation mentioned in the award has been paid, the Deputy Commissioner shall thereupon take possession of the property (Ch.2, Section 13)	No provision requires assistance other than compensation.	Include assistance other than compensation in PAP and monitor the implementation before displacement.
6	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. (JICA GL)	N/A	No provision requires preparing a Resettlement Action Plan. However, for international donor projects, the plan is prepared as per the donor's requirement.	Prepare Resettlement Plan and made it available to the public.
7	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA GL)	Public notice of acquisition to be published at convenient places (Ch.2 Section 4) Public notice of affected property is to be published at convenient places or near a such property (Ch.2 Section 7)	No provision requires consultation with PAPs and their community (only public notice).	Disclose information in advance and conduct consultation with PAPs and their community.
8	When consultations are held, explanations must be given in a form, manner, and language that is understandable to the affected people. (JICA GL)	Same as above.	No provisions requiring the use of languages and styles that can be understood by PAPs at the time of consultation	Explain with languages and styles that can be understood by PAPs at the time of consultation
9	Appropriate participation of affected people must be promoted in the planning, implementation, and monitoring of resettlement action plans. (JICA GL)	N/A	No provisions requiring the participation of PAPs for the planning, implementation, and monitoring of RAP.	Consider allowing the PAPs to participate in the process of RAP.

No.	JICA Guidelines (2010)	ARIPA (2017)	Gaps	Measures
10	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)	PAPs can file an objection against the acquisition proceeding to DC within 15 working days (Ch.2 Section 5) PAPs can apply to the arbitrator for revision of the award within 45 days from the notice of award (Ch.4 Section 30)	Procedures for hearing objections are to DC or through arbitrator which is not necessarily easy to exercise by PAPs.	Consider the Grievance Redress Mechanism which is accessible by PAPs
11	Affected people are to be identified and recorded as early as possible to establish their eligibility through an initial baseline survey, preferably at the project identification stage, to prevent a subsequent influx of encroachers who wish to take advance of such benefits. (WB OP4.12 Para.6)	Preliminary notice of acquisition to be published. (Ch.2 Section 4) Amount of compensation to be based on the market value at the date of publication of the notice under Section 4 (Ch.2 Section 9)	No provision to identify non-titled holders.	The cut-off date shall be declared for non-titled holders.
12	Eligibility of benefits includes; the PAPs who have formal legal rights to land, the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets, and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12 Para.15)	Eligibility of benefits includes a person who is legally in possession of the property (Ch.1, Section 2)	The eligibility of non-title holders is not mentioned.	PAPs with assets and income sources affected by the project have the right to receive compensation and assistance regardless of their legal status.
13	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para.11)	N/A	No provisions require providing land-based resettlement strategies.	Consider land-based resettlement strategies if PAPs' livelihoods depend on land
14	Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 Para.6)	N/A	No provisions require providing support during the transition period.	Consider support for the transition period.
15	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities, etc. (WB OP4.12 Para.8)	N/A	No provisions requiring the consideration of vulnerable groups	Vulnerable groups shall be identified, and special assistance shall be considered in the RAP.

Source: JST

13.2.4 Land Acquisition and Resettlement Policy

Based on the above gap analysis, the land acquisition and resettlement policy to be adopted in the Project are described below.

I. The Government of Bangladesh will use the Project Resettlement Policy (the Project Policy) specifically because existing national laws and regulations have not been designed to address involuntary resettlement according to international practice, including JICA guidelines for ESC. The Project Policy is aimed at filling in any gaps that local laws and regulations cannot provide to help ensure that PAPs can rehabilitate themselves to at least their pre-project condition. This section discusses the principles of the Project Policy and the entitlements of the PAPs based on the type and degree of their losses. Where there are gaps between the Bangladesh Government's legal framework for resettlement and JICA guideline for ESC on Involuntary Resettlement, practicable mutually agreeable approaches will be designed consistent with Government practices and JICA guidelines for ESC.

II. Land acquisition and involuntary resettlement will be avoided where feasible, or minimized, by identifying possible alternative project designs that have the least adverse impact on the communities in the project area.

III. Where displacement of households is unavoidable, all PAPs (including communities) losing assets, livelihoods, or resources will be fully compensated and assisted so that they can improve, or at least restore their former economic and social conditions.

IV. Compensation and rehabilitation support will be provided to any PAPs, that is, any person or household, or business which on account of project implementation would have his, her, or their:

- Standard of living adversely affected;
- Right, title, or interest in any house, interest in, or right to use, any land (including premises, agricultural land, commercial properties, tenancy, or right in annual or perennial crops and trees or any other fixed or moveable assets, acquired or possessed, temporarily or permanently;
- Income earning opportunities, business, occupation, work or place of residence or habitat adversely affected temporarily or permanently; or
- Social and cultural activities and relationships are affected or any other losses that may be identified during the process of resettlement planning.

V. All affected people will be eligible for compensation and rehabilitation assistance, irrespective of tenure status, social or economic standing, and any such factors that may discriminate against the achievement of the objectives outlined above. Lack of legal rights to the assets lost or adversely affected tenure status and social or economic status will not bar the PAPs from entitlements to such compensation and rehabilitation measures or resettlement objectives. All PAPs residing, working, doing business, and/or cultivating land within the project-impacted areas as of the date of the latest census and inventory of lost

assets, are entitled to compensation for their lost assets (land and/or non-land assets), at replacement cost, if available and restoration of incomes and businesses, and will be provided with rehabilitation measures sufficient to assist them to improve or at least maintain their pre-project living standards, income-earning capacity, and production levels.

VI. PAPs that lose only part of their physical assets will not be left with a portion that will be inadequate to sustain their current standard of living. The minimum size of the remaining land and structures will be agreed upon during the resettlement planning process.

VII. People temporarily affected are to be considered PAPs and appropriate support will be considered.

VIII. Where a host community is affected by the development of a resettlement site in that community, the host community shall be involved in any resettlement planning and decision-making. All attempts shall be made to minimize the adverse impacts of resettlement upon host communities.

IX. The resettlement plans will be designed in accordance with Bangladesh's ARIPA 2017, and JICA guidelines for ESC on Involuntary Resettlement.

X. The Resettlement Plan will be translated into local languages and disclosed for the reference of PAPs as well as other interested groups.

XI. Payment for land and/or non-land assets will be based on the principle of the replacement cost.

XII. Compensation for PAPs dependent on agricultural activities will be compensated for income loss and upgradation of livelihoods by providing opportunities for re-training, skill development, wage employment, or self-employment, including access to credit. Solely cash compensation will be avoided as an option if possible, as this may not address losses that are not easily quantified, such as access to services and traditional rights, and may eventually lead to those populations being worse off than without the project.

XIII. Replacement lands, if the preferred option of PAPs, should be within the immediate vicinity of the affected lands wherever possible and be of comparable productive capacity and potential. As a second option, sites should be identified that minimize the social disruption of those affected; such lands should also have access to services and facilities similar to those available in the lands affected.

XIV. Resettlement assistance will be provided not only for an immediate loss but also for a transition period needed to restore the livelihood and standards of living of PAPs. Such support could take the form of short-term jobs, subsistence support, salary maintenance, or similar arrangements.

XV. The resettlement plan must consider the needs of those most vulnerable to the adverse impacts of resettlement (including the poor, those without legal title to land, and women, children, elderly and disabled) and ensure they are considered in resettlement planning and

mitigation measures identified. Assistance should be provided to help them improve their socio-economic status.

XVI. PAPs will be involved in the process of developing and implementing resettlement plans.

XVII. PAPs and their communities will be consulted about the project, the rights and options available to them, proposed mitigation measures for adverse effects, and to the extent possible be involved in the decisions that are made concerning their resettlement.

XVIII. Adequate budgetary support will be fully committed and made available to cover the costs of land acquisition (including compensation and income restoration measures) within the agreed implementation period. The funds for all resettlement activities will come from the Government.

XIX. Displacement does not occur before the provision of compensation and other assistance required for relocation. Sufficient civic infrastructure must be provided in the resettlement site prior to relocation. Acquisition of assets, payment of compensation, and the resettlement and start of the livelihood rehabilitation activities of PAPs will be completed prior to any construction activities, except when a court of law orders so in expropriation cases. (Livelihood restoration measures must also be in place but not necessarily completed prior to construction activities, as these may be ongoing activities.)

XX. Organization and administrative arrangements for the effective preparation and implementation of the resettlement plan will be identified and in place prior to the commencement of the process; this will include the provision of adequate human resources for supervision, consultation, and monitoring of land acquisition and rehabilitation activities.

XXI. Appropriate reporting (including auditing and redress functions), monitoring, and evaluation mechanisms, will be identified and set in place as part of the resettlement management system. An external monitoring group will be hired.

Cut-off-date of Eligibility

The COD of eligibility refers to the date prior to which the occupation or use of the project area makes residents/users of the same eligible to be categorized as PAPs and be eligible for Project entitlements. In the Project, COD for titleholders will be the date of the notification based on Section 4 of ARIPA 2017. This date has been / will be disclosed by the DC of each district to their populations. COD for nontitle holders will be the date that affected structures were marked before the survey. The establishment of the eligibility COD is intended to prevent the influx of ineligible non-residents who might take advantage of Project entitlements.

Principle of Replacement Cost

All compensation for land and non-land assets owned by households/shop owners who meet the COD will be based on the principle of the replacement cost. Replacement cost is the amount calculated before displacement which is needed to replace an affected asset without depreciation and deduction for taxes and/or costs of the transaction. The details will be described in the 13.4.5 Entitlement Matrix.

13.3 Scope of Land Acquisition and Resettlement Impact

13.3.1 Survey Method

A series of surveys for the Project has conducted from October to November 2022 for structure-based PAPs and March to April 2023 for land-based PAPs. The survey methods include the following.

- Census Survey: Basic information on affected households/people
- Inventory of Loss (IOL) survey: Size of land and assets, ownership status, etc.
- Socio-economic survey: Education status, income level, access to service, etc.
- Current Market Price (CMP) survey: Market value/price of land, structures, etc.
- Stakeholder Meeting (SHM): Collect opinions and concerns of interested parties in the project area.
- Focus Group Discussion (FGD): Collect opinions and concerns of different groups, women, transport operators, farmers/fishermen, etc.

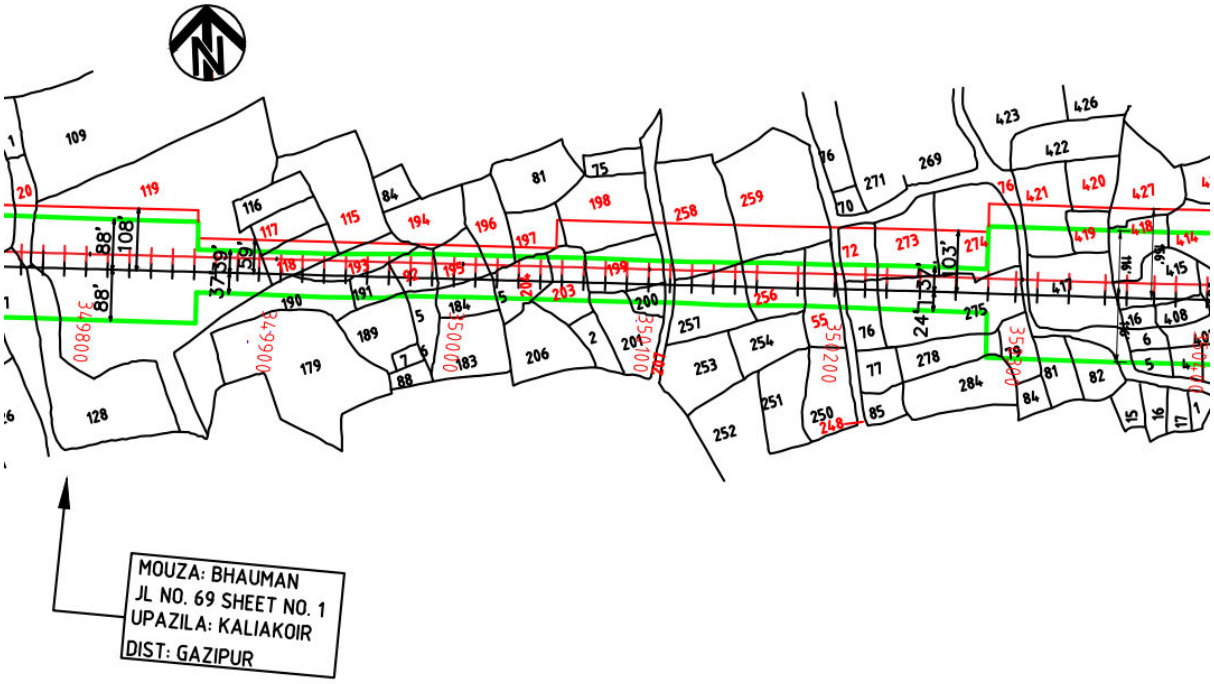
Census and IOL surveys were conducted based on the latest information available at the time of the survey. As shown in the table below, in Gazipur, Pabna, and Natore, the survey was based on the Land Acquisition Plan (LAP) prepared by BR and verified by DC after the field reconnaissance. Whereas in Sirajganj and Tangail, the survey was based on the information before it is verified by the field reconnaissance.

Table 13.3 Information Base of the Census and IOL survey

Districts	Sub-district	Base data
Gazipur	Sadar	Information verified by the field reconnaissance
	Kaliakolior	Information verified by the field reconnaissance
Tangail	-	Updated mouza map (field reconnaissance was not yet started)
Sirajganj	-	Updated mouza map (field reconnaissance was not yet started)
Pabna	-	Information verified by the field reconnaissance
Natore	-	Information verified by the field reconnaissance

Source: JST

The figure below shows LAP overlapped on the mouza maps. It indicates the existing railway ROW owned by the government shown in the green line and the red line shows the additional private land required for the Project which is CROW.



Source: BR

Figure 13.4 Survey Area

The LAP is prepared on a scale, so PAHs were identified by measuring the distance from the centerline of the railway track to the CROW as shown in Figure 13.5. Those who are within the CROW were covered by the census survey and the size of affected structures within the CROW was physically measured in the IOL survey.

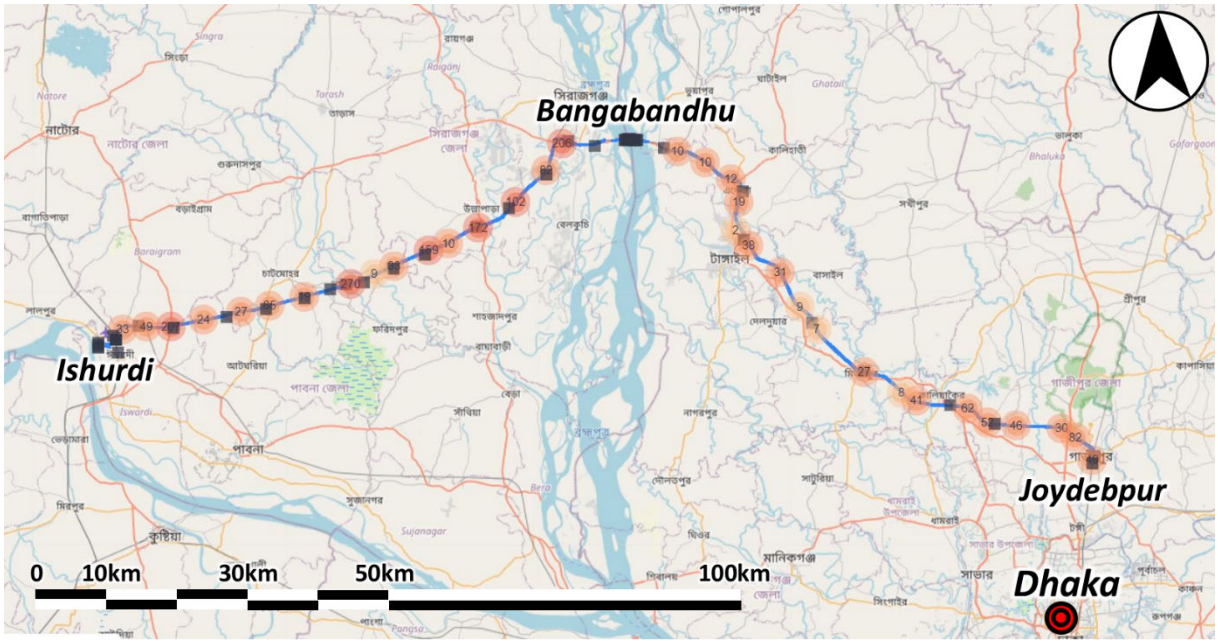
Measuring distance from the rail track

Measuring the size of the affected structure

Source: JST

Figure 13.5 Method of Measurement

A set of questionnaires was prepared for these surveys and Open-Source Software was used for collecting, managing, and mapping data. This software records coordinates and allows for offline data collection with Android Tablets. The stored data from the Tabs in the field have been processed and the tables or figures were generated to prepare the RAP report. The figure below shows the locations of affected structures along the alignment covered by the IOL survey.



Source: JST

Figure 13.6 Survey Location

13.3.2 Cut-off-date (COD)

Eligibility to receive compensation and resettlement assistance will be limited by "cut-off dates (COD)". Based on the discussion with BR and also following the previous projects/experiences with development partners, two CODs were set for this Project as described below; one for titled holders and one for non-title holders to meet the international guideline.

- The first cut-off date is for titled holders to be notified by the Deputy Commissioner (DC) under Section 4 of the ARIPA 2017 informing the landowners of the Project right-of-way.
- The second cut-off date is called the "social cut-off date" based on the census for identification and eligibility for non-title holders and "non-land" related entitlements. This was set at the marking of potentially affected structures along the alignment before the 1st stakeholder meeting to avoid an influx of people.

Structures within CROW are marked
Source: JST

Figure 13.7 Structure marking in the Survey

COD for titleholders is the date when the land acquisition notice was issued based on Section 4 of ARIPA 2017. As of now, COD has not been set for Tangail, and Sirajganj. On the other hand, CODs for nontitle holders were set at the time of structure marking by the Project. CODs of each district are summarized in the following table.

Table 13.4 Summary of Cut-off-date

Districts	Sub-district	Cut-off-date (Section 4)	Social cut-off-date
Gazipur	Sadar	26 October 2023	10 October 2022
	Kaliakolior	25 February 2021	08 October 2022
Tangail	-	Not yet	08 October 2022
Sirajganj	-	Not yet	17 October 2022
Pabna	-	28 February 2023	15 October 2022
Natore	-	21 January 2021	16 October 2022

Source: JST

13.3.3 Key Impact of the Project

The overall impact of the Project is summarized in the table below.

Table 13.5 Summary of Affected Area and People

Impacts	Title holder	Non-title holder	Total
Total Affected Land (acre)			1,774.03
Affected Public Land	-	-	1,702.00
Affected Private Land*	-	-	72.12
Total PAH (household)			2,991
Total PAP (people)			12,150
Number of Only Lands Affected PAH	1,328	-	1,328
Number of Only Lands Affected PAP	5,109	-	5,109
Number of Primary structures affected PAH (Displaced)	715	886	1,601
Number of Primary structures affected PAP (Displaced)	2,870	3,883	6,753
Number of Secondary structures affected PAH	16	18	34
Number of Other structures affected PAH	15	13	28
Number of Vulnerable PAH	320	279	599
Total Business Affected People (people)			797
Sharecropper	-	-	47
Tenants	-	-	645
Worker / Employees	-	-	105
Total Affected Structures & Trees (units)			
Number of Affected Structures	1,139	1,532	2,671
Number of Common/Community Property Resources (CPR)	17	19	36
Number of Affected trees	18,521	30,082	48,603

*Updated on 15th June 2024

Source: JST

(1) Project Affected Land

BR has its land along the existing track as their ROW. However, an estimated 72.12 acres of private land will be additionally required for this Project as shown in the table below. Since the LAP survey is still ongoing in Tangail, the affected area in Tangail is based on the BR estimates which are subject to change. Affected land areas in other districts are based on the information in Section 4.

Table 13.6 Affected Areas

Districts	Area (acres)
Gazipur	21.97
Tangail	41.18
Sirajganj	3.02
Pabna	3.19
Natore	2.76
Total	72.12

Source: DC office

(2) Project Affected Household and People

The total numbers of Project Affected Household (PAH) and Project Affected People (PAP) are 2,991 PAHs and 12,150 PAPs, respectively. The proportion of PAHs without titles is 32.9%. In specific, the share of non-title holders is high in Pabna and Sirajganj which are 44.0% and 33.6% of total non-title PAHs. Among total PAHs, 1,601 PAHs and 6,753 PAPs are considered displaced whose structure and the combination of structure, land, and income sources will be affected by the project. Detail is present in the table below.

Table 13.7 Project Affected Households/People and Displaced Households/People

District	Total		Without titles		Displaced	
	PAH	PAP	PAH	PAP	PAH	PAP
Gazipur	471	2,186	127	602	382	1,877
Tangail	1,281	5,246	86	406	195	964
Sirajganj	573	2,285	330	1,315	484	1,907
Pabna	589	2,171	433	1,535	516	1,917
Natore	77	262	7	25	24	88
Total	**2,991**	**12,150**	983	3,883	1,601	6,753

Source: Census & IOL survey 2022-23

In terms of the type of loss, land only affected households are 958 PAHs, 1,001 PAHs will experience the losses of a residential structure, 516 households will lose commercial structures, and 84 households will lose residential-cum-commercial structures. PAH by type of loss is presented Table 13.8 and the legal status of PAHs is detailed in the tables below respectively.

Table 13.8 Project Affected Households by Type of Loss

Districts	Land only	Residential structures	Commercial structures	Residential & commercial structures	Other structures	Total
Gazipur	52	265	83	33	10	443
Tangail	747	147	39	11	8	952
Sirajganj	75	262	203	19	12	371
Pabna	43	311	184	20	29	587
Natore	41	16	7	1	3	68
Total	958	1,001	516	84	62	2,621

Note: Number of Land only affected PAHs in Tangail is subject to change as LAP is still in progress.
*Other: secondary structure

Source: Census & IOL survey 2022-23

Table 13.9 Structure Affected Household by Legal Status

Districts	Residential		Commercial		Residential & Commercial		Others		Total	
	Title	Nontitle	Title	Nontitle	Title	Nontitle	Title	Nontitle	Title	Nontitle
Gazipur	207	58	21	62	27	6	8	2	263	128
Tangail	86	61	17	22	7	4	8	0	118	87
Sirajganj	90	172	62	141	9	10	5	7	166	330
Pabna	36	275	64	120	5	15	7	22	112	432
Natore	13	3	3	4	1	0	3	0	20	7
Total	432	569	167	349	49	35	31	31	679	984

*Other: secondary structures

Source: Census & IOL survey 2022-23

(3) Project Affected Structures

The type and legal status of affected structures are summarised in Table 13.10. The total number of affected structures is 2,671 units and the majority of which are residential structures which account for 65.9%. Commercial structures are 24.3%, residential-cum-commercial structures are 8.6% and others are 1.1%. The legal status of the structures shows that 57.4% of total structures are categorized as non-title structures.

Table 13.10 Project Affected Structures by Legal Status

Districts	Residential		Commercial		Residential & Commercial		Others		Total
	Title	Nontitle	Title	Nontitle	Title	Nontitle	Title	Nontitle	
Gazipur	391	113	27	73	63	21	5	1	694
Tangail	173	86	23	23	19	10	6	0	340
Sirajganj	145	307	71	202	28	31	0	1	785
Pabna	61	456	82	140	11	46	4	11	811
Natore	23	5	3	6	2	0	2	0	41
Total	793	967	206	444	123	108	17	13	2,671
%	29.7%	36.2%	7.7%	16.6%	4.6%	4.0%	0.6%	0.5%	100%

Source: Census & IOL survey 2022-23

(4) Project Affected Trees

The survey revealed that a total of 48,603 trees[27] will be affected in both government and private land which belong to PAPs thus subject for compensation. A summary of the affected trees is presented in Table 13.11. Fruit tree consists of 30.9%, followed by Timber & fruit (25.1%), Bamboo (18.8%), Timber (12.9%), Banana (11.8%), Papaya (0.3%), and Medicinal tree (0.1%) in that order.

Table 13.11 Affected Trees

Districts	Fruit	Timber & fruit	Timber	Medicinal	Banana	Bamboo	Papaya	Total
Gazipur	351	2,786	581	43	89	3,428	5	7,283
Tangail	570	4,874	3,678	0	194	1,902	12	11,230
Sirajganj	13,913	2,517	1,301	4	2,842	3,602	48	24,227
Pabna	176	1,946	638	11	2,542	211	82	5,606
Natore	15	95	70	1	75	0	1	257
Total	15,025	12,218	6,268	59	5,742	9,143	148	48,603
% of total	30.9%	25.1%	12.9%	0.1%	11.8%	18.8%	0.3%	100%

Source: Census & IOL survey 2022-23

(5) Loss of Property Resources (CPR)

A total of 36 CPRs will be affected by the Project. Those CPRs include one local educational center, one secondary school (only a boundary wall will be affected thus it does not need relocation), 16 mosques which are also used as Madrasha[28], one cultural space and one cultural facility, and 16 other structures such as offices for workers' unions, and local political leaders. Some of the photos of CPRs are provided in Figure 13.8. In case of the relocation of those facilities especially for the education centers, mosques, and cultural facilities, the local religious leader/ community representatives will be consulted in advance and compensation and relocation support will be provided by BR and RAP implementing NGO/Firm. The survey confirmed that there are no cultural and historical heritages affected by this Project.

Table 13.12 Affected CPRs

Districts	Education centers	Mosque / Madrasha	Cultural space	Others	Total
Gazipur	0	2	0	0	2
Tangail	0	2	0	1	3
Sirajganj	2	8	0	7	17
Pabna	0	4	2	8	14
Natore	0	0	0	0	0
Total	2	16	2	16	36

Source: Census & IOL survey 2022-23

[27] In the EIA survey, affected trees were surveyed within 30m north of the rail line which would have to be cut down due to construction and includes government-owned trees. Whereas 48,603 trees identified in the RAP survey are the number of trees in the CROW owned by PAPs that are eligible for compensation.

[28] Madrasha is an educational institution that teaches the religion of Islam

Mosque/Madrasha

Mosque

Local education center

Secondary school (only the wall will be affected)

Works union office

Cultural spaces

Source: IoL survey 2022-2023

Figure 13.8 Photos of Some Affected CPRs

13.3.4 Socio-economic Survey

(1) Demographic Characteristics

In the project area, a total of 2,991 PAHs will be affected comprising 12,150 PAPs, of which, 51.6% are male and 48.4% are female. The largest number of PAHs are in Tangail (42.8%) followed by Pabna (19.7%), Sirajganj (19.1%), Gazipur (15.7%), and Natore (2.6%). The average household size of the PAHs is 4.12. The household size in Gazipur is larger than the national average (4.44), which is 4.64 members.

Table 13.13 Demographic Characteristics

Districts	PAH		PAP				HH size
	Total	%	Male	Female	Total	%	
Gazipur	471	15.7%	1,076	1,110	2,186	18.0%	4.64
Tangail	1,281	42.8%	2,700	2,546	5,246	43.2%	4.10
Sirajganj	573	19.2%	1,232	1,053	2,285	18.8%	3.99
Pabna	589	19.7%	1,131	1,040	2,171	17.9%	3.69
Natore	77	2.6%	134	128	262	2.2%	3.40
Total	**2,991**	**100.0%**	**6,273**	**5,877**	**12,150**	**100.0%**	**3.96**

Source: Census & IOL survey 2022-23

(2) Age Distribution

The following table shows the age distribution of household members of the PAHs. 22.3% are children below the age of 15 and 3.7% are senior citizens with the age of over 66. The remaining 74.0% can be considered as the working population between the age of 15 to 59.

Table 13.14 Age Distribution

Districts	0-5	6-15	16-25	26-35	36-45	46-55	56-65	Over 66
Gazipur	155	340	389	373	420	315	135	59
Tangail	237	717	960	1,044	721	773	610	184
Sirajganj	194	426	434	388	329	266	160	88
Pabna	182	413	387	342	340	268	148	91
Natore	16	31	38	51	37	35	30	24
Total	**784**	**1,927**	**2,208**	**2,198**	**1,847**	**1,657**	**1,083**	**446**
% of PAPs	6.5%	15.9%	18.2%	18.1%	15.2%	13.6%	8.9%	3.7%

Source: Socioeconomic survey 2022-23

(3) Households by Religion

The predominant religion of PAHs is Muslim which accounts for 95.9%, while Hindu households are around 4.1% and one household was Christian.

Table 13.15 Profile of Religion

Districts	Muslim	Hindu	Christian
Gazipur	444	26	1
Tangail	1,234	47	0
Sirajganj	556	17	0
Pabna	557	32	0
Natore	76	1	0
Total	**2,867**	**123**	**1**
% of PAHs	95.9%	4.1%	0.0%

Source: Socioeconomic survey 2022-23

(4) Ethnicity and Language

In the Project area, almost all PAHs use Bengali as a primary language except for 2 PAHs in Pabna who speak Bhojpuri as a primary language. Bhojpuri is spoken in eastern India and is socio-linguistically considered to be one of the main Hindi dialects. The survey also confirmed that those identified 2 PAHs speak and understand Bengali without any difficulty. In terms of ethnicity, 100% of PAHs surveyed identified themselves as Bengali, and no other ethnicity was identified. Based on the survey result, it is confirmed that there are no ethnic minority/indigenous peoples in PAHs.

(5) Education Status

According to Population & Housing Census 2022, the illiteracy rate of the population 7 years and above is 25.3% at the national level. As shown in Table 13.16, 30.4% of the household head of PAHs have no education, therefore illiteracy rate is higher than the national average. The household head of PAHs having education up to the primary level is 32.8% and the secondary level is 21.4%. Those having higher secondary education is 8.9% and the graduate and above is 6.6%. In terms of the education status of total PAPs, it slightly improves by including family members as presented in the table below.

Table 13.16 Education Status of Head of Households

Districts	No Education	Primary	Secondary	Higher Secondary	University or Above	Total
Gazipur	130	140	114	48	39	471
Tangail	319	467	286	128	81	1,281
Sirajganj	170	182	113	53	55	573
Pabna	257	170	110	31	21	589
Natore	33	21	17	5	1	77
Total	909	980	640	265	197	2,991
% of PAHs	30.4%	32.8%	21.4%	8.9%	6.6%	100.0%

Source: Socioeconomic survey 2022-23

Table 13.17 Education Status of PAPs

Districts	No Education	Primary	Secondary	Higher Secondary	University or Above	Total
Gazipur	595	581	589	268	153	2,186
Tangail	1,178	1,834	1,201	718	315	5,246
Sirajganj	586	744	546	239	170	2,285
Pabna	705	725	496	162	83	2,171
Natore	91	84	55	21	11	262
Total	3,155	3,968	2,887	1,408	732	12,150
% of PAPs	26.0%	32.7%	23.8%	11.6%	6.0%	100.0%

Source: Socioeconomic survey 2022-23

(6) Occupation

The principal occupations of the PAHs are presented in Table 13.18. The highest number of PAHs are engaged in business (shop owners and vendors) accounting for 31.5% followed by labor both casual and skilled (23.6%). Others engaged in agriculture, livestock, and fishery at 21.9%, and employee in government and private offices at 11.4%. Apart from these, there are household heads identified as housewives (4.7%), unemployed (3.6%), retired (0.4%), and others (2.3%).

Table 13.18 Type of Occupation

Districts	Agriculture/ Livestock/ Fishery	Business	Labor	Employee	Expatriate	Housewife/ Assistant to HH	Unemployed	Retired	Others
Gazipur	62	168	115	51	8	27	27	4	8
Tangail	408	329	248	190	8	52	8	4	34
Sirajganj	94	227	110	66	0	33	35	0	11
Pabna	68	203	213	30	2	25	30	2	13
Natore	24	14	20	5	0	3	8	2	2
Total	656	941	706	342	18	140	108	12	68
% of PAHs	21.9%	31.5%	23.6%	11.4%	0.6%	4.7%	3.6%	0.4%	2.3%

Source: Socioeconomic survey 2022-23

(7) Monthly Household Income

Among PAHs, the survey identified that about 14.1% of PAHs live below the poverty line[29], which is less than BDT 137,000 per year. About 48.3% of PAHs' income range from BDT 137,000 to 240,000, 31.8% earn BDT 240,000 to 480,000, and the remaining 5.8% of PAHs have income above BDT 480,000 per year. The households belonging to the below poverty line will be considered vulnerable households in the Project.

Table 13.19 Annual Income of PAHs

Districts	Less than BDT 137,000	BDT 137,001 – 240,000	BDT 240,001 – 480,000	BDT 480,001 – 600,000	BDT 600,001 – 720,000	Above BDT 720,000
Gazipur	55	220	156	23	8	9
Tangail	108	697	423	35	8	10
Sirajganj	127	234	162	30	13	7
Pabna	114	261	185	20	5	4
Natore	17	32	26	1	1	0
Total	**421**	**1,444**	**952**	**109**	**35**	**30**
% of PAHs	14.1%	48.3%	31.8%	3.6%	1.2%	1.0%

Source: Socioeconomic survey 2022-23

[29] World Bank (2022 global poverty update): The poverty line for lower middle-income countries is set as $3.65.

(8) Access to social services

The following table shows the PAHs who have no access to basic infrastructure services, namely: electricity, water, toilet/sewage, and waste collection system. The results show that 3.6% of PAHs have no access to electricity, 12.3% with no water access, and 10.6% with no toilet facilities. The majority (95.4%) do not have access to a waste collection system.

Table 13.20 PAHs with No Access to Infrastructure Services

District	Electricity	Water	Toilet/Sewage	Waste
Gazipur	6	10	12	356
Tangail	7	3	3	200
Sirajganj	17	89	78	484
Pabna	29	101	82	520
Natore	1	2	2	27
Total	60	205	177	1,587
% of surveyed PAHs	3.6%	12.3%	10.6%	95.4%

Source: Socioeconomic survey 2022-23

In terms of access to basic social and public services such as schools, hospitals/clinics, and transport services, 10.5% of PAHs expressed they have poor access to schools, 15.3% have poor access to hospitals/clinics, and 19.7% to transport services.

Table 13.21 PAHs with Poor Access to Social and Public Services

District	Schools	Hospitals/Clinics	Transport
Gazipur	63	92	102
Tangail	71	84	87
Sirajganj	37	49	65
Pabna	3	22	74
Natore	0	7	0
Total	174	254	328
% of surveyed PAHs	10.5%	15.3%	19.7%

Source: Socioeconomic survey 2022-23

(9) Vulnerability

Vulnerable groups in this Project are defined as 1) Female-headed households, 2) Households with elder people without means of support, 3) Households with disabled members, and 4) Households under the poverty line. Those households are considered vulnerable because they may have limited time or opportunities to engage in economic activities and may have to engage in additional caretaking tasks aside from income-generating activities. Therefore, they may have low coping ability against possible negative impacts from the Project. The survey informed that 599 PAHs which consists of 20.0% of surveyed PAHs are categorized as vulnerable households.

Table 13.22 Vulnerability Status of Affected Households

Districts	Female-headed HH	HH with elderly with no immediate support member	HH with a disabled member	HH below the poverty line
Gazipur	64	12	15	93
Tangail	85	35	23	131
Sirajganj	56	27	31	197
Pabna	74	34	29	210
Natore	17	5	3	20

HH: Household
Note: Some households fall into multiple categories.
Source: Socioeconomic survey 2022-23

13.3.5 Gender Mainstreaming

(1) Related Policies and Legislations

The policies and legislation related to gender are summarized in the following table. As a fundamental legislation, the Constitution of Bangladesh 1972 protects women against gender discrimination. The government ratified the UN Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) in 1984 to commit to undertaking measures to end discrimination against women. Based on CEDAW, National Policy for Women Development was prepared in 2011 to emphasize gender issues in different arenas. There is also an Act that prohibits discrimination and ensures the rights of persons with disabilities.

Table 13.23 Relevant Laws and Policies on Gender Mainstreaming

Laws & Policies	Content
Constitution of Bangladesh, 1972	The Constitution stipulates that the State shall be taken to ensure the participation of women in all spheres of national life, the state shall adopt effective measures to remove social and economic equality between men and women, and ensure the equitable distribution of wealth among citizens, and opportunities.
UN Convention of the Elimination of All Forms of Discrimination against Women (CEDAW), ratified in 1984	By accepting the Convention, GoB commits to undertake measures to end discrimination against women in all forms: to incorporate the principle of equality in their legal system, to abolish discriminatory laws and adopt appropriate ones prohibiting discrimination; to establish public institutions to ensure the effective protection of women; and to ensure elimination of all acts of discrimination against women by persons, organizations or enterprises.
National Policy for Women Development, 2011	Based on CEDAW, the Ministry of Women and Children Affairs established the policy: to ensure the security and safety of women; socio-economic, political, administrative, and legal empowerment; to bring up women as educated and skilled human resources; to establish gender equality in politics; to ensure priority of women in provision for proper shelter and housing; and to extend assistance to the women of backward, small ethnic groups, and disabled women.
DMTC Gender Action Policy, 2015	Following National Policy for Women Development 2011, the Policy provides policies against gender discrimination which includes equal participation in employment, security at the station and on a train, underemployment, and traveling as passengers. It also includes Gender Action Plan for planning, design, construction, and operation.

Laws & Policies	Content
The Rights and Protection of Persons with Disabilities Act, 2013	The Act affirms the rights of persons with disabilities. Section 16 enshrines their right to equal legal recognition and access to justice, as well as the right to be employed in public and private establishments. It also mentions their right to a safe, healthy environment, and protection from torture. It prohibits any form of discrimination by any individual, institution, authority, or organization against any person with disabilities. Section 35 specifies that there cannot be any discrimination or restraint against any person with disabilities in terms of employment for which they are eligible to apply.

Source: JST

(2) Institutional Overview in BR

In BR, there is no specific department dedicated to gender-related issues, however, the gender aspects are studied during the survey phase of the project, and the project implementation unit of the project addresses the issues during the implementation. In the case of projects funded by development partners, their policies and guidelines are followed.

In terms of an institutional gender gap, the ratio of women in BR is significantly small in number. At present, there are approximately 95% male and only 5% female employees working in BR including all officers and staff, although there is a 10% female quota for the position. Although women are also encouraged to participate and join in the transport sector, it can be considered that female representation in decision-making may be limited as of now.

(3) General Overview of the Gender Gap

To identify the potential gender issues, gender aggregated data was examined for this Project. The gender ratio of PAPs and the ratio of the women-headed household of PAHs are shown in the table below. The female ratio of PAP is 48.4% which is lower than that of the national average. The proportion of female-headed households is 9.9% which is lower than the national average.

Table 13.24 Sex Ratio of the PAPs and Women headed PAHs

District	% of Female	% of Women HH
Gazipur	50.8%	13.6%
Tangail	48.5%	6.6%
Sirajganj	46.1%	9.8%
Pabna	47.9%	12.6%
Natore	48.9%	22.1%
PAP/PAH average	48.4%	9.9%
Bangladesh average*	49.5%	15.1%

* World Development Indicators 2018
Source: Census, Socio-economic survey 2022-23

The education level of women-headed households is lower than total PAHs. As shown in the table below, more than half of women-headed household (51.0%) is illiterate compared to 26.0% of total PAHs. Differences in educational level shall be considered during information dissemination and when planning for the level of new skill development programs.

Table 13.25 Education level of Women headed PAHs

Districts	No Education	Primary	Secondary	Higher Secondary	University or above
Gazipur	25	19	12	5	3
Tangail	40	25	15	7	2
Sirajganj	22	17	11	4	2
Pabna	55	12	6	1	0
Natore	9	3	1	0	0
Total	151	76	45	17	7
% of Women headed PAHs	51.0%	25.7%	15.2%	5.7%	2.4%
% of Total PAHs	26.0%	32.7%	23.8%	11.6%	6.0%

Source: Census, Socio-economic survey 2022-23

The main occupations of women-headed PAHs are housewives which is 31.1% which is significantly different from the characteristics of total PAHs. Another major difference is that only 7.8% of women-headed PAHs are engaged in business whereas it was the majority for the total PAHs (31.5%). Labor is the second largest occupation for women-headed households, however, wage differences in daily labor were expressed during the FGDs. These differences will be considered when designing the livelihood restoration program.

Table 13.26 Occupation of Women headed PAHs

Districts	Agriculture/ Livestock/ Fishery	Business	Labor	Employee	Expatriate	Housewife/ Assistant to HH	Unemployed	Retired	Others
Gazipur	3	8	19	7	0	25	1	0	1
Tangail	33	10	22	10	0	10	0	0	0
Sirajganj	5	2	8	4	0	30	5	0	2
Pabna	4	3	32	3	0	23	4	0	5
Natore	1	0	6	1	0	4	1	4	0
Total Women headed PAHs	**46**	**23**	**87**	**25**	**0**	**92**	**11**	**4**	**8**
% of Women headed PAHs	15.5%	7.8%	29.4%	8.4%	0.0%	31.1%	3.7%	1.4%	2.7%
% of Total PAHs	21.9%	31.5%	23.6%	11.4%	0.6%	4.7%	3.6%	0.4%	2.3%

Source: Socioeconomic survey 2022-23

(4) Gender Needs Assessment for the Project

To understand women's needs, concerns, and expectations in the project were collected through FGDs. The main findings are summarized in the table below and more information is provided in 13.10.2 Focus Group Discussions. People raised concerns about accidents and the impact of dust, noise, and vibration during construction especially for children. There are different concerns raised among women at relocation and livelihood restoration stages depending on the economic status of the household. Therefore, different options will be prepared and made available based on different needs.

Table 13.27 Concerns and Expectations Expressed by Women

Items	Main concerns and expectations
Design and operation	• There are limited tickets available to travel by train. It is expected that the project provides more opportunities for passenger travel and goods transport. • There are issues with lighting at the stations, limited spaces, and safety issues in local trains. The prayer rooms are not available for women in many stations.
Construction and operation	• The project may increase accident risks (especially for children and animals) during construction and railway operations. • Dust, noise, and vibration during construction would be disturbing, especially for small children. • Some are not interested in engaging in any construction activities, while some of them are interested to work if there is a type of work that is available for them. • The issues of difference in wages were expressed by women especially those engaged in daily labor.
Resettlement and relocation	• Some wish to stay in the locality and are worried about the location to relocate, while some do not mind the location if there are job opportunities. Some expressed that with proper cash compensation, they can relocate by themselves. • Many women are housewives so they expressed that there will be no major changes in terms of their livelihood after the relocation. • In terms of acquiring new skills, some expressed that running stores and stalls are for men, so for women handicrafts, tailoring, and animal rearing are preferred which can be done at home. • Elders people are difficult to acquire new skills, and younger people are more open to those training.

Source: JST

(5) Gender Consideration in the Project

In this project, based on the overview of the gender gap, and past and ongoing projects, appropriate gender-responsive measures are integrated into the Project. Based on the findings, the Project incorporated gender consideration as presented in the table below. The considerations are focused on equal benefits from the project and opportunities for economic activities.

Table 13.28 Gender Consideration in the Project

Items	Gender Consideration in the Project
Design and operation	• New stations and renovated stations to consider incorporating user-friendly station facilities (current initiatives are described below).
Construction and operation	• Safety measures are incorporated in the Environmental Management Plan (EMP) (refer to 12.7). • Mitigation measures are incorporated in the EMP (refer to 12.7) • Provide support to coordinate with the contractor to identify suitable works for women. Form a group to negotiate with the contractor on the issues of employment conditions and wages (refer to 13.4.413.4.4(2)).
Resettlement and relocation	• Provide support to PAHs to look for land/homestead if requested (refer to 13.4.4). • A variety of skill training programs will be prepared based on a needs assessment survey of different groups and available opportunities in the project area. Participants in the training can choose their preferred program (refer to 13.4.4). • Allow PAHs to nominate those who will participate in the skill training program (refer to 13.4.4).
Monitoring	• Monitoring the status of women-headed households (refer to Appendix monitoring form) • Monitoring the employment status of women during the construction and operation of the project (refer to Appendix monitoring form)

Source: JST

Ministry of Railway (MOR) has taken initiative to modernize the railway services by incorporating facilities in the major stations and for the future planned railway stations especially for the disabled, elderly, and women to improve the usability and safety of users. Those facilities include separate ticket counters for women, a designated prayer room, the installation of security cameras, and bringing the level of the platform to the same height as the train, which is currently difficult for women, the elder, and other vulnerable groups to use the train services. Currently, 52 railway stations are now being renovated and modernized throughout the country. Depending on the budget, BR will consider a user-friendly design for new stations and stations subject to renovation.

A height difference between a platform and a train

A platform on the same level as a train

Designated room for women

Reserved carriage for women in some local train

Source: JST

Figure 13.9 User-friendly measures for station facilities and railcar

13.4 Compensation and Assistance Policy

13.4.1 Eligibility Criteria

Eligibility to receive compensation and other assistance has been limited by the COD mentioned in 13.3.2 Cut-off-date (COD). PAPs are entitled to compensation and assistance based on the impact categories, as specified in the Entitlement Matrix in this section. The absence of legal title will not bar PAPs from compensation and assistance.

13.4.2 Compensation and Entitlement Policy

The basic items of compensation and assistance for each category are described as follows.

a) compensation for the loss of land, crops/trees at their replacement value;
b) compensation for structures and other immovable assets at their replacement value;
c) assistance for loss of business/wage income;
d) assistance for shifting and reconstruction of affected structures;
e) re-building and/or restoration of community resources/facilities;
f) livelihood restoration assistance; and
g) additional assistance for vulnerable groups

(1) Loss of land

- ***PAHs with legal rights:*** They will receive cash compensation under the law (CCL) by the DC office following the ARIPA 2017. CCL will be the market value assessed based on the mouza rate. If there is a difference between Replacement Cost (RC) and CCL, they will also receive additional assistance (top-up) from BR.
- ***PAHs without legal rights:*** They will receive compensation, grants, and assistance as per the entitlement matrix presented in this RAP.

(2) Loss of structure

- Same as the loss of land.

(3) Loss of standing crops/fish stocks

- ***Loss of access to agricultural land and pond:*** Loss of access to agricultural land and pond by tenants (non-titled sharecroppers, licensees, and lessees) and thereby loss of income from productive land/pond will be compensated through providing cash grants to share-croppers, licensees, and lessees.
- Moreover, the crops/fish owners will be given one-month prior notice to harvest the crops if it is at or near the harvesting period. If the Project damages the standing crops, the actual owners of the crops will be entitled to compensation for crops at market price.

(4) Loss of trees

- ***The owner/planter of the trees:*** The PAPs will be allowed to take away trees free of cost without delaying the Project works.
- ***Loss of fruit trees****:* The market value of 3-year fruit tree production will be provided for any loss of mature fruit trees.

(5) Loss of income

- ***Allowance for loss of income for business owners:*** All owners of affected businesses will receive a cash allowance, equivalent to a 3-month's income, for loss of business income. This assistance is intended to support them in the transition and help them re-establish their enterprises in new locations and to continue their previous occupations and commercial activities in the new locations.

- ***Allowance for loss of income for employees, and wage earners**:* Temporary loss of employment due to severe impact on business and commercial enterprises for acquisition and taking over land for implementation of the Project will be supplemented with cash allowance to the affected employees/wage earners. Cash grants will be provided to the affected employees, and wage earners equivalent to 3 months' income.
- ***Allowance for loss of income due to renting residential/commercial structures:*** Affected households losing income from rented-out residential and/or commercial structures will be provided with rental assistance equivalent to 3 months' rent.

(6) Assistance for shifting and reconstruction of affected structures

- ***Structure Transfer Grant / Structure Reconstruction Grant (residential and commercial):*** A transfer of 12.50% of the RC of the primary structure will be provided to titled owners and non-titled owners of residential and commercial structures. The owner will be allowed to take away all salvageable materials (within BR declared deadline) free of cost.
- ***Transfer Grant for moving goods (residential, commercial, tenants):*** Affected residential owners, commercial owners, and tenants will be provided with a One-time grant for moving furniture and goods depending on the type of structures.

(7) Identifying Available Space and Rental Assistance Measure

- ***Assist in identifying available space and renting space:*** The NGO/Firm will conduct a survey and provide displaced PAHs with a list of available plots, structures, and spaces for rent or purchase for residential or commercial purposes. Also, the NGO/Firm will support the relocation of CPRs as much as possible including identifying potential alternative locations such as Community land/Khas land in the vicinity.
- ***Priority to lease on BR land around the station for commercial purposes:*** BR will give priority to providing a lease for commercial purposes to former leaseholders and PAHs who lost a business space due to the Project.

(8) Special Assistance Measures

- ***Assistance to Vulnerable Households:*** Vulnerable households, defined as women-headed households, a household with elderly without immediate support, a household with disabled members, and a household below the poverty line, will be provided with a one-time grant in addition to other compensations. Households headed by women are to be recognised and compensated equally with households headed by men.

(9) Livelihood Restoration Program (LRP)

- ***Provision of LRP:*** The LRP will be provided for one member of PAHs nominated by the household, who experienced a loss of income sources, and those identified as vulnerable households. The LRP will consist of employment opportunities and skill development training as well as seed grant money to launch the business.

13.4.3 Preference for Resettlement/Relocation Method

The preference for resettlement and relocation methods for potentially displaced PAHs were enumerated during the socioeconomic survey. The survey result shows that 69.4% of PAHs prefer cash compensation and self-relocation either by purchasing new land or relocating on their own land. The remaining 30.6% answered that they prefer project-assisted relocation. Out of which, the majority (84.3%) of those who answered project-assisted relocation are nontitle holders settled on the BR land.

Table 13.29 Preferred Resettlement/Relocation Method

District	Self-Relocation to a new land	Self-Relocation on own land	Project Assisted Resettlement
Gazipur	256	12	123
Tangail	145	9	51
Sirajganj	208	127	161
Pabna	280	95	169
Natore	16	7	4
Total	905	250	508
% of PAHs	54.4%	15.0%	30.6%

Source: Socioeconomic survey 2022-23

In terms of relocation locations, most of those who preferred project-assisted relocation expressed they wish to resettle in adjacent areas as shown in Table 13.30. However, since PAHs are scattered along the stretch of rail line in 5 districts, it would be difficult to provide an appropriate alternative site for all. Therefore, in the project, the compensation policy will include sufficient support for PAHs to restore their livelihoods and for finding relocation sites supported by the RAP implementing NGO/Firm.

Table 13.30 Preferred Location for Relocation

District	Near to existing location	Accessibility to job and school	No answer
Gazipur	109	1	13
Tangail	46	2	3
Sirajganj	159	1	1
Pabna	155	10	4
Natore	4	0	0
Total	473	14	21
% of PAHs	93.1%	2.8%	4.1%

Source: Socioeconomic survey 2022-23

Especially non-title holders expressed their wish to move back and reestablish unaffected BR land in FGDs, which may be made available as one option. Another option is to apply for government projects. One of which is called Asrayan Project under the Prime Minister's Office which provides housing to landless and homeless families in the country. If it is considered applicable, BR and NGO/Firm will coordinate with DC offices to consider applying for these projects.

13.4.4 Livelihood Restoration Program

(1) Livelihood Impact and Risks

Impact on the livelihood of PAHs means the loss of earning sources based on which households survive and progress. It includes physical resources like land, and business assets and nonphysical resources such as business opportunities, employment, and other economic activities.

Based on the survey, PAHs will experience a loss of earning sources mainly due to the loss of shops/business structures, rented structures, and agricultural lands. Associated wage earners will also experience losses in their income. In addition, the displaced households compelling physical relocation due to the Project will experience temporary dislocation in their income and workdays. The following table shows those who are eligible for LRP.

Table 13.31 Eligible Groups for PAHs

Type of Loss	PAH/PAP
Displaced PAHs	1,601 PAH
Sharecropper	1,506 PAP
Tenants	645 PAP
Worker / Employees	105 PAP

Source: JST

(2) Measures to Restore Income and Livelihood

The LRP focuses on the improvement or at least restoration of income and livelihood during and after relocation. The followings are the possible LRP proposed in the Project. The appropriate skills development training will be identified, and the program will be developed by the RAP Implementing NGO/Firm.

1) Employment in Construction Work

The construction activities under the Project will require many unskilled laborers for the construction of rail embankments, rail bridges/culverts, staff accommodation, etc. The contractor will be conditioned to give preference to hiring affected persons (with ID), including women, willing to work in construction activities as much as possible. Provisions in the general contract conditions should require the contractors to pay equal wages to men and women without discrimination. In addition, affected women willing to work in construction will form a labor contracting society (LCS) with the help of an NGO/Firm to coordinate with the contractor for suitable work such as embankment slope turfing, watering, tree plantation, etc., or any other suitable works.

2) Skill Development Training

During the FGDs, preferred skill development training was collected from different groups as shown in the following table. The training in handicrafts, bakery, tailoring, and poultry was raised by women who wish to engage in economic activities at home. For those engaged in economic activities

expressed their interest in enhancing their skills in a similar occupation such as agriculture and cultivation, small businesses. In addition, title holders and local leaders suggested that occupational training such as computer operation, mechanical workshops, and driving can be beneficial if PAHs must change their occupations.

Table 13.32 Preference for Professional Skill Development Training

Preferred training	Stakeholders suggested
Handicrafts	Women
Bakery	Women
Sewing / Tailoring	Women
Agriculture / cultivation	Agriculture labors
Livestock / poultry / honey farming	Non-title holders
Business operation / marketing	Business owners
Mechanical / workshops	Title holders
Computer operation	Title holders, non-title holders, Local leaders
Driving	Local leaders

Source: JST

The detailed training courses will be identified by NGO/Firm through a needs assessment of the participants and potential livelihood development options and opportunities available in local areas. The NGO/Firm is also responsible for facilitating community mobilization and implementation of the planned livelihood programs.

3) Initial Investment Support

From past experiences, it was observed that funds for income restoration programs become a major constraint to the PAHs utilizing their skills obtained/enhanced through training. Therefore, financial/capital support is necessary to generate potential income generation activities. The same issue was also raised during FGDs. In this project, the trained households would be provided with seed money for setting up their small enterprises. The management of the funds and business operations will also be included in the training program.

4) Provision of Income Support

Those who experience loss of livelihood by the Project will be provided with income support during the transition periods. Depending on the type of employment, income support was set and included in the entitlement matrix. Regardless of legal status, 3 months' income will be supported for PAHs losing their business and 45 days' wages for daily labor for their lost workdays.

13.4.5 Entitlement Matrix

Based on the above compensation policy, the entitlement matrix is developed and presented in the following table.

Table 13.33 Entitlement Matrix

No.	Type of Loss	Entitled Persons	Entitlement	Implementation issues/Guidelines	Responsible Organization
1	Loss of agricultural land	Legal owner/ titleholders as identified by Deputy Commissioner (DC)	• Cash compensation under Law (CCL) (200% premium of government rate) assessed by DC. If the Replacement Cost (RC) determined by Property Valuation Advisory Committee (PVAC) is more than CCL, the difference is to be paid by the Project. • Stamp duty & registration cost at the actual prevailing rate (currently 11.5%) on the purchase of alternative land up to the amount of acquired land in the same land category within 12 months of issuance of notice under Sec 8. • Owners are allowed to take standing crops and fish stock within BR's declared deadline.	• DC will determine the market price of land based on the mouza rate. • PVAC will recommend RV for land based on the current market price (CMP) Compensation will be paid by BR with assistance from the RAP NGO/Firm. The RC may be updated at the time of dispossession. • Applicable stamp duty & registration cost will be calculated based on the acquired land type and amount.	• DC • PVAC/BR • BR/ NGO/Firm
2	Loss of homestead, commercial land	Legal owner/ titleholders	• CCL (200% premium of government rate) assessed by DC. If the RC determined by PVAC is more than CCL, the difference is to be paid by the Project. • Stamp duty & registration cost at the actual prevailing rate (currently 11.5%) on the purchase of alternative land up to the amount of acquired land in the same land category within 12 months of issuance of notice under Section 8.	• DC will determine the market price of land based on the mouza rate. • PVAC will recommend RC for land based on the CMP. Compensation will be paid by BR with assistance from the RAP NGO/Firm. The RC may be updated at the time of dispossession. • Applicable stamp duty & registration cost will be calculated based on the acquired land type and amount.	• DC • PVAC/BR • BR/ NGO/Firm
3	Loss of access to standing crops/ fish stock (a) with title to land and (b) without title to land	(a) Legal owner/ cultivators/ sharecropper (b) Socially recognised users of land	(a) CCL for standing crops/fish stocks assessed by the DC for those with titles. If the RC determined by PVAC is more than CCL, the difference is to be paid by the Project. (b) RC for standing crops/fish stocks determined by PVAC for those without a title. • In both cases, users will be allowed to take standing crops/fish stocks within BR's declared deadline (based on the agreement between the owner)	• DC will determine the market price of crops with assistance from the district Department of Agricultural Extension and District Agricultural Marketing and the market price of fish with assistance from the district Department of Fisheries. • PVAC will recommend RV for structure based on CMP. • BR provides notice prior to land acquisition	• DC • PVAC/BR • BR

No.	Type of Loss	Entitled Persons	Entitlement	Implementation issues/Guidelines	Responsible Organization
4	Loss of timber/ perennials/ fruit trees (a) with tile to land and (b) without title to land	(a) Legal owner of the land (b) socially recognized owner/ unauthorized occupant of land	(a) CCL (100% premium of government rate) for trees assessed by the DC for those with titles. If the RC determined by PVAC is more than CCL, the difference is to be paid by the Project. (b) RC for trees will be assessed by PVAC for those without a title. • In both cases, owners will be allowed to cut and take away their trees free of cost without delaying the Project. • *For fruit-bearing trees*, compensation for fruits will be calculated at 30% of the timber value.	• DCs will determine the market price of the tree from the standard rate of the Forest Department • PVAC will recommend RC for structure based on CMP. • NGO/Firm to explain RAP policies regarding compensation for the trees of different categories and sizes and make the EPs aware that they could take the timber and fruits free of cost.	• DC • PVAC/BR • NGO/Firm
5	Loss of residential/ commercial structure (a) with tile to land and (b) without title to land	Legal owners/ unauthorized occupants of the land	(a) CCL (100% premium of government rate) is assessed by DC for those with titles and the difference between CCL and RV is determined by PVAC. (b) RC for structures will be assessed by PVAC for those without a title. • Structure Transfer Grant (STG) and Structure Reconstruction Grant (SRG) will be paid at BDT 12.50% of the replacement value of the primary structure. • In both cases, owners will be allowed to take all salvageable materials free of cost within the stipulated time notified by BR. • *For residential structure owners*, a One-time Transfer Grant (TG) for portable materials at the rate of (i) BDT 3,000 for the Katcha structure, (ii) BDT 4,000 for the Tin structure, (iii) BDT 5,000 for the Semi-Pucca structure and (iv) BDT 7,000 for Pucca structures. • *For commercial structure owners*, Stock Transfer Grant (STG) for commercial entities at the rate of (i) BDT 5,000 for small businesses, (ii) BDT 10,000 for medium businesses, and (iii) BDT 15,000 for large businesses. • Livelihood improvement Program/Training on Income Generation Assistance (IGA).	• DC will determine the market price of the structure based on the PWD rate. • PVAC will recommend RV for structure based on CMP. The RC may be updated at the time of dispossession. • Assistance to be provided by NGO/Firm in identifying available premises to rent or buy. • BR provides notice prior to land acquisition	• DC • PVAC/BR • NGO/Firm • BR

No.	Type of Loss	Entitled Persons	Entitlement	Implementation issues/Guidelines	Responsible Organization
6	Loss of access to residential/ commercial structure	Tenants of rented/ leased properties	• House Transfer Grant (HTG) or shifting furniture and belongings of tenants at the rate of (i) BDT 2,000 for the Katcha structure, (ii) BDT 3,000 for the tin structure, (iii) BDT 4,000 for the semi-Pucca structure, and (iv) BDT 6,000 for Pucca structures.	• PVAC will recommend a grant based on CMP.	• PVAC/BR
7	Loss of Common Property Resources (CPR) Structures (a) with or (b) without Title to Land	(a) Legal owners (or registered committee) (b) Socially recognized owners of structures within ROW	(a) CCL (100% premium of government rate) or structure assessed by DC, and the difference between CCL and RV determined by PVAC. (b) RV of structures determined by PVAC. • Structure Transfer Grant (STG) and Structure Reconstruction Grant (SRG) will be paid at BDT 12.50% of the replacement value of the primary structure. • In both cases, owners will be allowed to take all salvageable materials free of cost within the stipulated time notified by BR	• DC will determine the market price of the structure based on the mouza rate. • PVAC will recommend RC for structure based on CMP. The RC may be updated at the time of dispossession. • NGO/Firm to conduct community consultations to ensure CPRs are relocated taking into account community concerns. • BR provides notice prior to land acquisition • NGO/Firm to conduct community consultations to ensure CPRs are relocated taking into account community concerns.	• DC • PVAC/BR • NGO/Firm • BR • NGO/Firm
8	Loss of business from dismantled Commercial/ Business Enterprise (CBE)	Owner/operator of the business including legal owners, squatters, and vendors	• Transition Allowance (TA) for the permanent loss of business/ income equivalent to 3 months' income at the rate of (i) BDT 30,000 for small businesses, (ii) BDT 60,000 for medium businesses, and (iii) BDT 90,000 for large business	• PVAC will recommend allowance based on CMP.	• PVAC/BR
9	Loss of business from rented-out and access to rented-in residential and commercial premises	Owners of rental premises (residential, commercial)	• TA for the loss of rental income equivalent to 3 months for each affected rented out premises at the rate of (i) BDT 15,000 for the Katcha structure; (ii) BDT 30,000 for the Tin structure, and (iii) BDT 45,000 for the Pucca structure.	• PVAC will recommend allowance based on CMP.	• PVAC/BR
10	Loss of Income and workdays due to displacement	Employees/ wage earners	• TA for the loss of income loss equivalent to 45 days' wage as per the prevailing government rate (which is currently, BDT 500/per day for unskilled laborers and BDT 550/per day for skilled laborers). • Preferential employment in the project construction work, if available.	• PVAC will recommend allowance based on CMP.	• PVAC/BR

No.	Type of Loss	Entitled Persons	Entitlement	Implementation issues/Guidelines	Responsible Organization
11	Loss of Utility connection (Electricity)	Households losing their electricity connection.	• The cost of transfer and reinstallation of the electricity connection will be provided at the rate of BDT 5,565 per household.	• BR will make payment of the compensation with assistance from an NGO/Firm	• BR/NGO/Firm
12	Special assistance for vulnerable groups	Women headed HH, HH with disabled people, elderly, HH below the poverty line	• An additional cash grant of BDT 20,000 for affected poor women-headed households and other vulnerable households. • Livelihood Restoration Program will be provided by BR with assistance from NGO/Firm.	• The resettlement benefits will be paid by BR with assistance from NGO/Firm. • The needs of vulnerable groups will be assessed.	• NGO/Firm/BR • NGO/Firm
13	Livelihood Restoration Program (LRP)/ Training on Income Generation Activities	Any displaced households and vulnerable groups who wish to join the program	• Opportunity to participate in LRP/ Training on Income Generation Activities. • Seed grant for a new business investment of BDT 16,000 for each trained member for investment.	• BR/NGO will organize training for income livelihood restoration based on the Needs Assessment survey. • LRP experts/NGOs will conduct the Needs Assessment survey. • A special LRP budget can be included in the NGO/Firm services contract organizing training.	• BR/NGO/Firm • NGO/Firm • NGO/Firm
14	Assistance in identifying Available Land/ Space/ Structure to Rent or Buy	Households losing their homestead/ business/ rented structure/CPR	• NGO/Firm will help the EPs to find land/homestead during the Project period. The assistance of BDT 5,000 for displaced households. • Priority to lease on BR land around the station for commercial purposes, if available • BR/NGO/Firm will support finding potential alternative locations for CPRs including Community land/Khas land in the vicinity.	• NGO/Firm will help the EPs to look for land/homestead during the Project period. • BR will give priority to former leaseholders to provide leasing land around the station, if available. • BR/NGO/Firm will consult with representatives and the community and support the relocation of CPRs in coordination with DC.	• NGO/Firm • BR • BR/NGO/Firm
15	Temporary impact during construction	Community / Individual	• The contractor shall bear the cost of any impact on structure or land due to the movement of machinery and in connection with the collection and transportation of borrowed materials. • The land will be returned to the owner rehabilitated to an original preferably better standard.	• All temporary use of lands outside the proposed ROW is to be through written approval of the landowner and contractor.	• Contractor

Source: JST

13.5 Grievance Redress Mechanisms

A grievances Redress Mechanism (GRM) will be established in the Project to resolve grievances related to compensation, resettlement, and relocation issues and make the project accountable to the affected persons and community. It also provides a channel for the disputant to resolve issues /conflicts amicably and quickly before taking expensive and time-consuming legal actions. This will be ensured through full participation and consultation with the PAPs, extensive communication, and coordination among the PAPs and BR. The project will maintain GRM during the RAP implementation.

13.5.1 Grievance Redress Committee (GRC)

A two-tier bottom-up GRC system will be established in this Project. The first tier will be GRCs at the Union Parishad or municipality level called LGRC, and the second will be at the Project level called PGRC. These GRCs will be established through gazette notifications from the Ministry of Railways (MOR).

The LGRC will hear the grievances first, then unresolved cases will be forwarded to the next tier, P GRC, for further review and resolution. If any disputant is unsatisfied with the outcome of the PGRC, PAP may file cases in court.

GRC decisions will be on a majority basis and will be disclosed and available for review by the stakeholders. The Member Secretary of GRCs will be regularly available and accessible for PAPs to address concerns and grievances. Female UP members will participate in the grievance redress sessions when the complainant will be a female. The Legal Advisor of the NGO will support the GRC processes (both local and project levels) in terms of legal and other interpretation matters.

(1) Local Grievance Redress Committee (LGRC)

LGRCs will be formed in each union Parishad or municipality to make it accessible for PAPs both in terms of distance and time. RAP implementing NGO/Firm will support PAPs to file complaints, as necessary. As shown in the table below, LGRC consists of representatives from BR who will be the chair, locally elected representatives from the Local Government Institutions (LGI), representatives of the APs (preferably women representatives in case of women PAPs), and RAP implementing NGO/Firm. Grievances will be redressed within 15 days at LGRC.

The main task of LGRC is to review, consider and resolve grievances related to social and resettlement mitigations received during the implementation of the RAP. LGRC members may undertake field visits to verify and review the issues in dispute, including titles/shares, the reason for any delay in payments, or other relevant matters, if required.

Table 13.34 Members of the LGRC at Union Parishad (UP) Level

Level	Members of the LGRC
Local Level GRC Composition	Assistant Director (AD) of BR – Convener (Chairman) Representative of RAP implementing NGO – Member Secretary Representative of the LGI – Member Local Women UP Member – Member Representative of the affected people – Member

Source: JST

(2) Project Level Grievance Redress Committee (PGRC)

PGRCs will review all unresolved cases forwarded from LGRCs. It will be headed by the PD or BR. With a representation of senior elected Upazila officials and civil society members, the PGRC ensures fairness and transparency in the resolution of disputes or grievances. The composition of the PGRC is presented in Table 13.35. Grievances will be redressed within 30 days at PGRC from the date of receiving the complaints.

The scope of work of PGRC is to review, consider and resolve grievances that were not resolved at LGRC. In case of complicated cases, the PGRC members can request additional information or carry out field-level verifications. In specific cases, PGRC may seek legal advice from an external legal advisor, if required. However, PGRC will not deal with any matters pending in a court of law.

Table 13.35 Composition of Project Level Grievance Redress Committee

Level	Members of the PGRC
Project Level GRC Composition	PD or representative–Convener (Chairman) Local UP Chairman/Representative-Member Local Women UP Member - Member Team Leader-NGO Member Secretary Representative of local civil society Organization-Member Representative of the affected people - Member

Source: JST

13.5.2 Grievances Redress Procedure

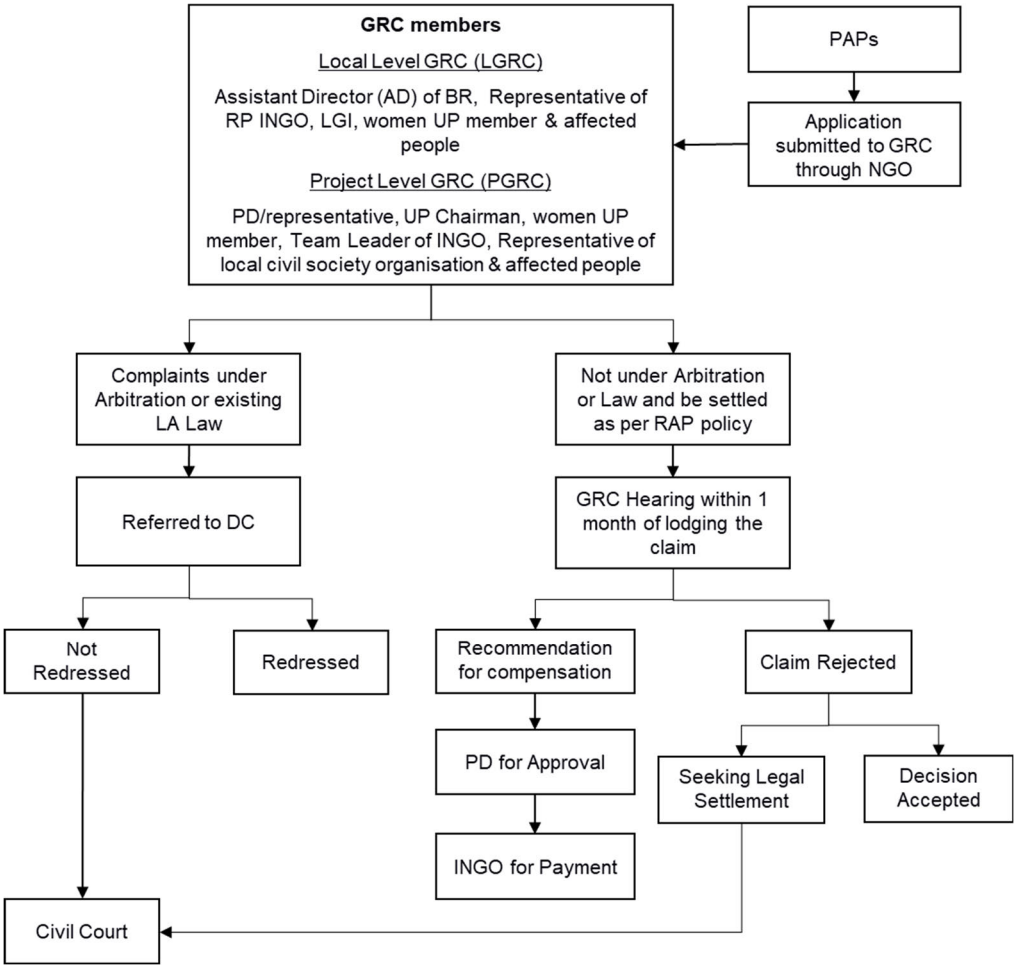
GRC procedures and operational rules will be publicized widely through community meetings and pamphlets in the local Bangla language so that PAPs are aware of their rights and obligations, and the procedure of grievance redress. Any complaints on ownership title or others that fall under arbitration which is to be resolved by the judiciary system will not be within the purview of the GRCs. GRCs will be activated during the land acquisition and resettlement process to allow PAPs sufficient time to lodge complaints and safeguard their recognized interests.

The GRCs will receive grievance cases from the affected persons through the NGO/Firm. Grievances can be shared verbally or in written form. In case it is in verbal form, the NGO/Firm representatives at the GRC will write it down in the first instance during the meeting at no cost to the PAPs. GRC will review grievances involving all resettlement benefits, relocation, and other assistance. Followings are some of the major grievances that might require mitigations.

- EPs (both titled and non-titled) are not enlisted;
- Losses not identified correctly;
- Compensation/assistance not as per entitlement matrix;
- Dispute over ownership status of the non-titled PAPs;
- Delay in disbursement of compensation/assistance;
- Improper distribution of compensation/assistance in case of joint ownership; and
- Incorrect name in the CCL of DC.
- Ownership problem among heirs of CCL recipients after death.

Upon receipt of the complaint, the representative of the NGO/Firm will inform the convener of the LGRC. The convener will organize a hearing session where the complaint would have been lodged. The LGRC will review the proceedings and pass a verdict that will be conveyed to the PAP concerned through the NGO. Unresolved cases will be forwarded by the Member-Secretary of the LGRC to the Convener of the PGRC. If matters exist relating to arbitration, those will be referred to the court.

The figure below shows the GRM Procedure of this Project.



Source: JST

Figure 13.10 Filing of Grievance Cases and Documentation

13.5.3 Grievances Redress Monitoring

To ensure impartiality and transparency, hearings on complaints will remain open to the public. Grievance resolution will be a continuous process in RAP implementation. The LGRC and PGRC will keep records of all resolved and unresolved complaints and grievances (one file for each case record) and make them available to interested persons/entities.

Under the prevalent system, the NGO/Firm prepares a monthly progress report on the activities carried out each month. The report will contain the result of a number of GRC meetings, the number of cases referred to the DC, and all others considered important by the BR and other organizations associated with the project. The Project Implementation Unit (PIU) at the BR will keep a record of complaints received, the resolution process, and the closing procedures for its use as well as for the use of JICA during regular supervision.

13.6 Implementation Arrangement

13.6.1 Institutional Framework

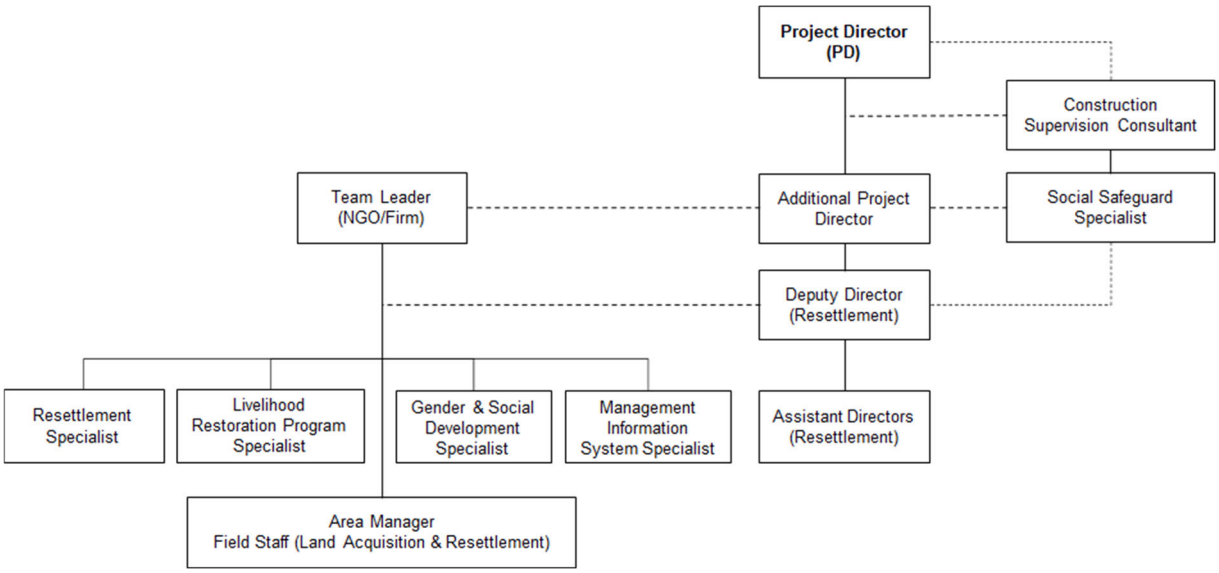
In BR, aside from the permanent set-up of a Director General who is supported by the Additional Director Generals at the Headquarters, and General Manager at two zones – East and West Zones, there are Project Directors (PD) who are responsible for the implementation of the Projects.

The Project Implementation Unit (PIU) will be set up in BR for the execution of the Project. PIU will be headed by a PD and will ensure assistance from LA offices of respective DCs for the implementation. A Resettlement Unit (RU) will be established within this PIU at the Project level, which is responsible for the implementation of the RAP.

The experienced NGO will be mobilized for designing and implementing the resettlement activities including the income and livelihood restoration program. The RU will undertake day-to-day activities with the NGO. The RU will coordinate the land acquisition, manage the resettlement and rehabilitation of the PAPs, disburse resettlement grants, and ensure PAPs' access to the development program.

13.6.2 Organizational Framework

The PD is the head of the PIU as well as RU assisted by the Additional PD. There will be one Deputy Director for Resettlement who will be assisted by AD (Resettlement). Additional PD will coordinate with NGO for the RAP implementation. The organizational setup of the RU is presented in Figure 13.11.



Source: JST

Figure 13.11 Organizational Setup of Resettlement Unit

(1) Role of the Project Director (PD)

The PD is responsible for the supervision and management of all resettlement activity. The PD also guides RU members to work with engineers and contractors for the smooth implementation of the RAP. Other important tasks include liaising with the DC offices to expedite the land acquisition process and ensure the availability of funds for the payment of compensation and resettlement benefits.

(2) Role of Resettlement Unit (RU)

The RU will be the implementation body for land acquisition and resettlement activities. The role of RU will be overall planning, management, and monitoring of the Land Acquisition Plan (LAP), Resettlement Action Plan (RAP), and Livelihood Restoration Program (LRP) supported by Implementation NGO/Firm described below.

(3) Role of Implementing NGO/Firm

It has now been generally recognized that the task of successfully implementing a RAP requires a special attitude, experience, and skills in dealing with the grassroots level people, which are available among some NGOs and Consulting Firms in the country. Therefore, it has been adopted to commission the services of such an NGO or Firm to assist in the implementation of this RAP implementation.

The principal task of the implementing NGO/Firm would be to identify the PAHs, and their category of loss, evaluate compensation amount and assistance, and process their entitlement as per the packages. The next main task would be to assist BR in disbursing entitlements, which are outside the purview of CCL, and implementing LRP. The NGO/Firm would also play an important role in addressing the legitimate grievances of the PAPs and vulnerable groups.

(4) Role of Social Safeguard Specialist

The social safeguard specialist is a member of the construction supervision consultant team. The main role is to oversee overall LAP and RAP implementation and check its compliance with JICA guidelines for ESC. The specialist also provides technical training to RU and other staffs.

13.6.3 Roles and Responsibilities of Other Agencies Involved in the RAP Process

(1) Role of Deputy Commissioner's Office(s)

DC has a key role to play in land acquisition and resettlement processes having the legal responsibility of acquiring land and paying compensation directly to the PAPs as per the ARIPA 2017. Furthermore, DC has the access to official records and the Legal/Administrative authority for the title of land and is responsible for providing CCL for land as well as for other assets, covered by the law.

BR and the implementing NGOs will work with the representatives of the DCs during the Joint Verification of affected properties and the market survey of the properties, for ascertaining the current replacement value, before budgeting the total compensation payable to the PAPs. DC's intervention and assistance will be required in matters such as land requisition, disposal of land ownership disputes, and allotment of Khas land or other lands.

(2) Role of Property Valuation Advisory Committee (PVAC)

The PAVC will be formed to verify the impact of losses collected through the Socio-Economic Survey conducted by NGO/Firm/Consultant. PAVC will be tasked to review and verify, as needed, through additional field investigations, the Replacement Cost (RC) assessed by type in all concerned districts. The Consultants will assist the PVACs by providing technical expertise in assessing the RCs for properties. They will recommend RCs to MOR for approval.

PVACs will be constituted of the following members.

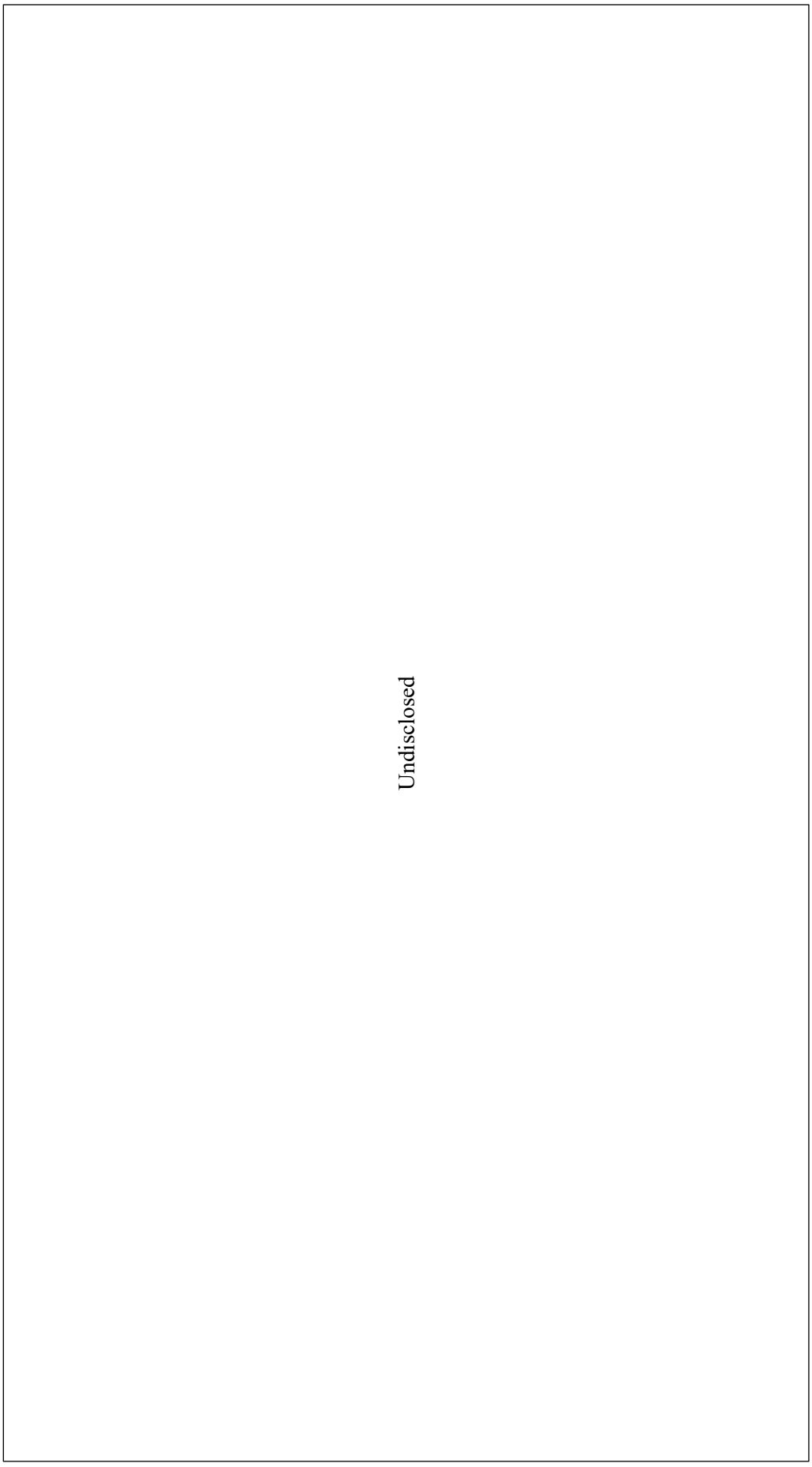
- Additional Chief Engineer of RU, BR (Convener)
- Upazila Parishad of concern Upazila (Member);
- Land Acquisition Officer or representative from Concerned District Commissioner (Member);
- Sub-Divisional Engineer of PWD of concerned District, (Member)
- Resettlement Consultant (Member)
- Implementation NGO/Firm (Member Secretary)

(3) Role of External Monitor

There will be a provision for internal monitoring of the RU of BR. The RU will monitor the work of the implementing NGO/Firm in the field. An external monitoring agency will conduct independent monitoring of the RAP implementation. The roles and responsibilities of external monitoring are presented in 13.9 Monitoring and Evaluation.

13.7 Implementation schedule

Undisclosed


Undisclosed

13.8 Land Acquisition and Resettlement Budget

The estimated cost for land acquisition and resettlement at this stage is based on the affected land area prepared by DC and BR and other types of losses from the Census and IOL survey of this project, and CMP survey for land, structures, and other assets. The PVAC will confirm the rates by types of affected properties and locations during the RAP implementation. As previously explained, the compensation and resettlement funds will be provided by the government in two ways: 1) the compensation as per the Act, and 2) the grant or assistance to meet the JICA guidelines for ESC as reiterated below.

1) Cash Compensation under the Law (CCL) disbursed through the DC
2) Additional grants or assistance (top-up) by BR with the assistance of NGO/Firm, if applicable.

Undisclosed

Undisclosed

Undisclosed

Undisclosed

Undisclosed

Undisclosed

Undisclosed

Undisclosed

Undisclosed

Undisclosed

13.9 Monitoring and Evaluation

Monitoring will be done both internally and externally to provide feedback to the BR and to assess the effectiveness of the RAP policy and implementation. Monitoring will be carried out by the Resettlement Unit (RU) through their field offices and prepare monthly reports on the progress of RAP implementation.

13.9.1 Internal Monitoring

Internal monitoring will be carried out by the RU in Project Implementation Unit (PIU) every month with assistance from implementing NGO/Firm. Based on the monitoring result, PIU will adjust the work program where necessary, in case of delays or any implementation problems as identified. The monitoring form is included in Appendix 13-2.

The main objectives of the internal monitoring are the followings.

- To monitor the administrative procedure and budget during the preparatory stage
- To monitor the progress of compensation and assistance during the resettlement stage
- To monitor the consultation and grievance from PAHs during the resettlement stage
- To monitor the progress of the income restoration program during the resettlement stage

13.9.2 External Monitoring

External monitoring will be undertaken by the independent agency, a third party, to assess the compliance of compensation, assistance, and income restoration program, and their impacts, and suggest any adjustments of delivery mechanisms and procedures as required. A post-resettlement evaluation will be carried out to confirm the effectiveness of the income restoration program in comparison with the baseline data.

The followings are the fundamental objectives of external monitoring

- To monitor the information dissemination of entitlement during the preparatory stage
- To monitor the compliance and effectiveness of RAP during the resettlement stage
- To monitor the effectiveness of the income restoration program during the resettlement stage
- To assess the resettlement outcomes in comparison with the baseline conditions at the evaluation stage

13.9.3 Monitoring and Evaluation Indicators and Frequency

The fulfillment of the RAP policy and the implementation process will be monitored based on the set of indicators. The following table contains a set of indicators for the achievement of the objectives under the resettlement program and monitoring frequency.

Table 13.36 Main Monitoring Indicators and Monitoring Frequency

Type	Examples of Indicators	Internal	External
Process Indicators (Preparation stage)	- Funds for Land Acquisition obtained - Notice for Land Acquisition published - NGO recruited and operational - Resettlement Unit (RU) established and operational - GRM in place and operational - Final RAP brochures disseminated among PAPs - RAP disclosed in local BR and administrative offices as well as on BR's website. - Assessment for and design of LRP - Number of consultation meetings held - Amount of RAP budget disbursed	Every month	Every year
Outcome Indicators (Resettlement stage)	- Number of CPR relocated - Number of affected HHs that received compensations for land - Number of HHs that received compensation for structures - Number of HHs that received relocation assistance - Number of vulnerable HHs who receive additional assistance - Number of FHHs who received additional assistance - Number of HHs who got new land titles re-issued - Types of skills training and number of participants for each type - Number of persons who received assistance from NGO for identifying relocation sites - Number of complaints registered, resolved, and unresolved - Capacity-building activities for BR staff conducted	Every month	Every year

Type	Examples of Indicators	Internal	External
Impact Indicators (Rehabilitation stage)	- Number of PAPs who purchased replacement agricultural land - Number of PAPs who re-established their businesses - Number of persons renting land/structures from private owners - Number of PAPs who relocated to BR land - Average income of PAP - Number of PAPs below the poverty line - Share of PAHs satisfied with the resettlement process	N/A	3 years after the resettlement

Source: JST

13.9.4 Reporting

PD will review the report and prepare biannual monitoring reports that describe the progress of the implementation of resettlement activities and any compliance issues and corrective actions, then submit them to JICA for comments. The costs of monitoring requirements are included in the Project budget. The table above provides details on the contents and timing of various progress monitoring reports.

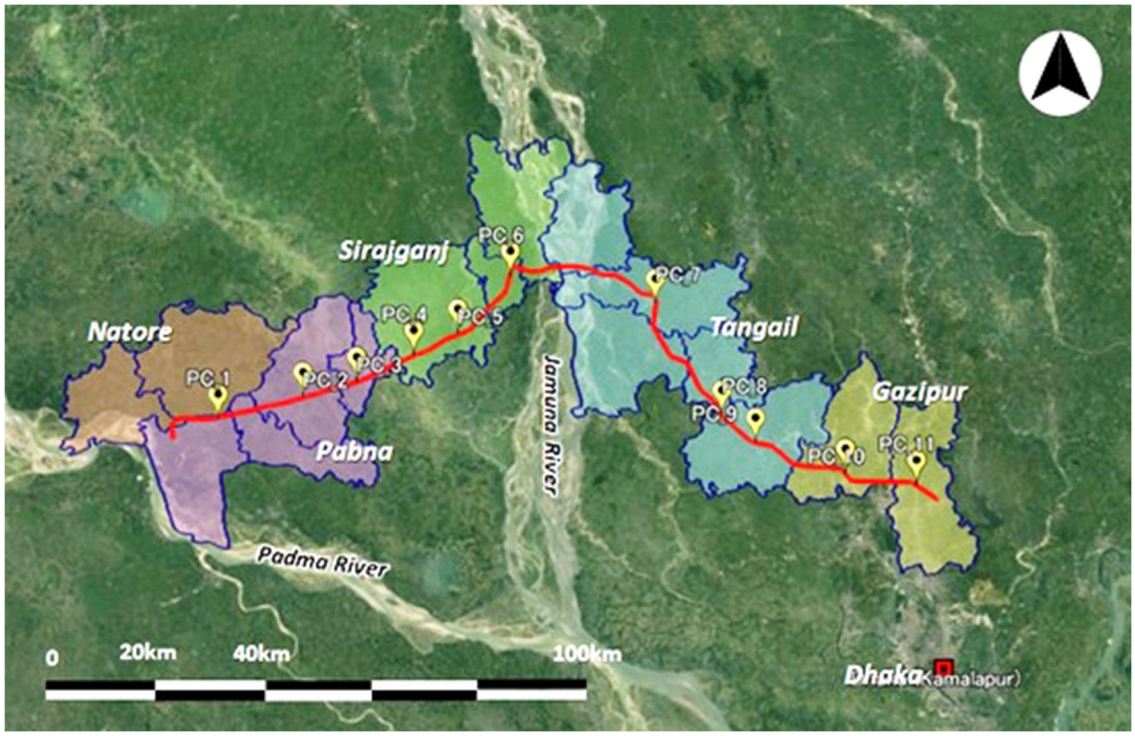
13.10 Stakeholder Meeting

13.10.1 Stakeholder Meeting

To identify PAPs' needs, expectations, grievances, perceptions, and choices/ recommendations, Stakeholders' Meetings (SHM) were organized in two stages. One was at the scoping stage to inform about the Project and Survey scope, and the other was at the DFR stage to explain survey results, mitigation measures, and compensation policies.

(1) 1st SHM

1st stakeholders meetings were conducted as a joint session of EIA and RAP at the scoping stage in October 2022. The meeting venues were selected based on the concentration of potential PAPs and accessibility of the area, and they are confirmed by BR. The locations of SHMs are shown in the figure below; at 11 locations in 5 districts. The announcement for SHMs was published in local newspapers which includes the date, time, and venue of each stakeholder meeting. In addition to a newspaper announcement, the PAHs were informed during site visits, and reminded by phone on the morning of the day of the meeting. The local community was also informed by distributing leaflets and verbal communications.



Source: JST based on Google Earth

Figure 13.12 Locations of SHMs

The purpose of the 1st SHM is to explain the project objective and scoping results of environmental and social impact from the project to obtain comments and concerns from the likely affected communities. The presentation material was prepared in the Bangladesh language containing the following contents.

1) Opening Remarks
2) Summary of the project
3) Alternative analysis
4) Scoping results of impact
5) Survey content and schedule
6) Q&A
7) Closing Remarks

The outline of the 1st SHM is summarized in Table 13.37. Participants include residents, local administration, and BR totaling 1,156 people, of which around 23.8% are women participants.

Table 13.37 Outline of 1st SHM

No.	Target	Venue	Date	M	F	Total
1	Gazipur	Salna Nasir Uddin School & College. Salna Bazaar, Gazipur	05.10.2022	67	16	83
2	Gazipur	Jatir Pita Banghabondhu High School. Chandra Bus Stand, Kaliakoir, Gazipur	06.10.2022	94	16	110
3	Tangail	Dr. Aeyesha Razia Khandakar School & College. Kadim Dallah, Mirzapur, Tangail	10.10.2022	77	17	94

No.	Target	Venue	Date	M	F	Total
4	Tangail	Sonaliya Govt Ptimary School. Karatiya, Tangail, Sadar, Tangail.	11.10.2022	87	21	108
5	Tangail	Lutfur Rahaman Matin Mohila Degree College,Rajabari, Elenga Kalihati, Tangail	12.10.2022	84	23	107
6	Tangail	JVCs Fly Over High School. Shahabazpur, Jhaweel, Chala, Kamarkanda, Sirajganj.	13.10.2022	80	15	95
7	Sirajganj	Khandakar Abdul Majid High School. Nayanganj Bazar, Ullapara, Sirajganj. (Near south side of Ullapara Rail Station)	14.10.2022	86	25	111
8	Sirajganj	Mohanpur K.M. Institution. Lahiri Mohanpur, Ullapara, Sirajganj.	15.10.2022	53	10	63
9	Sirajganj	Hazi Goyej Uddin Mohila Fazil (Degree) Madrasha.Chowbaria Dakkin para, (South side of Baral Bridge Rail Station). Vhangura, Pabna.	16.10.2022	81	90	171
10	Pabna	62 Amritakonda Govt. Primary School. Rail Bazar, Mulgram, Chatmohor, Pabna	17.10.2022	52	16	68
11	Pabna, Natore	Mooladuli Union Parishad Muladuly Bazar, Ishurdi, Pabna	18.10.2022	120	26	146

M: Male, F: Female

Source: JST

The main comments from participants and responses from the project proponent are summarized in Table 13.38. Many of the comments are related to concerns about noise/vibration, waste, and accidents for EIA and eligibility and adequate compensation for the RAP session. The full version of the minutes of the meeting is included in Appendix 13-1.

Table 13.38 Main Comments in 1st SHM

Topics	Main comments	Main responses
Project schedule	**Schedule:** When will the project be implemented, for a long time we are hearing that there will be a project, but nothing has started yet.	Implementing such a huge project that requires extensive surveys to identify affected people and property which takes a long time. All the preliminary work has started and is ongoing.
The adverse impact of the Project	**Pollution:** Long-time construction will cause soil, water, dust, and noise/vibration pollution.	Mitigation measures will be taken during the construction period to minimize the impact
	Railway sewage needs to be better managed.	The sewage system of Bangladeshi trains needs to be upgraded. Some newer trains have better sewage facilities.
	Damages: Transportation of heavy vehicles during construction works damages existing roads	The solution will be prescribed in Environmental Management Plan (EMP)
	Safety: The level crossing and side roads near rail lines are prone to accidents. Due to the lack of underpass and overpass accident is increasing.	The consultant has noted the issue.
	Congestion: Traffic congestion will increase at the train crossing	Traffic safety will be considered.
	Environment: Many trees will be cut	We have a plan for tree plantation. It will be three to four times higher than cuttings trees.
	Wetlands should be protected from any environmental degradation	The solution will be prescribed in Environmental Management Plan (EMP)

Topics	Main comments	Main responses
Compensation against loss	**Compensation category:** Compensation for shops and houses within RoW.	Every affected person will get compensation according to their loss category, loss of structure, land, business, etc.
	Compensations for those living on BR land	The structure will be compensated.
	Compensation for leased land	Compensation will be decided based on a deed document.
	Compensation amount: The land valuation method should be clear. There is a difference in the price of land even along the same road.	It will be determined based on the three times Mouza rate. If it is less than the market value, the remaining will be provided by BR
	It was not compensated properly during the previous acquisition. Please make sure proper compensation this time.	The consultant has noted the issue.
	Livelihood: Agricultural land will be lost. The creation of employment opportunities will be appreciated.	Appropriate compensation will be considered.

Source: JST

1st SHM in Gazipur

1st SHM in Tangail

1st SHM in Sirajganj

1st SHM in Pabna

Source: JST

Figure 13.13 Photos of 1st SHM

(2) 2nd SHM

2nd SHM was organized at the draft report stage as a joint session of EIA and RAP. SHMs were held in April 2023 at 11 locations in 5 districts, at the same locations as the 1st SHMs.

The Announcement of the 2nd SHM was published in local newspapers 2 weeks prior to the SHMs. As the same 1st SHM, invitations were delivered to government agencies, and information was disseminated by local leaders. The surveyed PAHs were also reached out by phone calls.

The purpose of the 2nd SHM is to explain the survey result of EIA and RAP and inform mitigation measures as well as compensation policies to the likely affected communities. The presentation material for the 2nd SHM was prepared in the Bangladesh language. The agenda of the 2nd SHM is as follows.

1) Opening remarks;
2) A brief recap of the proposed project;
3) Presentation on the EIA survey result and mitigation measures;
4) Presentation on the RAP survey result and compensation policies;
5) Question and answers; and
6) Closing remarks

The outline of the 2nd SHM is summarized in the table below. A total of 865 people including residents, business owners, local administrations, NGO representatives, and BR officials have attended the SHM, out of which, 26.6% are women participants.

Table 13.39 Outline of 2nd SHM

No.	Target	Venue	Date	M	F	Total
1	Gazipur	Salna Nasir Uddin School & College. Salna Bazaar, Gazipur	02.04.2023	71	14	85
2	Gazipur	Jatir Pita Banghabondhu High School. Chandra Bus Stand, Kaliakoir, Gazipur	03.04.2023	69	24	93
3	Tangail	Dr. Aeyesha Razia Khandakar School & College. Kadim Dallah, Mirzapur, Tangail	04.04.2023	54	12	66
4	Tangail	Sonaliya Govt Ptimary School. Karatiya, Tangail, Sadar, Tangail.	05.04.2023	48	20	68
5	Tangail	Lutfur Rahaman Matin Mohila Degree College,Rajabari, Elenga Kalihati, Tangail	06.04.2023	38	13	51
6	Sirajganj	JVCs Fly Over High School. Shahabazpur, Jhaweel, Chala, Kamarkanda, Sirajganj.	07.04.2023	92	9	101
7	Sirajganj	Khandakar Abdul Majid High School. Nayanganj Bazar, Ullapara, Sirajganj. (Near south side of Ullapara Rail Station)	08.04.2023	60	35	95
8	Sirajganj	Mohanpur K.M. Institution. Lahiri Mohanpur, Ullapara, Sirajganj.	09.04.2023	42	13	55
9	Pabna	Hazi Goyej Uddin Mohila Fazil (Degree) Madrasha.Chowbaria Dakkin para, (South side of Baral Bridge Rail Station). Vhangura, Pabna.	10.04.2023	54	64	118
10	Pabna	62 Amritakonda Govt. Primary School. Rail Bazar, Mulgram, Chatmohor, Pabna	11.04.2023	43	10	53
11	Pabna, Natore	Mooladuli Union Parishad Muladuly Bazar, Ishurdi, Pabna	12.04.2023	64	16	80

Source: JST

A summary of comments from the 2nd SHM is described in the following table. Most of the comments were related to clarification of compensation, and payment methods, and there were some comments on the support for relocation spaces for RAP-related Q&A. As for the EIA portion, there were some questions about the mitigation measures for congestion, accidents, and pollution during construction as well as operation stages. While many questions and opinions were raised by the participants, once their concerns were answered, there we no objections to the Project.

The full version of the minutes is included in Appendix 13-1.

Table 13.40 Summary of Comments from 2nd SHM

Topics	Main comments	Main responses
Project schedule	**Schedule:** When may the project start so that we can shift our affected home ahead of time?	The project is currently at the survey stage, and implementation will start in 2025-2026. Compensations will be received before acquisition.
Compensation	**Compensation amount:** Mouza rate is different in different areas. Also, the Mouza rate may not reflect the market rate.	The compensation amount will be calculated based on the Mouza rate. If 3 times of mouza rate is less than the market value, then according to JICA policy the difference will be paid by BR.
	Differences in compensation for structures/trees on private land and government land?	The compensation amount will be the same. The amount will be based on the type of structures/trees.
	Compensation items: Compensation for employees who are working in the affected commercial structures.	Employees working in affected structures will receive a 3 monthly average salary.
	Compensation for those renting the shops/houses	3 months' equivalent rent will be provided
	Compensation for business loss	Compensation for affected structures and 3 months' average salary will be provided. Training will be provided under the livelihood restoration program.
Payment method	**Payment method:** Distribution of the compensation should be made directly to the PAP's bank accounts.	The compensation will be provided to the individual bank accounts.
	Request for easier payment terms, considering the situation of the illiterate people.	The consultant has noted the issue.
	If the record is not updated, who will receive compensation?	The household head of your family will receive the compensation money.
Land acquisition	**Acquisition:** Any provision for partial compensation for partial land acquisition?	You will be compensated for the affected area. PVAC will discuss with you how you want it to be acquired.
	Land arrangement: There are open spaces, so I request BR to allow PAPs to settle in those available open spaces.	The consultant has noted the issue.
	Request to allow continued use of the remaining BR land to sustain livelihood	

Topics	Main comments	Main responses
Impact during construction and operation	**Congestion:** Traffic congestion will be increased during the construction, especially at busy train crossings, and a traffic signaling system must be created.	Mitigation measures will be provided in Environmental Management Plan (EMP).
	Accidents: Rail crossing is an accident-prone area. We would like to propose an overpass and an underpass.	Overpass and underpass will be suggested as per the requirement.
	There should be a side road to avoid accidents along the rail line.	The consultant has noted the issue
	Wastes: Open-dumped toilets are an issue. Railway sewage needs to be managed.	The sewage system of Bangladeshi trains needs to be upgraded. Some newer trains have better sewage facilities.
	Pollution: Long duration of construction will result in dust and noise pollution	Mitigation measures such as watering to reduce dust pollution during construction to minimize the pollution. The solution will be prescribed in EMP.
	Damages: Transportation of heavy vehicles during construction works damages existing roads.	The solution will be prescribed in EMP.
	Tree cutting: Cutting trees causes a negative impact on the environment.	If one tree will need to be cut, then three seedlings will be planted.

Source: JST

2nd SHM in Gazipur

2nd SHM in Tangail

2nd SHM in Sirajganj

2nd SHM in Pabna/Natore

Source: JST

Figure 13.14 Photos of 2nd SHM

13.10.2 Focus Group Discussions

(1) 1st FGD

As a part of stakeholder meetings, Focus Group Discussions (FGDs) were arranged with different interest groups after the 1st SHMs to understand possible project impacts and concerns from different groups. A total of 20 FGDs were arranged with different groups including women, transport operators, farmers/fishermen, business owners, local leaders, and title holders/non-title holders. When planning the FGDs, it made sure that the vulnerable groups are invited to the discussions, by arranging women's group discussions, and by requesting elderly people to also join in each discussion. Considering the low educational levels of PAPs, the survey team explained in an easy-to-understand language and encouraged participants to raise questions and comments so as to check their level of understanding while guiding the discussions. The outline of the FGD is shown in Table 13.41.

Table 13.41 Outline of 1st FGDs

No.	Location	Venue	Date	Time	Participants
Women					
1	Mouchak Gazipur	Near Ratanpur rail crossing	01.11.2022	10:00	16
2	Chatmohor, Pabna	Near Chatmohor rail crossing	02.11.2022	16:30	17
3	Ullapara, Sirajganj	Shampur, Ullapara	03.11.2022	14:30	18
4	Mirjapur, Tangail	Bonsai road	20.11 2022	10:00	18
Transport operators					
5	Joydebpur, Gazipur	Joydevpur station area	01.11.2022	13:30	14
6	Chourasta, Gazipur	Balaka, bus counter, Gazipur	27.11.2022	10:00	14
Farmer/Fishermen					
7	Chatmohor, Pabna	Near Chatmohor rail crossing	02.11.2022	15:30	15
8	Ullapara, Sirajganj	Near Chatmohor station	03.11.2022	12:30	20
9	Sonalia, Tangail	Pouli Primary School	21.11.2022	10:30	15
10	Tangail	Sarotia, Dorun	06.12.2022	14:30	15
11	Kamarkhand, Sirajganj	Haluakandi Primary School	28.12.2022	15:00	14
12	Majhgram, Pabna	Near Mokarrampur Primary School	29.12.2022	14:30	15
Business owner					
13	Chatmohor, Pabna	Chatmohor Railway station	02.11.2022	14:00	12
14	Kalihati, Tangail	Bolla road rail crossing, Kalihati	05.12.2022	11:00	16
15	Salna Gazipur	Near Salna rail overpass	06.11.2022	11:00	16
Local leaders					
16	Kaliakayr, Gazipur	Near Chandra Bus stand	06.11.2022	15:30	12
17	Elenga, Tangail	Near Rajbari Govt primary school	06.12.2022	10:00	12
Title-holders					
18	Tangail	Near Tangail Railway Station	05.12.2022	15:30	18
19	Sirajganj	Near Monsur ali station	28.12.2022	12:00	18
Students					
20	Mohera, Tangail	An open place near M A Aziz Market Mohera	20.11.2022	14:30	17

Source: JST

The summary of the discussions in each group is further mentioned below.

1) Women

FGDs for the women group were conducted in four districts. In Gazipur and Tangail districts, most of the women are housewives and some are engaged in small businesses, and garment factories and some engage in agriculture labor. In Pabna and Sirajganj, the majority are housewives, and some are engaged as seasonal agriculture laborers. Those who work as agriculture laborers mentioned that women are paid half of that of men.

The project impact and concerns raised by women were dust, noise, and health measures during the construction and safety for the animals and children during the construction and operation. In Gazipur and Tangail, they mentioned that if proper compensation was given, they could shift to other locations, while women in Pabna and Sirajganj raised concerns about moving to different areas.

For employment opportunities in the Project, they expressed their interest in engaging in construction work, such as carrying sand, cleaning offices and work camp, etc. They are interested in gaining skills in bakery, handicraft, and tailoring which can be done while staying at home. Those who engaged in agriculture labor requested training in agriculture. Elders expressed that it is difficult to acquire new skills. The livelihood restoration program will be considered depending on the opportunities in the area and their capabilities. Some photos of FGDs are shown in the figure below.

Women group FGD (Gazipur)

Women group FGD (Sirajganj)

Source: JST

Figure 13.15 FDGs for women groups

2) Transport Operators

The main local transport businesses along the alignment are three-wheeler auto and microbus operators around the stations as shown in the figure below. Their current operation is mostly between residential areas to the stations and customers are students and daily employees. Their primary income is a driver earning BDT 25,000-30,000/month which is higher than their secondary income of agriculture labor BDT 12,000/month.

According to inter-city bus transport operators, the majority of bus users are businessmen or students travelling from Gazipur to Dhaka, Chandra, Nabinagar, Trishal, and Mymensingh. A local bus carries 30-35 people and 40-50 during rush hours. The daily income is BDT 400-800/day with no secondary income source.

Three-wheeler auto and microbus operators expressed that there be no conflict with the Project but rather it complements their business and expects more passengers from the Project. Bus operators were also positive towards the Project because the current roads are overcrowded so if some passengers take the railway service, there will be less congestion. They also think that passengers for the shorter route will continue to use bus services.

Three-wheeler auto (Gazipur)

Microbus (Gazipur)

Source: JST

Figure 13.16 Main Local Transport in the area

3) Farmers/Fishermen

A total of five FGDs were arranged for farmers and fishermen along the alignment. In Sirajganj and Pabna, many of them are seasonal fishermen during the rainy season (Mar-Oct) and daily agricultural laborers in the winter (Nov-Feb). Their secondary income sources are driving and handicrafts, if not fishery or farming. Their income level is BDT 10,000-15,000/month for fishermen and agriculture labor for BDT 400-700/day. Some are using BR land to cultivate vegetables and earning BDT 200,000-800,000/year. Some are using submerged land as fishing grounds during the rainy season. According to fishermen, the fishing ground will not be affected during the construction as their fishing area extends 10-15 km. For those who practice agriculture on BR land, standing crops shall be subject to compensation.

In Gazipur and Tangail districts, farmers grow paddy and vegetables during the winter season (Nov-Mar). Most of the agricultural land is submerged underwater in the rainy season (Apr-Oct). Their income from agriculture activities is BDT 12,000-20,000/month and usually have secondary income from small businesses, skilled/nonskilled labor, etc. They mentioned that if they are compensated properly, they will shift as required.

FGDs with Farmers/Fishermen in Pabna

FGDs with Farmers/Fishermen in Sirajganj

Source: JST

Figure 13.17 FGDs with Farmers/Fishermen

4) Business owners

FGDs with business owners were conducted in three districts. Affected businesses are located near the station either on BR land or private land. Types of shops are tea stalls, stationery, grocery, vegetable shops, etc. Some of their shops have been operational since the 1980s and most of them have been in the business for 10-15 years. They either own or rent the structure and the rental fee of the fixed structure is BDT 3,000/month. Some shops pay a land rental fee of BDT 18/sqft to BR. Local peoples are mainly the customers of these shops. Their income level is around 20,000-25,000/month.

They expressed that they wish to continue engaging in a similar business. They also mentioned that these affected shops target neighboring customers, so starting a business elsewhere may be difficult. If they were to relocate, they request their market spaces close to the existing place and they also accept if BR can provide the space on their land. The following figure shows stores beside the station and FGDs in Pabna

Stores beside the station (Pabna)

FGDs with business owners (Pabna)

Source: JST

Figure 13.18 FGDs with business owners

5) Local Leaders

FGDs with local leaders were arranged in Gazipur and Tangail as shown in the figure below. They welcomed the Project and expressed that increasing the capacity of railway operations will benefit passengers in the area and goods can be easily moved from one place to another within a short period.

However, some raised concerns about noise and dust during the construction, and the increasing risk of traffic accidents during operation. In terms of impact on the property, they were of the view that if the government can compensate properly for the losses, PAHs can rebuild their houses elsewhere. They also mentioned that occupational training such as computer operation, driving, etc. will be beneficial if they have to change their occupations.

FGD in Gazipur

FGD in Tangail

Source: JST

Figure 13.19 FGDs with Local Leaders

6) Title holders

Title holders in Gazipur and Tangail expressed that the local people will benefit from the Project. Some concerns raised during the construction stage were noise and dust problems. During the operation period, it is very essential to keep enough overpasses and level crossings for the local people, because the rail line will get busier and accidental risks will also increase.

In terms of resettlement, they mention that they can rebuild their houses elsewhere as long as the government provides proper compensation for the loss of structure and property. They stressed that training is needed mainly for the unemployed youth such as technical, workshops, computer-based training for boys, handicrafts, boutiques, and baking for girls.

7) Non-title holders

Non-title holders in Sirajganj and Pabna have lived in the location for a long time, some of them moved in the 1970s due to the riverbank erosion in the neighboring districts. They own their structures which shall be subject to compensation.

In terms of the concern about the resettlement, they prefer to continue living in the current place but if not, they are willing to move as long as there are job opportunities. On the other hand, some,

especially women in Sirajganj, expressed that they would like to stay in their locality as they are not familiar with other areas. Special attention shall be paid to those vulnerable groups for the preparation or resettlement assistance.

(2) 2nd FGDs

Another set of FGDs was conducted after the 2nd SHM to supplement the explanation of the SHMs. This 2nd FGDs were arranged to target specifically non-title holders and vulnerable groups including women-headed households, and other groups who have not attended the SHMs to inform the entitlement matrix and livelihood restoration program and receive their questions or comments. A total of 10 FGDs were conducted as shown in the table below.

Table 13.42 Outline of 2nd FGDs

No.	Location	Venue	Date	Time	Participants
1	Natore	Majhgaon, Lalpur , Natore	11.04.2023	11:30	16
2	Pabna	Hogolbaria, Chatmohor	13.04.2023	12:00	12
3	Pabna	Bamongram, Gofurabad, Pabna	16.04.2023	12:00	10
4	Sirajganj	Jamtoli, Sirajganj	17.04.2023	11:30	12
5	Sirajganj	Jamtoli, Sirajganj	17.04.2023	12:30	13
6	Tangail	Gorail, Mirzapur Bypass	25.06.2023	11:00	12
7	Tangail	Hatilla Moddhopara, Mirzapur	19.06.2023	12:00	14
8	Gazipur	Bhauman, Kaliakair	21.06.2023	11:30	14
9	Tangail	Railgate, Mohera	05.07.2023	10:30	13
10	Tangail	Mirhamjani, Kalihati	06.07.2023	14:30	18

Source: JST

The main comments raised in those FGDs are summarized below. The issues of resettlement and relocation sites were mentioned in multiple meetings and possible supports and required considerations were included in the compensation and assistance policy as well as in the entitlement matrix.

- They appreciate the compensation policy recognizes non-title holders as eligible for compensation.
- They were worried about the delivery of compensation due to their illegal status. They are of the view that authorities are reluctant to provide compensation for non-title holders.
- As most PAHs do not have alternative land, they wish the project to support the space to resettle. While some mentioned that with the compensation amount, they will be able to resettle elsewhere, others expressed their wish for BR to allow using an unoccupied place for living.
- They showed interest in various types of training and also mentioned that small initial capital will help them to restart their business.

2nd FGD in Natore

2nd FGD in Pabna

Source: JST

Figure 13.20 FGDs with Non-title holders and Vulnerable groups

13.10.3 Key Measures Adopted in Entitlement Matrix

Through SHMs and FGDs, comments and concerns were raised and the main comments from the stakeholders were reflected and adopted in the resettlement policies and entitlement matrix. Following is the corresponding table.

Table 13.43 Stakeholders comments and measures adopted in Entitlement Matrix

Stakeholders' comments	Mitigations adopted in the Entitlement Matrix
Compensation for land and structure should be at the market price.	Compensation will be based on replacement cost (RC). If the market price is higher than CCL (200% premium of government rate), the difference is to be paid by the Project.
Compensations for those living on BR land (non-title holders) will be appreciated.	Non-title holders of the land will be eligible for compensation for structure, trees, and standing crops/fish stocks.
Compensations for Tenant	A transfer grant will be provided for the tenant. In case of income loss associated with the displacement, 3 months of income support will be provided.
Interest in various types of training.	LRP experts/NGOs will conduct the Needs Assessment survey and provide skill development training for the representative of PAHs
The creation of employment opportunities will be appreciated.	PAHs will be provided with opportunities to engage in the construction activities of the Project. The contractor will be conditioned to give preference to hiring PAHs.
Wish the project to support the space to resettle.	NGO/Firm will help the EPs to find land/homestead during the Project period. BR/NGO/Firm will also support finding potential alternative locations for CPRs including Community land/Khas land in the vicinity.
Small initial capital will help them to restart their business.	A seed grant for new business investment (BDT 16,000) is provided to each trained member for investment.

Source: JST

13.11 Land Acquisition Status and Recommendation

(1) Land Acquisition Status

The latest progress of the land acquisition process is shown in the Table 13.44. As of June 2024, all

the process up to Section 7 notice has been completed in Natore and Pabna districts. In Gazipur district, Section 7 notice publication is being processed, while field verification for section 4 is still pending for Tangail and Sirajganj districts.

The remaining work in Tangail district is estimated to take another 6 months until Section 7 is published as it has the largest area of land acquisition. In Sirajganj district, the same process remains and is estimated to take 2.5 months with less land acquisition. In Gazipur district, due to changes in the ADC, final field check is required, and it is estimated to take another 30-40 days to publish the Section 7 notice.

Table 13.44 LAP Status (as of June 2024)

LAP major steps	Gazipur	Tangail	Sirajganj	Pabna	Natore
LAP documents submission	Done	Done	Done	Done	Done
Feasibility Visit	Done	Done	Done	Done	Done
DLAC Meeting	Done	Done	Done	Done	Done
Section-4 Field Verification	Done	Pending	Pending	Done	Done
Section-4 Notice Publication	Done	Pending	Pending	Done	Done
Section-7 Field Verification	Done	Pending	Pending	Done	Done
Section-7 Notice Publication	Pending	Pending	Pending	Done	Done
Tentative days required	30-40 days	6 months	2.5 months	-	-

*DLAC: District Land Acquisition Committee
Source: ENRAC (Sub-contracted company for LAP support)

(2) Recommendation

The land acquisition process takes time and delays are mainly due to the busy schedules of DC officials. Bangladesh Railway officials also have limited time and resources to follow up on the process. Therefore, it is important to involve local consultants to support the work of DC officials.

Particularly in Gazipur district, since most of the field-level verification has already been completed, it is a very important time to complete the remaining process of Section 7 by maintaining communication with DC officials, the Forest Department, and other authorities until the publication of the notice.

There is still work to be done in Tangail and Sirajganj districts. In order to expedite the process, it is recommended that BR engage local consultants to assist with the work, including preparing documents, accompanying field verifications, and contacting and following up with various agencies for the confirmation and approval process. It is also important to have senior officials from BR on the ground to explain and resolve issues when there is a need for boundary confirmation in the field.

Since there is a possibility of redoing any process if there is no progress for a long time, this is a very important time to complete the remaining work by maintaining constant communication with DC officials and other authorities to proceed without delay and complete the work up to Section 7, which essentially fixes the land acquisition area and compensation amount.