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1. INTRODUCTION

1.1 GENERAL

National Highways and Infrastructure Development Corporation (NHIDCL) is a fully owned organization of the Ministry of Road Transport & Highways, Government of India. The organization promotes, surveys, establishes, designs, builds, operates, maintains, and upgrades National Highways and Strategic Roads including interconnecting roads in parts of the country which share international boundaries with neighboring countries. The regional connectivity so enhanced would promote cross border trade and commerce and help safeguard India's international borders. An approximate aggregate length of 10,000 km has been identified to begin with for development through this organization. The organization envisages creating customized and specialized skills in terms of addressing issues like complexities of geographical terrains and addressing extensive coordination requirements with security agencies.

As part of endeavor, NHIDCL has appointed M/s Aarvee Associates Architects Engineers & Consultants Pvt. Ltd. for the work of consultancy services for preparation of DPR and Pre-Construction services from– (i) Silchar ISBT (Start point of Silchar Bypass) to junction of NH-37 & NH-6 at Dhaleshwari, (ii) End of proposed Badarpur bypass to Churaibari (Assam-Tripura border), (iii) Spur from NH-8 near Karimganj to Sutarkandi.

To achieve the above task, NHIDCL has appointed M/s. Aarvee Associates Architects Engineers and Consultants Pvt. Ltd. The Letter of Acceptance was communicated vide letter No. NHIDCL / Assam / DPR / SilcharChuraibari / 222542 / 2581 and the agreement was signed on 1st September, 2023. The Agreement for consultancy services was concluded with NHIDCL on 01/09/2023. Reconnaissance/preliminary surveys commenced with immediate effect. The Inception report is prepared based on reconnaissance survey conducted on 22nd & 23rd August 2023 and in accordance with the Contract Agreement for preparation of Detailed Project Report and submitted on 13/09/2023. For preparing the Feasibility and Detail Report of the project corridor and designs of proposals, it is essential to have full knowledge of the physical conditions and existing scenario under consideration. The current Draft Feasibility Report has been prepared based on analysis of data derived from the surveys, observations made during site visits and in accordance with contractual stipulations.

1.2 PROJECT LOCATION

The Project Road is a part of (i) Silchar ISBT (Start point of Silchar Bypass) to junction of NH-37 & NH-6 at Dhaleshwari, (ii) End of proposed Badarpur bypass to Churaibari (Assam-Tripura border), (iii)Spur from NH-8 near Karimganj to Sutarkandi. The consultant had conducted a reconnaissance survey to be acquainted with actual site conditions. The observations are made and discussed in subsequent sections. Section -II is divided into 3 packages ie., Pkg 4, Pkg 5, Pkg 6 and details of Pkg 4 is given in Table 1-2

Table 1-1: Project Stretch

S No.	NH No.	Section	Section No	District	State
1	NH-37 & NH-8	End of proposed Badarpur bypass to Churaibari (Assam-Tripura Border)	Section-II	Karimganj	Assam

The co-ordinates of the project stretches are mentioned in following table:

Table 1-2: Coordinates of Start and End of the Package-IV

S. No	Section No.	Package	From (Km.)	To (Km.)	Length (km0	Geographic Coordinates	
						Start	End
1	II	IV	38.600	62.800	24.200	2750501.476N, 449695.133E	2739114.410N, 436489.714E

1.3 SCOPE OF SERVICES

1.3.1 Primary Tasks

1. Review of all available reports and published information about the project road and the project influence area.
2. Environmental and social impact assessment, including such as related to cultural properties, natural habitats, involuntary resettlement etc.
   Public consultation, including consultation with Communities located along the road, NGOs working in the area, other stakeholders, and relevant Government departments at all the different stages of assignment (such as inception stage, feasibility stage, preliminary design stage and once final designs are concretized).
3. Detailed Reconnaissance
4. Identification of possible improvements in the existing alignment and bypassing congested locations with alternatives, evaluation of different alternatives comparison on techno-economic and other considerations and recommendations regarding most appropriate option.
5. Traffic studies include traffic surveys and Axle load surveys and demand forecasting for the next thirty years.
6. Inventory and condition surveys for road.
7. Inventory and condition surveys for bridges, cross-drainage structures, other Structures, riverbank training/Protection works and drainage provisions.
8. Detailed topographic surveys using LiDAR equipped with minimum engineering grade system or any other better technology having output accuracy not less than specified in

IRC SP 19 Total Station (c) GPS/ DGPS. The use of conventional high precision instruments i.e., Total Station or equivalent can be used at locations such as major bypasses, water bodies etc. where it may not be possible to survey using LiDAR. Use of mobile / Aerial LiDAR survey is preferable.

9. Pavement investigations.
10. Sub-grade characteristics and strength: investigation of required sub-grade and sub-soil characteristics and strength for road and embankment design and sub soil investigation.
11. Identification of sources of construction materials.
12. Detailed design of road, its x-sections, horizontal and vertical alignment and design of embankment of height more than 6m and also in poor soil conditions and where density consideration require, even lesser height embankment. Detailed design of structures preparation of GAD and construction drawings and cross-drainage structures and underpasses etc.
13. Identification of the type and the design of intersections.
14. Design of complete drainage system and disposal point for storm water.
15. Value analysis / value engineering and project costing.
16. Economic and financial analyses.
17. Contract packaging and implementation schedule.
18. Strip plan indicating the scheme for carriageway widening, location of all existing utility services (both over- and underground) and the scheme for their relocation, trees to be felled, transplanted, and planted and land acquisition requirements including schedule for LA: reports documents and drawings arrangement of estimates for cutting/ transplanting of trees and shifting of utilities from the concerned department.
19. Develop 3D engineered models of terrain and elevation, as-is project highway, proposed and project highway along with all features, current and proposed structures, current and proposed utilities, and land acquisition plans.
20. To find out the financial viability of project for implementation and suggest the preferred mode on which the project is to be taken up.
21. Preparation of detailed project report, cost estimate, approved for construction Drawings, rate analysis, detailed bill of quantities, bid documents for execution of civil works through budgeting resources.
22. Design of toll plaza and identification of their numbers and location and office cum residential complex including working drawings
23. Design of weighing stations, parking areas and rest areas.
24. Any other user-oriented facility en-route toll facility.
25. Tie-in of on-going/sanctioned works of MORT&H/ National Highways Authority of India/ other agencies.

26. Preparation of social plans for the project affected people as per policy of the lending agencies/ Govt. of India R&R Policy.

- ✓ While carrying out the field studies, investigations and design, the development plans being implemented or proposed for future implementation by the local bodies, should be considered. Such an aspect should be clearly discussed in the reports and drawings.
- ✓ The consultant shall study the possible locations and design of toll plaza, wayside amenities required and arboriculture along the highway shall also be planned.
- ✓ The local and slow traffic may need segregation from the main traffic and provision of service roads and physical barrier including fencing may be considered, wherever necessary to improve efficiency and safety.

1.4 OBJECTIVE

The main objective of the consultancy services is to establish the technical, economic, and financial viability of the project.

To accomplish above objective, a detailed project report is planned for the purpose of firming up the Authority's requirements in respect of development and construction of the Project Highway and Project Facilities and enabling the prospective bidders to assess the Authority's requirements in a clear and predictable manner.

The viability of the project will be established considering the requirements based with regard to rehabilitation, upgrading and improvement based on highway design, pavement design, type of Interchanges and intersections, construction of new bridges and structures, road safety features, quantities of various items of works and cost estimates and economic analysis.

The Detailed Project Report (DPR) would include highway design, design of pavement, and overlay with options for flexible or rigid pavements, design of bridges and cross drainage structures and grade separated structures, quantities of various items, detailed working drawings, detailed cost estimates, economic and financial viability analysis, environmental and social feasibility, social and environmental action plans as appropriate and documents required for tendering the project.

The Detailed project report (DPR) would also include aspects of value engineering, quality audit and safety audit requirements in design and implementation.

1.5 APPROACH

The consultant's approach towards the project is in accordance to the ToR in lines with the project objectives. The prescribed engineering surveys and investigations will be carried out on project stretch conforming to MORTH/IRC/BIS specifications/Codes as per TOR to generate adequate database for preparing the most appropriate proposal for rehabilitation and upgrading of the existing highway.

1.6 SCHEDULE OF DELIVERABLES

As per Terms of Reference of Contract Agreement, the following documents have to be prepared and submitted to the NHIDCL.

Stage I:	Draft Inception Report including QAP document. Final Inception Report including QAP document
Stage II:	Draft Feasibility Report including option study report including draft 3(a) report. Final Feasibility Report
Stage III	Draft LA & Clearances report including draft 3(A) report. Final LA & Clearance, I Report including compliance of comments of client
Stage IV:	Draft Detailed Project Report Final Detailed Project Report
Stage V:	Draft Technical Schedules Final Technical Schedules
Stage VI	LA and Clearances II Report.
Stage VII	Land Acquisition III & Award Determination
Stage VIII	Land possession

1.7 STRUCTURE OF THE REPORT

The Feasibility Report has been presented in volumes to cover all the details on road design, social and environmental aspects etc. These are as follows:

- **EXECUTIVE SUMMARY**
- **VOLUME I: MAIN REPORT**
  - **Chapter-1: Introduction:** Briefly discusses the scope, project report organization.
  - **Chapter-2: Overview of NHIDCL:** Provides overview of NHIDCL and its activities as well as project financing and cost recovery mechanisms.
  - **Chapter-3: Project Background:** Briefly describes the project corridor and salient features of the alignment.
  - **Chapter-4: Methodology:** Briefly describes the methodology adopted for various surveys, investigations and their analysis.
  - **Chapter-5: Socio Impact Assessment**
  - **Chapter-6: Design Standards:** Discusses draft design standards, methodologies and specifications to be adopted.
  - **Chapter-7: Traffic Demand Assessment:** Discusses on the traffic surveys conducted, travel pattern, traffic projections etc.
  - **Chapter-8: Pavement Design:** Discuss on design of various pavement options.

- **Chapter-9: Project Proposals:** Project proposals for highway and cross drainage structures, cross section schedules etc.
- **Chapter-10: Environmental Impact Assessment**
- **Chapter-11: Socio-Economic Profile of the project Area**
- **Chapter-12: Project Cost Estimate:** Presents the rate analysis, detailed analysis for BOQ assessment, cost estimations etc.
- **Chapter-13: EIRR and FIRR:** Presents the economic viability of the project using economic indicators and provides the financial rate of returns using cash flow analysis.
- **Chapter-14: Conclusions and Recommendations:** Concludes the feasibility of the project.

- **ANNEXURES (Traffic, Pavement, MI, OGL, SG, Structure Inventory)**
- **VOLUME II: RATE ANALYSIS**
- **VOLUME II: COST ESTIMATES**
- **VOLUME IV: BOQ**

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2. OVERVIEW OF NHIDCL

"To meet the nation's need for the provision and maintenance of National Highways network to global standards and to meet user's expectations in the most time bound and cost-effective manner, within the strategic policy framework set by the Government of India and thus promote economic wellbeing and quality of life of the people."

2.1 INTRODUCTION

The National Highways and Infrastructure Development Corporation Limited (NHIDCL) was incorporated as a Public Sector Undertaking under the Companies Act, 2013, on 18th July, 2014 under Ministry of Road Transport & Highways, Government of India, inter alia, with authorized share capital of ₹10 crores and paid up capital of ₹1 crore with an objective to fast pace construction of National Highways and other infrastructure in the North Eastern Region and Strategic Areas of the country which share international boundaries. The effort is aimed at economically consolidating these areas with overall economic benefits flowing to the local population while integrating them in a more robust manner with the mainstream. The company started its effective functioning on 22nd Sep. 2014

The company has been entrusted with the task of developing and improving road connectivity of an approximate aggregate length of 10,000 km including the international trade corridor in the Northeast, and 500 km in the North Bengal and Northeastern region of India to enable efficient and safe transport regionally with other South Asia Sub-Regional Economic Cooperation (SASEC) member countries & promote cross border trade and commerce besides helping safeguard India's international borders.

The company envisages creating customized and specialized skills for addressing issues like complexities of geographical terrains and addressing extensive coordination requirements with security agencies. The company would endeavor to undertake infrastructure projects including but not restricted to urban infrastructure and urban or city transport and to act as an agency for development of all types of Infrastructure. The company envisages working towards cross sharing of technical know-how and enhancing opportunities for business development with other nations and their agencies, including the multilateral organizations and institutions.

NHIDCL has played a major role in the development of the road network in India. It has constructed some of the most challenging roads in the country, including the Rohtang Pass Tunnel and the Bogibeel Bridge.

Here are some of the key achievements of NHIDCL:

- Constructed over 10,000 km of national highways in India.
- Developed some of the most challenging roads in the country, such as the Rohtang Pass Tunnel and the Bogibeel Bridge.

- Committed to sustainable development and uses innovative technologies and materials to construct roads that are environmentally friendly and durable.
- Achieved an all-time high of 1,408 km of national highway construction in FY 2022-23.
- Paid a dividend of Rs. 33.99 Cr. to the Government of India for the year 2021-22.

NHIDCL is an asset to the Government of India and is playing a vital role in the development of the country's infrastructure.

2.2 ORGANIZATION CHART

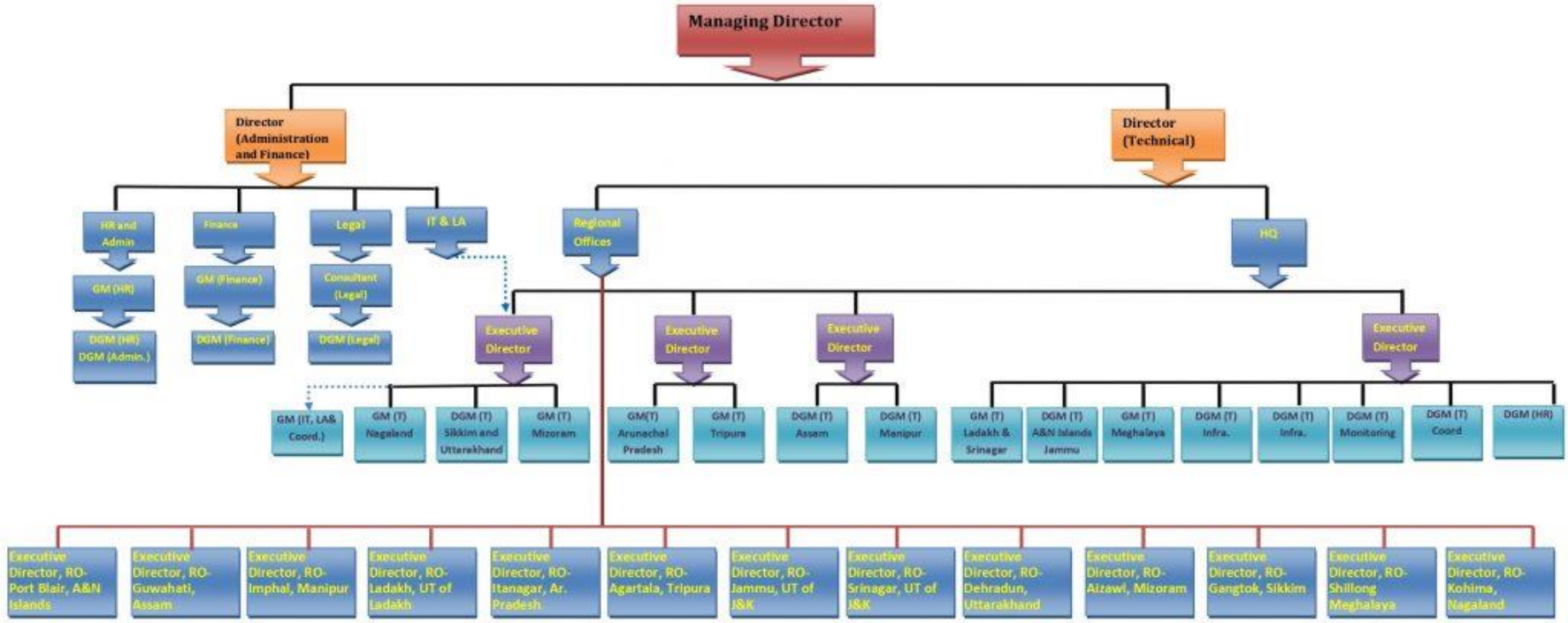

Figure 2-1: NHIDCL Organization Chart

Source: www.nhidcl.com

2.3 NATIONAL HIGHWAYS

National highways in India are a network of trunk roads owned by the Ministry of Road Transport and Highways of the Government of India. As of March 2022, there are 161,350 km (100,260 mi) of national highways in India. National highways constitute only 2.7% of India's total road network but carry about 40% of road traffic.

National highways are numbered according to a systematic scheme based on the orientation and the geographic location of the highway. North-south oriented highways have even numbers increasing from the east to the west, while east-west oriented highways have odd numbers increasing from the north to the south.

The longest national highway in India is National Highway 44, which runs from Srinagar in Jammu and Kashmir to Kanyakumari in Tamil Nadu. It is also the longest highway in Asia.

National highways in India are maintained by the National Highways Authority of India (NHAI) and the National Highways and Infrastructure Development Corporation Limited (NHIDCL). These agencies are responsible for the construction, upgrading, and maintenance of national highways.

National highways play a vital role in the Indian economy and transportation system. They connect major cities and industrial centers, and facilitate the movement of goods and people across the country. The Indian government has been investing heavily in the development of national highways in recent years, and is committed to doubling the length of the network to 200,000 km by 2025. Classification of roads and their lengths are mentioned in Table 1.1

Table 2-1: Classification of Roads and Length

Class	Length (km) (Approx.)
Expressways	1000
Total National Highways	92,852
National Highways (4 / 6 lane)	22,900
State Highways	1,54,522
MDR and Other district roads	25,77,396
Rural and Other roads	14,33,577
Total Approx.	42,45,429

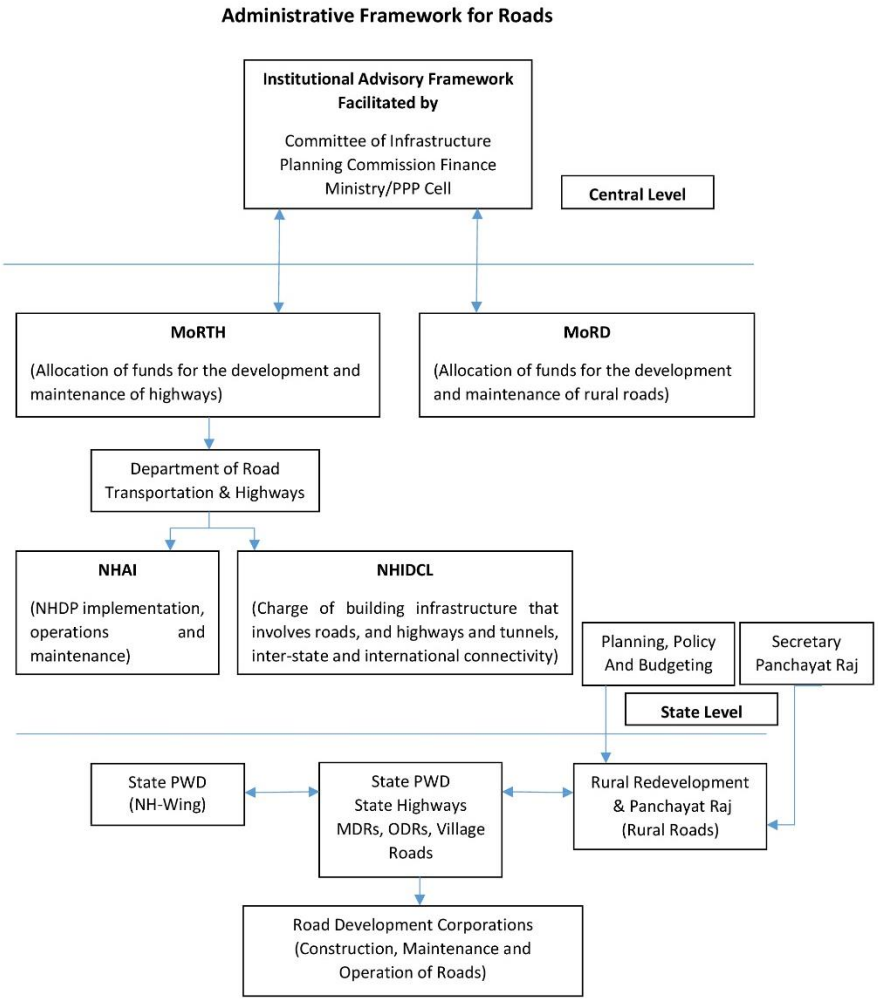

Figure 2-2: Administrative Framework of Roads

2.4 NHIDCL CURRENT PROJECTS

SARDP-NE: NHIDCL is currently implementing several projects under the Special Accelerated Road Development Programme for Northeastern Region (SARDP-NE). These projects include the construction of new highways, bridges, and tunnels.

Bharat Mala Pariyojana: NHIDCL is also implementing a few projects under the Bharat Mala Pariyojana. These projects include the construction of new highways, bridges, and tunnels.

Other projects: NHIDCL is also implementing several other projects, including the development of roads and other infrastructure in strategic areas of the country that share international boundaries.

2.5 NHIDCL COMPLETED PROJECTS

NHIDCL has completed several projects, including the construction of over 19,000 km of national highways and over 200 bridges. Some of the notable completed projects include:

Zojila Tunnel: The Zojila Tunnel is a 14.25 km long tunnel that connects Kashmir Valley with Ladakh. It is the highest tunnel in the world and was opened to traffic in 2021.

Sela Tunnel: The Sela Tunnel is a 4.15 km long tunnel that connects Tawang district in Arunachal Pradesh with the rest of the country. It is one of the highest tunnels in the world and was opened to traffic in 2017.

Dhola Sadiya Bridge: The Dhola Sadiya Bridge is a 9.15 km long bridge that connects Assam and Arunachal Pradesh. It is the longest bridge in India and was opened to traffic in 2017.

NHIDCL is playing a vital role in the development of national highways in India. The company is committed to developing high-quality highways that meet international standards and to ensuring that the local communities are benefited from its work

Table 2-2: Completed & Ongoing projects of NHIDCL

S. No.	Name of Project	NH No. (Old/New)	Length(km)	Sanctioned cost (in crores)	Awarded Cost (in crores)	Target date of completion as per contract	Likely date of completion
1	Improvement and Strengthening of Road Section from Chand Khera to Kurti Bridge on Assam-Tripura Border in the state of Assam on EPC basis	208A	17.95	66.94	60.21	24-01-2018	Completed
2	One time improvement of Moran Town section of NH-37 from km 555.000 to 558.500	NH-37	31.5	14.52	13.5	17-08-2020	Completed
3	One time improvement of Digboi to Ledo Town section (via Powal and Margherita) of NH38 from km 20.000 to 53.000	NH-38	15.5	30.84	26.92	23-09-2020	Completed
4	4-Lane highway connecting km 17.3 of NH 37A and km 182 of NH 52 between Dolabari and Jamuguri on EPC basis	37A &52	16.862	1049.5	1124.58	11-08-2023	11-08-2023

S. No.	Name of Project	NH No. (Old/New)	Length(km)	Sanctioned cost (in crores)	Awarded Cost (in crores)	Target date of completion as per contract	Likely date of completion
5	4-Laning from Biswanath Chariali by-pass km 208.00 to Gohpur 265.50 (Total length 57.50) in the state of Assam on EPC basis Under SARDP-NE	52	57.5	1099.35	393.482	14-06-2023	14-06-2023
6	Widening/ Improvemet to 4-Lane with paved shoulders from km 51+246 to 66+000 (Design Chainage 50+710 km to 65+923 km) of ParokhuwaDokmoka section (Package-2)	29	15.21	335.88	138.33	11-01-2024	11-01-2024

2.6 NHIDCL MANDATE

Charge of building infrastructure that involves roads, highways and tunnels, interstate and international connectivity mainly in North Eastern Region (NER), Himalayan region and Andaman & Nicobar Islands. • Implementation of Government's action plan in bringing 'Act East Policy' on the ground and act as Nodal agency in NER. Major objective includes minimum 2-Lane connectivity to each district of NER. • Implementation of SARDP-NE and to act as a Nodal agency for development of NH in the NER. • Implementation of Bharat Mala Pariyojana (BMP) to develop Border roads, Economic Annual Report | 2021-22 5 corridors, Feeder roads for inland waterways, Improvement of choke/congestion points and international connectivity roads. • A 'lean and thin' organization to work with limited staff equipped with expertise in different arena for fast track decision making for cost-effective construction. • Broad improvement in the infrastructure development process through an inclusive development strategy. • Specialized ways to shorten the time span taken by other executing bodies in the states, with better

technical know-how. • Planning and construction of tunnels in Himalayan region. • To yield IT initiatives on behalf of the Ministry of Road Transport and Highways. Some of the IT initiatives are e-PACE, INAMPRO & INAMPRO+, INFRACON and SAP. • Development of automated parking, multi-modal logistics parks and bus ports. • Other infra works assigned by the Ministry including Project Management Consultancies.

2.7 FUNDS FOR HIGHWAY DEVELOPMENT AND MAINTENANCE

The funds for highway development and maintenance to NHIDCL are provided by the Government of India through the Ministry of Road Transport and Highways (MoRTH). The MoRTH allocates funds to NHIDCL based on the company's annual budget proposal. The budget proposal is prepared by NHIDCL based on its assessment of the funds required for various highway projects and maintenance activities.

In addition to the funds provided by the MoRTH, NHIDCL also raises funds through various other sources, such as:

External borrowings: NHIDCL has borrowed funds from international financial institutions such as the World Bank and the Asian Development Bank to finance its highway projects.

Public-private partnerships (PPPs):* NHIDCL has also entered PPPs with private sector companies to develop and maintain national highways.

Tolls: NHIDCL collects tolls from vehicles that use certain national highways. The toll revenue is used to finance the maintenance and development of these highways.

NHIDCL is also exploring new ways to raise funds, such as through green bonds and infrastructure investment trusts.

Here is a breakdown of the funds allocated to NHIDCL for highway development and maintenance in the last few years:

Table 2-3: Funds allocated to NHIDCL

Financial Year	Budget Estimate (₹ in crores)
2022-23	71,550
2021-22	65,000
2020-21	42,500

The increase in the allocation of funds to NHIDCL in recent years reflects the government's commitment to developing and maintaining high-quality national highways.

NHIDCL is committed to using the funds provided to it in the most efficient and effective manner. The company is working on several initiatives to improve its project execution capabilities and to reduce costs. NHIDCL is also working to improve the quality of its maintenance activities.

2.8 BHARATMALA PARIYOJANA

Bharatmala Pariyojana (BMP) is a flagship program of the Government of India to develop a world-class road infrastructure in the country. The program includes the construction of new national highways, bridges, and tunnels.

The BMP was launched in 2015 with an estimated cost of ₹5.35 trillion. The program is divided into three phases:

Phase I (2017-2022): This phase involved the construction of 24,800 km of new national highways and bridges.

Phase II (2023-2027): This phase involves the construction of 10,000 km of new national highways and bridges.

Phase III (2028-2030): This phase involves the construction of 5,000 km of new national highways and bridges.

The BMP is expected to improve connectivity between major cities and towns, boost economic growth, and create jobs in India.

The Bharatmala Pariyojana includes the following components:

Economic Corridors: These corridors will connect major economic centers in the country and facilitate the movement of goods and people.

Inter Corridors: These corridors will connect economic corridors and improve connectivity between different parts of the country.

Feeder Routes: These routes will connect economic corridors and inter corridors to smaller towns and villages.

Border and International Connectivity Roads: These roads will improve connectivity to border areas and to neighboring countries.

Coastal and Port Connectivity Roads: These roads will improve connectivity to ports and coastal areas.

Greenfield Expressways: These expressways will provide a high-speed network of roads across the country.

Impact of the Bharatmala Pariyojana:

The Bharatmala Pariyojana is expected to have a significant impact on the development of the Indian economy. The program is expected to:

- Reduce logistics costs: The improved connectivity provided by the BMP is expected to reduce logistics costs, which will make Indian goods more competitive in the global market.
- Boost economic growth: The BMP is expected to boost economic growth by making it easier for businesses to transport goods and people.
- Create jobs: The construction and maintenance of new roads under the BMP is expected to create millions of jobs.

Challenges faced by the Bharatmala Pariyojana:

The Bharatmala Pariyojana faces several challenges, including:

- Land acquisition: The acquisition of land for new roads is a major challenge for the BMP.
- Environmental impact: The construction of new roads can have a negative impact on the environment.
- Cost overruns: There have been concerns about cost overruns in some BMP projects.

Despite these challenges, the Bharatmala Pariyojana is a major initiative that has the potential to transform the road infrastructure in India.

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3. PROJECT BACKGROUND

3.1 GENERAL

The Project Road is from– (i) Silchar ISBT (Start point of Silchar Bypass) to junction of NH-37 & NH-6 at Dhaleshwari, (ii) End of proposed Badarpur bypass to Churaibari (Assam-Tripura border), (iii) Spur from NH-8 near Karimganj to Sutarkandi in the State of Assam

Table 3-1: Details of the project stretch

S. No	Section No.	Package	From (Km.)	To (Km.)	Length (km0	Geographic Coordinates	
						Start	End
1	II	IV	38.600	62.800	24.200	2750501.476N, 449695.133E	2739114.410N, 436489.714E

The Consultant had conducted a detailed inventory survey to get acquainted with the actual site conditions. The observations made are discussed in subsequent sections.

Start of Section-II (End of Badarpur bypass)

End of Section-II (Assam-Tripura Border)

Figure 3-1: Start and End Point of Section II

3.2 ABUTTING LAND USE

During the reconnaissance survey, the majority of the adjoining land was observed agriculture land. Important crops grown along the project stretch are Paddy.

In Section-II, abutting land use is observed to be majorly agriculture, forest land in the end and few built-up locations.

	
Agriculture Land along the Highway	Built-up along the Highway

Figure 3-2 Abutting Land Use

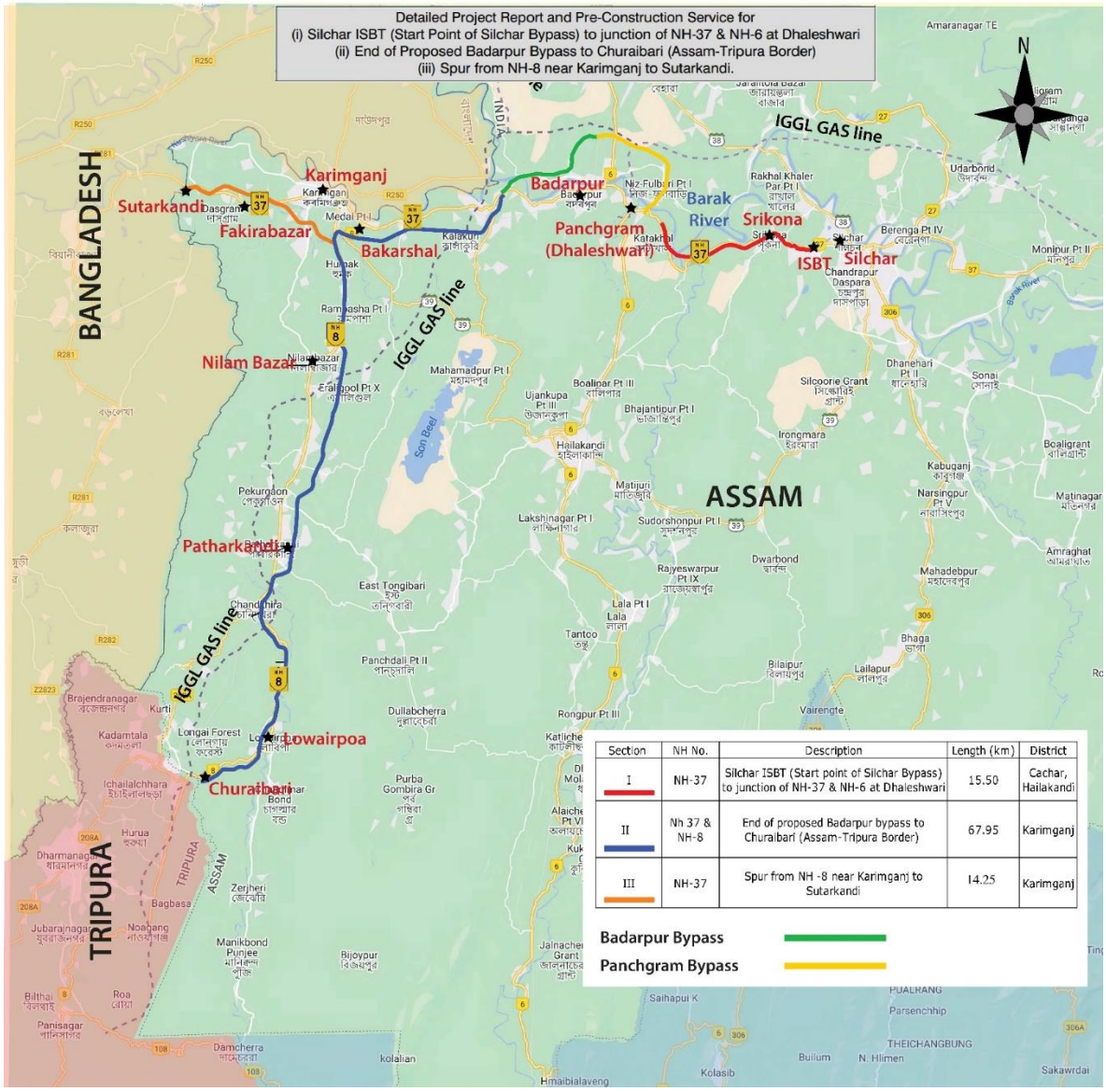

Figure 3-3 : Index Map of Project Corridor

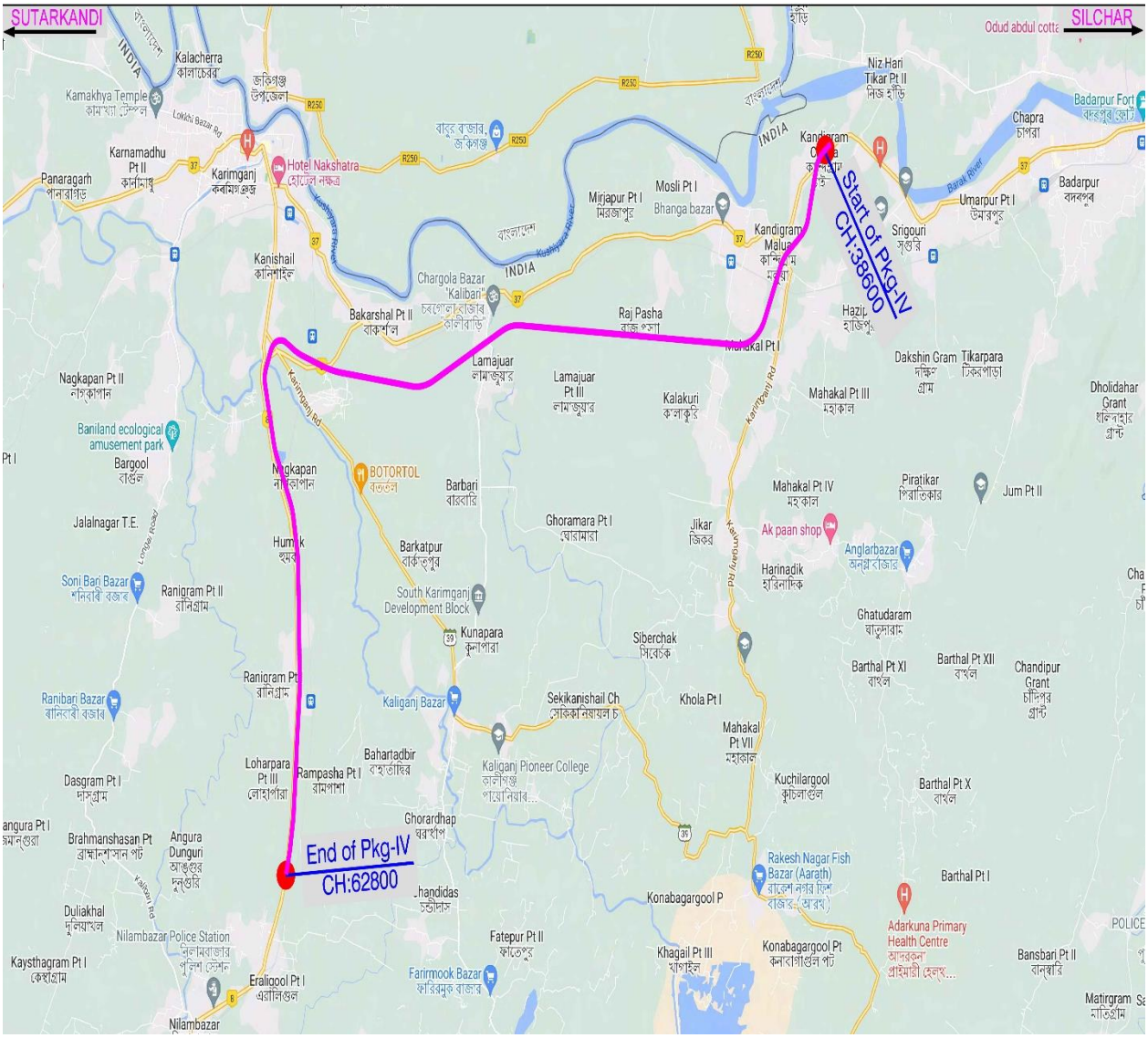

Figure 3-4: Index Map of Package-IV

3.3 INTERSECTIONS

At present, the project corridor is 2-lane with paved shoulders and connects various built- up sections by major district roads and village roads.There are 1 major junction, 7 minor junctions and many roads leading to clusters of villages and hamlets. List of Major and Minor Junctions is enclosed hereunder.

Major Junction - NH-8 and NH-37

Figure 3-5: Major Junctions Along Project Corridor

Table 3-2 List of Major Junction

S.No	Design Chainage Km.	Type of Junction	Leads to		Remarks/Cross Road Details
			LHS	RHS	
1	54.117	+	Hailakandi	Karimganj	Junction between NH-8 & SH-39

(NH: National Highway, SH: State Highway, MDR: Major District Road)

Table 3-3: List of Minor Junctions

S.No	Design Chainage Km.	Type of Junction	Leads to	
			LHS	RHS
1	54.759	Y	-	Karimganj
2	55.228	T	-	Saif Nagar
3	56.294	T	Road to Karimganj substation	-
4	57.895	T	Bhojendra nagar	
5	58.964	T	Nairgram	Suprakandi

S.No	Design Chainage Km.	Type of Junction	Leads to	
			LHS	RHS
6	59.984	Staggered	Suprakandi Railway station	Suprakandi
7	60.968	T	Rampasha Pt I	

3.4 EXISTING GRADE SEPERATOR STRUCTURES

3.4.1 ROBs

All NHs, SHs, MDR's, ODR's crossings and other important junctions are proposed for improvementby providing Vehicular Overpasses/ underpasses. There is only one ROB existing along the proposed alignment and no existing underpasses/overpasses. The details of ROB is given in Table 3-

Table 3-4: Existing ROBs

S.No.	Design Chainage (Km)	Destination	
		LHS	RHS
1	53.328	Nilambazar	Karimganj

3.5 LEVEL CROSSINGS

It was observed that the Railway line passes parallel to our project stretch in Section-II, but there is no Level crossings in package-IV.

3.6 CROSS DRAINAGE STRUCTURES

As a part of upgradation/Improvement of the existing stretch, it is required to assess existing structures based on adequacy to fulfill the objective of the project. The existing project stretch is of 2-Lane Road with 2-lane cross drainage structures.

3.6.1 Major Bridges

Table 3-4: Existing Major Bridges

Sl. No	Design Chainage (Km)	Span Arrangement (No. x Span Length in metres)	Super Structure	Deck Width (m)
1	54.460	1 x 80.0	Truss Bridge	12.8

3.6.2 Minor Bridges

Table 3-5: Existing Minor Bridges

Sl. No	Design Chainage (Km)	Span Arrangement (No. x Span Length in meter)	Super Structure	Deck Width (m)
1	56.998	1 x 6.0	Box type	12.0
2	58.103	1 x 6.0	Box type	12.0
3	59.732	1 x 6.0	Box type	12.0
4	61.029	1 x 6.0	Box type	12.0

3.6.3 Pipe Culverts

Table 3-6: Existnig Pipe Culverts

Sl. No	Design Chainage (Km)	Span Arrangement (No. x Dia in meter)	Width (m)	Remarks
1	38.823	2 x 1.2	15.0	-
2	53.347	1 x 0.9	12.0	Culvert within ROB spans
3	53.804	1 x 0.9	25.0	-

3.6.4 Summary of Existing Structures

Table 3-7: Existing cross drainage structure

S. No	Type of Structure	Existing
1	Major bridges	1
2	Minor Bridges	4
4	Causeways	0
6	ROBs	1
7	RUBs	0
8	Railway Level Crossings	0
9	Grade separators	0
10	Flyovers	0

S. No	Type of Structure	Existing
11	Vehicular Underpasses	0
12	Vehicular Overpasses	0
13	Cattle /Pedestrian Underpasses	0
14	Pipe Culverts	3
Total		9

3.7 BYPASSES:

To avoid the ribbon development on both sides of the project corridor, and to provide an alternative route for through traffic, bypasses are proposed.

There are no existing bypasses in Package-IV

3.8 BUS SHELTERS

Table 3-8: Existing Bus Shelters

S.No.	Design Chainage (Km)	Side	Remarks
1	55.230	RHS	-
2	57.900	LHS	-
3	58.950	RHS	-

3.9 SETTLEMENTS

A part of the total population of the town is situated on both sides of the project corridor or local roads connecting it. Hence the land use pattern of the project corridor is mainly built-up and cultivation type. The project corridor passes through many villages. List of Villages/Built-up locations are enclosed hereunder.

Table 3-9: List of Villages in Section-II along Alignment

S.No.	Village name	Package	Taluk/ Circle	District
1	Kandigram Malua	Package- IV	Badarpur	Karimganj
2	Paterakandi			
3	Mahakal Pt I			
4	Kankalesh Pt I			
5	Mahakal Pt II			
6	Kankalesh Pt II (Sh 1 & 2)			
7				
8	Mosli Pt II			
9	Raj Pasha kitte Khag sheet-1 & 2			
10	Lamajuar Pt III			

S.No.	Village name	Package	Taluk/ Circle	District
11	Lamajuar Pt II			
12				
13	Nairgram			
14	Lamajuar Pt II kitte Ambari		Karimganj	
15	Nathupur Pt I			
16	Bakarshal Pt III			
17	Jinahabra			
18	Medal Pt II			
19	Medal Pt III			
20	Saidambar Pt I			
21	Saidambar Pt II			
22	Alampur			
23	Umarpur Pt I			
24	Nagkapan Chak			
25	Umarpur Pt II			
26	Umarpur Pt V			
27	Umarpur Pt III			
28	Umarpur Pt IV			
29	Berajal		Nilambazar	

3.10 EXISTING ALIGNMENT

The Existing Alignment of the project stretch is two-lane with paved shoulder with 2-lane structureconfiguration. There are many locations where the existing geometry is substandard and inadequate sight distances, curve radii were observed.

3.11 CARRIAGEWAY

The existing road configuration is uniform two-lane carriageway with 1.5m width of paved shoulders and 1.5-2.0m earthen shoulders. Flexible pavement for both carriageway and paved shoulders and the earthen shoulders on either side.

3.12 RIGHT OF WAY

The existing Right of Way (RoW) is of 20m along Section-II. RoW pillars were found at a few locations along the project stretch. The precise RoW details will be ascertained from the revenue records to clarify the exact land available for construction. Land acquisition plans would be prepared to have uniform ROW in accordance with NHIDCL guidelines. Additional land acquisition will be proposed as per project requirements and in accordance with TOR/ NHIDCL guidelines.

3.13 PAVEMENT

Flexible pavement is observed throughout the project stretch except at existing toll plaza in Section II. The riding quality/pavement condition varies from good to fair along the entire stretch with very few sections of the road showing various types of distresses such as Potholes, undulations, and cracks.

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4. METHODOLOGY

4.1 GENERAL APPROACH

Various engineering surveys and investigations have been carried out on the Project Road strictly following the relevant specifications mentioned in MoRTH/ IRC/ BIS Codes to generate adequate database for preparing the most appropriate proposal for the (i) Silchar ISBT (Start point of Silchar Bypass) to junction of NH-37 & NH-6 at Dhaleshwari, (ii) End of proposed Badarpur bypass to Churaibari (Assam-Tripura border), (iii) Spur from NH-8 near Karimganj to Sutarkandi.

Various engineering surveys and investigations carried out are listed below:

- Alignment Study
- Topographic Surveys
- Road Inventory and Condition survey
- Traffic Surveys
- Inventory and condition survey of bridges and culverts
- Hydraulic and Hydrological Investigations
- Pavement Investigations
- Soil and Material Investigations
- Sub-soil Investigations

4.2 RECONNAISSANCE AND ALIGNMENT STUDY

- In-depth study of the available land width (RoW), study of topographic maps of the project area was made and other available relevant information has been collected concerning the existing alignment and the vicinity of the project corridor.
- The detailed ground reconnaissance has been taken up immediately after the study of maps and other data. The primary tasks of reconnaissance survey include:
- Topographical features of the area.
- Typical physical features along the existing alignment within the RoW for understanding land use pattern along the project stretch.
- Possible alignment alternatives, vis-à-vis, scheme for the construction of additional lanes or paved shoulders parallel to the existing road to the left or right or central widening.
- Provision of the interchanges and underpasses for vehicle/pedestrian/animal crossing
- Traffic pattern and preliminary identification of traffic homogeneous sections.
- Identification of sections passing through congested areas.
- Critical areas requiring detailed investigations.
- Requirement for carrying out supplementary investigations.
- Soil (textural classifications) and drainage conditions.
- Type and extent of existing utility services along the alignment (within RoW).

- Identification of various agencies of the Govt. from whom the concerned project clearances for implementation are to be sought.
- General observations of the condition of existing pavement.

4.3 TOPOGRAPHICAL SURVEY

The basic objective of the topographic survey is to collect the essential ground features along the existing alignment and develop Digital Terrain Model (DTM). The equipment used for this purpose is the Mobile LIDAR. This data forms the basis for all the designs to be carried out, so as to take care of design requirements of new carriageway, possible improvements in highway geometrics, identifying areas of restriction and their remedies and relocation of utilities. The data collected will result in the final design and for the computation of earthwork and other quantities required. The detailed methodology including the various intermediate quality check procedures, control points and pillars, horizontal and vertical controls etc. have been described in detail, in the QAP, document submitted to NHIDCL.

4.3.1 Scope of Work

The detailed scope of services is enclosed in the contract agreement.

a) Topographic Surveys along the Existing Right of Way (RoW):
- Running a continuous open traverse along the existing road and realignments.
- Fixation of Horizontal Intersection Points (HIP's), centre points, transit points etc.
- Fixing reference pillars on either side of centre line at safe places within the RoW.
- Establishment of Height Control by Auto Level.

b) Detailed Topographical Survey to generate Digital Terrain Model of the defined corridor of the project road.

c) Additional survey as required for geometric improvements like designing of Junctions and bypasses/realignment.

4.4 ROAD INVENTORY AND CONDITION SURVEY

4.4.1 Road Inventory

Road Inventory has been carried out for the Project stretch through dimensional measurements and visual inspection. The road inventory has been referenced to the existing kilometer & hectometer stones established along the roadside. The details of road inventory survey collected at every 100m, includes:

- Carriageway width
- Shoulder width
- Formation width
- Horizontal curve details and locations
- Height of fill and depth of cutting
- Cross road details

- Terrain
- Land use
- Details of drain condition
- Submergence, if any
- Existing drainage

4.4.2 Horizontal Curves

It is observed that the project highway has straight and curved alignments and traverse's majority of the stretch through plain and hilly terrain. Some horizontal curves are not confirming to acceptable geometric standards. The vertical gradients are gentle and the required sight distances are available as per the design standards.

4.4.3 Road Junctions

There are few major and minor junctions existing along the project road.

4.4.4 Road Condition

Road condition survey is conducted to evaluate the condition of pavement, shoulder and embankment.

4.4.5 Pavement Condition

- The criteria used for the pavement condition is, no cracking or rutting less than 10mm is classified as Good, rutting observed between 10mm to 20mm is classified as Fair and rutting.more than 20mm or cracking exceeding 20% is treated as Poor. The major distresses are:
- Crack type (longitudinal, transverse, alligator and block), width (fine cracks <3mm and wide cracks >3mm) and as a percentage of total area.
- Raveling as percentage proportion per km.
- Pothole area as average Nos per km.
- Rut depth as average depth per km which is classified in three types-type I (<10mm), type II (10-20mm) and type III (>20mm)
- Edge fretting as average length per km.
- Material loss by checking the level difference between the paved surface and unpaved surface.
- Embankment condition and the material loss in the embankment.
- Drainage condition.
- The existing road condition varies from Good to fair.

4.5 Traffic Studies and Analysis

The methodology and details of traffic studies and analysis are mentioned in detail, in Chapter-8, of this Volume-I.

4.6 Inventory and Condition Survey of Structures

Detailed inventory of the bridges has been carried out as per the guidelines stipulated in IRC SP: 35–1990 and the results of the inventory are presented in the format prescribed in IRC SP: 35-1990 in Annexures in Volume IIB.

4.6.1 Inspection of Bridges, Culverts and Causeways

- Preliminary inspection of the existing structures has been carried out by Sr. Bridge Engineer and data on the condition survey has been collected. Based on the condition survey of existing two-lane culverts, it has been decided whether they can be retained after carrying out repairs or not. In case any culvert is found to be beyond economical repair, it has been considered for reconstruction.
- Preliminary inspection of bridges has been carried out as per Appendix-4 of IRC SP: 35-1990 identifying the bridges which need attention for detailed inspection and further investigations. The bridges would be categorized as given below:
- Those with minor defect, and
- Those need further examination.
- Detailed Investigations can be done afterwards but Hammer test, inspection of bearings and other visual signs of distress are mentioned in separate report of each structure.
- All bridges showing signs of distress have been examined thoroughly as per Appendix-5 of IRC SP: 35-1990.
- The existing structures have been surveyed and data is collected on the following points:
- Type of structure and details of span, vent height etc.
- Existing width of structures.
- Condition of sub-structure, super structure etc. and any deficiency required to be rectified.
- Signs of silting and blockage of the vent way, need for change in invert levels if required after studying the present levels on both sides of culverts, over topping of the structure, observed scour level etc.
- Scouring below the pier locations and if sand is being excavated from the major bridge site had not been verified due to full flow of water. This will be verified during dry season while proposing sub-soil investigations.

4.6.2 Culverts

Various types of culverts found in the project road are:

Slab culverts / Box Culverts: Inventory data of existing Slab / Box culverts are examined to determine their present condition to assess the performance in future. These comprise of masonry / PCC abutments, wing walls, open foundations and RCC / Stone deck slabs. Structural Distress in deck slab, abutment and wing walls are examined. It is found that most of the slab culverts are in satisfactory condition and recommended for widening. Minor repairing

and strengthening works also suggested for the existing part of culverts. The list of Slab / Box / Pipe culverts and their improvement proposals are listed in structure inventory.

Pipe culverts: Detailed inventory of all the Pipe culverts was made and their condition survey was carried out to determine their present condition. Repair or replacement of culverts is called for when these are in distressed condition. Most of the pipe culverts are fair to good condition and are proposed for widening. Culverts having very poor condition are recommended for reconstruction with pipe diameter of 1200mm. The pipe culverts which have diameter less than 900mm are to be replaced with 1200mm diameter pipes keeping in view the constraints and inadvertences of maintenance. The list of Pipe culverts and their improvement proposals are listed in the condition survey report.

4.7 Hydraulic and Hydrological Investigations

4.7.1 Requirements for Hydraulic and Hydrological Investigation

The hydrological study aims at estimating the peak discharge of the flood generated by the run-off of rainfall within the catchment area. The hydrological study requires:

- Knowledge of the characteristics of peak rainfall in the regions
- Knowledge of the characteristics of the catchment areas
- Topographic data about the stream, upstream and downstream
- Survey of India topo sheets maps to a scale of 1:50,000 for identification of catchment area and its characteristics.

4.7.2 Data Collection

Topographic Survey Data: Topographic surveys will be done at all the major and minor river crossings with a view to obtain the cross section of the rivers at the centre line of the road and up to a reasonable distance at upstream and downstream. The High Flood Levels (HFL) will be obtained from existing flood marks/flood marks on Railway bridges or ascertained from enquiry with local knowledgeable persons.

Catchment Areas: The characteristics of the catchment areas will be ascertained from Survey of India topo sheets to a scale of 1:50,000 from which, catchment area at the proposed bridge site, length of the stream and fall in elevation from originating point to the point of crossing, could be determined. The slope of the stream will be determined from the contours on the topo sheets.

Rainfall Data: For rivers/streams having catchment area more than 25 sq. km, CWC Report No. C/16/1988 – Flood Estimation Report for Barak zone with data from Anipur, Fakirabazar, Patharakandi, Kaliganj, Katigora and Matijuri CWC site will be obtained. These Reports will be referred to determining the characteristics of peak rainfall regimes. These reports have been jointly prepared by CWC, MOST, Ministry of Railways and IMD and contain all the rainfall data required for estimation of design discharge of 25, 50 and 100 year returns periods by applying the Synthetic Unit Hydrograph approach, the parameters of which have been indicated in the

above report. For streams having a catchment area less than 25 sq km, IRC-SP-13 and RBF-16 have been referred to.

4.7.3 Hydrologic Design

The following methods will be used to estimate the peak discharge for bridge sites on major and minor streams:

- Rational Method
- Synthetic Unit Hydrograph Method
- Area-Velocity Method or Slope Area Method

i. Discharge Estimation for the Catchment Areas Less than 25 Sq. Km (Rational Method) (Ref: IRC-SP-13 and BRIDGES AND FLOODS WING REPORT No. RBF- 16) This is a well-known method given in IRC: SP-13 and has been suitably improved as per report RBF-16 and is in use from many years.

Here, 50-year Peak Discharge is calculated by following formula

Qmax = 0.28fCIA

Where,

Qmax = design flood (m3/s) for 50-year return period

f = Areal Distribution Factor

C = runoff coefficient between 0 and 1.0

A = catchment area (sq.km)

I = mean intensity of rainfall in mm/h during the time of concentration (the time required for the most distant part of the catchment to Contribute to the outflow at bridge site)

Time of concentration has been taken from Bransby- Williams' formula as suggested in RBF-16:

tc = 0.615 L / (A0.1 S 0.2)

Where,

tc = time of concentration (h)

L = mainstream length (km)

S = mean slope of mainstream (%)

A = catchment area (Km2)

Intensity of rainfall has been determined from formula I = 2*R/ (tc+1)

ii. Synthetic Unit Hydrograph (SUH) Approach for Bridges having Catchment Area More than 25 Sq. Km

This method has been used for those bridges, which cater for more than 25 sq km of catchment area. In this method 1-hour Synthetic Unit Hydrograph is determined for an ungauged catchment. The following steps have been followed as suggested in CWC report for determination of discharge by this method.

a) Physiographic parameters of the ungauged catchment viz. A, L and S will be determined from toposheets or field observations.
b) SUH parameters will be computed using the equations set out in subzone manuals.
c) The values calculated will be plotted to arrive at a unit hydrograph.
d) The design storm duration is taken as equal to base period of unit graph.
e) (TB =1.1* tp).
f) Point rainfall is available in the given plate in CWC report for 50 year 24 hr rainfall.
g) The areal rainfall of design storm duration is split into 1-hour rainfall increments
h) Using time distribution coefficients.
i) Estimation of effective rainfall excess unit will be done after taking design loss rate into account.
j) Base flow will be estimated based upon the catchment area.
k) Finally, for 50 year peak discharge, the effective rainfall excess after removing the losses from rainfall increments are arranged against unit hydrograph ordinates such that the maximum of effective rainfall is placed against the maximum UG ordinate, next lower value of effective rainfall against next lower value of UG ordinate and so on. Sum of the product of the above two added together with base flow gives peak discharge.

iii. Area Velocity Method/Slope Area Method

This method can be utilized to calculate the discharge from the stream cross-section and stream slope/bed slope at the proposed bridge sites, for both major and minor bridges. After plotting the cross section of the river, and marking the observed HFL, the cross-sectional area (A) and wetted perimeter (P) will be computed.

The velocity and Discharge are calculated using the Manning's formula:

$V = 1/n\ R^{2/3}\ S^{1/2}$

$Q = A \times V$

Where,

V = Velocity in m/sec
R = Hydraulic mean depth in m
S = Flood slope/bed slope
n = Co-efficient of rugosity
Q = Peak Discharge in cumecs
A = Area of cross section in sq.m

4.7.4 Fixing of Design Discharge

In general, the design discharge is taken as the highest of the discharges obtained from above methods. However, the general condition laid down in IRC SP-13 will be used to fix the design discharge, that is, if the discharge obtained by one method is greater than 1.5 times the discharge obtained from the other, the design discharge should be limited to 1.5 times of the smaller one. In the case where Average discharge obtained by Area Velocity method is higher

than 1.5 times the discharge obtained by the other method; design discharge has been taken as that of from previous method. Accordingly, the design discharge has been established for all the bridges. Also, in the case where area velocity method is governing case (i.e. discharge by catchment area method is lesser than the area velocity method) and the average discharge by area velocity method has been found lesser as compared to discharge by same at proposed bridge site, the discharge calculated at proposed bridge site has been considered as design discharge.

4.7.5 Afflux Calculation

Since some of the bridges in the alignment will have less clear waterway as compared to natural stream width and also velocities at bridge sites high due to steep bed slopes, this combined effect causes afflux at bridge sites during flood. Afflux for the bridges will be calculated using Weir and Orifice formulae as described in IRC SP-13.

4.7.6 Vertical Clearance

The vertical clearance for each structure will be calculated as per the standards set out in IRC SP-13.

4.8 Material and Geo-Technical Investigations

4.8.1 Material Investigations

It has been ensured that all Geo-technical investigations confirm IRC, BIS codes and MoRT&H specifications. The Geo-technical investigation scheme has been prepared in accordance with the “Terms of reference”. The Material investigations for road construction have been carried out to identify the potential source of construction materials and to assess their general availability, nature and quantum of materials available for the project. This is one of the most important factors for stable, economic and successful implementation of the project within the stipulated time frame. The investigation and testing of materials is carried out in accordance with MoRT&H, IS and IRC specifications.

Objectives:

The investigation into these material sources was carried out with the following basic objectives.

- Material investigation was carried out based on information collected from local PWD, Panchayat office, Zilla parishad office and from material suppliers along with public enquiry.
- Investigations have been carried out to identify and assess potential sources for bulk procurement of the following materials.
- Embankment fill material.
- Gravel for sub-grade
- Natural Gravel for GSB, if any
- Stone quarry for aggregate to be used for bituminous & non bituminous layers and GSB in case of non-availability of natural GSB

- Sand to be used for Cement Concrete
- Demarcating the location of source indicating place, kilometer stone and lead distance from the project road and the status whether it is in operation or new source.
- Identify the ownership of land/quarry, (Government or Private).
- Testing of materials to indicate the quality, classification and suitability of materials.
- To assess probable use of materials at various stages of construction activities, i.e. embankment fill, sub-grade, sub-base, wearing course and structures.
- During the process of investigation, due consideration has been given such that no material shall be selected from the right of way, at the same time locally available materials were selected for reducing the cost of construction.

4.8.2 Material Testing

The samples from various identified sources have been collected for laboratory testing as per IS & AASHTO standards.

(i) Interpretation of Test Results

The test results of soil samples have been presented as per IS:1498-1959. In addition to the tests already mentioned, soil samples to be used for sub-grade purpose shall be tested for soaked CBR in the laboratory on remoulded specimen compacted to 97 per cent Modified Proctor Density at Optimum Moisture Content. For this purpose, three individual specimens are subjected to different blows (10, 30 and 65) and CBR for each of the soaked specimen is determined. Actual CBR value corresponds to 97% of MDD is determined from a graph plotted between CBR and corresponding dry density.

The following tests have been performed on stone aggregate collected from various quarries:

Aggregate Impact Value

Specific Gravity

Water Absorption

Granular sub-base materials have been tested for its grading and Atterberg Limits. In addition, a soaked CBR test has been carried out following the standard procedure at 98% of modified Proctor Density. The sub-base material could be either natural granular material available in the quarries/borrow areas or shall be designed using crushed aggregates to meet the specific requirements of sub-base material as per MoRT&H specifications. The LL and PI of such material shall not be more than 25% and 6% respectively and soaked CBR value shall not be less than 30%.

For proper identification, index map and quarry charts, showing the following details will accompany the tables: Approximate Quantities and type of material available from each quarry source.

Location of each quarry and the distance up to the nearest link point of the Project Highway. The coarse aggregate for Wet Mix Macadam Sub-Base/Base shall be crushed stone

and confirm to MOSRT&H specification. Potential quarries have been identified in consultation with Forest dept/Mining dept. and shown in quarry charts. In case crushed gravel/shingle has to be used for advantage of availability and economy, not less than 90 percent by weight of the gravel/shingle pieces retained on 4.75mm sieve shall have at least two fractured faces.

4.8.3 Methodology for Conducting Sub-Soil Investigations

Geo-technical investigations are carried out with a view to furnish the Detailed Technical Information of the nature of sub-soil strata for foundation design and assessment of stability of high embankments.

4.8.4 Objectives and Scope of Work

The objectives of Geo-Technical Investigation are to evaluate the following:

1. To ascertain the sub-soil strata at structure locations.
2. To study standing Ground Water Level.
3. To study the physical and engineering properties of soil strata.
4. To evaluate allowable safe bearing capacity of soils to design foundations.
5. To recommend type and depth of foundation.
6. To recommend improvements to the weak soil strata if any.
7. To evaluate the stability of high embankment.
8. The Scope of Geo-technical Investigations includes the following field and Laboratory Tests.

a. Field Investigations

i. The scope of Field investigations is as follows:
ii. Boring of 150-mm dia holes in all kinds of soils up to refusal strata (N>100 Blows for 30 cms penetration) using Auger equipment.
iii. Boring of 150-mm dia Boreholes in all kinds of soils in Hard Rock whichever
iv. Encounter early using Calyx operated Rotary Boring Rig with Wash Boring Method.
v. Collecting Disturbed / Representative samples (DS / RS) during drilling and also
vi. During SPT Tests. Disturbed samples using the split spoon sampler and UDS samples using 100 mm thin-walled Shelby tubes shall be collected. The samples recovered will be packed in polythene bags, labelled and sent to the laboratory for testing.
vii. During field investigations, the standing Water Table levels will be studied and recorded in the Borehole log.

b. Laboratory Testing

i. The scope of Laboratory Testing is as follows:
ii. For Samples Obtained from SPT
iii. Grain Size Analysis as per IS 2720 part 4.
iv. For samples Obtained from UDS tube:
v. Specific Gravity as per IS 2720- part 3-Section 1 and IS 2720 – part 3
vi. Grain Size Analysis as per IS 2720 part 4

vii. Atterberg Limits as per IS 2720 part 5, IS 2720 part 2.
viii. Determination of natural moisture content as per IS 2720 part 2.
ix. Determination of natural density as per IS 2720
x. Determination of Tri-axial Shear Strength tests by UU and CU method as per IS 2720-part 10
xi. For samples Obtained from Rock Cores:
xii. Determination of Specific Gravity and Water Absorption of Rock Core Samples.
xiii. Determination of Unit Weight and Classification of Rock Core Samples.
xiv. Determination of Unconfined Compressive Strength of Rock Core Samples.

4.8.5 Contents of Geo-Technical Report

The report shall include in brief, the following contents:

1. The test procedure employed.
2. The sample calculation with reference to formula used to evaluate various parameters.
3. Summary of various soil parameters evaluated.
4. Type and character of soil.
5. Procedure of Investigation
6. Detailed bore logs, sub-soil strata, laboratory and field-test results.
7. Results obtained and their interpretation.
8. Recommendation for type and depth of formulation. Safe bearing capacity and settlement of the foundations adopted.
9. All recommendations shall be supported by a set of sample and back up calculations.
10. Any other information of special significance encountered during investigations shall be brought out in the Geo – Technical report.

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5. SOCIAL ECONOMIC PROFILE OF THE PROJECT AREA

5.1 General

Generally, the area which contributes to the total traffic plying on the road is called the project Influenced Area (PIA). PIA is further classified into a broad and immediate influence area depending on its proximity to the project corridor. The immediate influence area for the current study comprises of Cachar, Hailakandi and Karimganj districts in Assam state.

The districts through which the project road passes are the primary project influence area. The Assam state highways facilitate the most important traffic movement for the various important towns of the state. Therefore, the influence area of the project corridor, for the purpose of socio economic study is considered with prime importance. The primary purpose of Socio-economic analysis is to provide an overview of the state's socio-economic setup and the relative status of the project influence area within the state. Data to be considered include demographic aspects, macroeconomic indicators and sectoral production of agriculture and allied activities, manufacturing, mining and service sectors including infrastructure. The profile provides the present scenario, the past performance and the prospective growth of the economy, population and urbanization. The profile depicts the spatial distribution of economic activities and provides basic inputs for estimating future growth in transport demand, on the basis of prospective economic growth rates and transport demand elasticity. Secondary data available with different state government departments have been collected and analyzed for preparation of socio-economic profile.

5.2 Assam State at a Glance

The state Assam is situated in the North-East India, which is the land of hills, valleys, mighty river Brahmaputra and land of Mother Goddess Kamakhya. The state Assam is sharing her border with 7 states like Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and West Bengal.

Assam is predominantly a rural based state, almost 86 per cent of its population still living in rural areas. The socio-economic position among the people in rural areas is very pathetic compared to urban area & all India figures. Rural poverty is more than twice that of urban poverty. The population growth in Assam also implied that there has hardly been any reduction in the absolute number of the poor over the years. As per census of India 2011, the state of Assam with an area of 78438 sq. Km. accounts for about 2.39% of the total geographical area of the country. It has a population of 31.20 million, which accounts for 2.58% of the population of the country. The adverse land-man ratio is 398 per sq. km. The decadal growth of population for 2001-2011 is 17.07%. According to 2011 census, the literacy rate in the state is 72.19% in which male literacy is 77.85% with respect to the male population and female literacy is 66.27% with respect to the female population, creating a gender gap of 11.58%. The Scheduled Caste

population comprises 7.15% whereas tribal population constitutes a mere 12.45% of the total population. About 61.64% of the population of the state is non-working. Therefore, there is a specific need for infrastructure development, so that, economy of the region can go in positive dimension. Some of the salient features of Assam State are listed below.

Table 5-1: Salient features of Assam State

Indicators		Census, 2011
Area (sq. km)		78438
Households (No.)		6406471
Population (No.)		31205576
Male Population		51.08
Female Population		48.92
Urban population		14.10
Rural population		85.90
SC Population		7.15
ST Population		12.45
Population growth rate		17.07
Population density (per sq. km.)		398
Sex Ratio (females+ 1000 males)		958
Total Literate		72.19
Total Male Literate		77.85
Total Female Literate		66.27
Work Participation Rate (WPR)		38.36
WPR (Male)		53.59
WPR (Female)		22.46
Main Workers		27.84
Main workers (Male)		44.13
Main workers (Female)		10.82
Main Workers	Cultivation Ratio	36.13
	Agriculture Ratio	10.40
	Household Ratio	2.79
	Others Ratio	50.69
Marginal workers		10.52
Marginal workers (Male)		9.45
Marginal workers (Female)		11.63
Marginal Workers	Cultivation Ratio	28.12
	Agriculture Ratio	28.70
	Household Ratio	7.59
	Others Ratio	35.59
Non-Workers		61.64
Male Non-workers		46.41
Female Non-workers		77.54

Source: Census of India, 2011

5.2.1 Economy

The economy of Assam is largely agriculture based with 69% of the population engaged in it. The state is a major producer of rice, tea, jute, sugarcane, and oilseeds. Assam is also a major producer of crude oil and natural gas.

The state's gross state domestic product (GSDP) for 2022-23 is estimated to be ₹5.67 lakh crore (US$71 billion), with a growth rate of 9.1%. The per capita income of Assam is ₹1.15 lakh crore (US$14 billion), which is lower than the national average.

The key sectors of the Assam economy are:

- Agriculture: Agriculture is the largest sector of the Assam economy, contributing about 18% to the GSDP. The state is a major producer of rice, tea, jute, sugarcane, and oilseeds.
- Industry: The industrial sector contributes about 27% to the GSDP. The major industries in Assam are oil and gas, tea, food processing, and textiles.
- Services: The services sector contributes about 55% to the GSDP. The major services in Assam are tourism, trade, and transport.

The Assam government has taken a number of initiatives to boost the state's economy, including:

- ReSTART Assam: This is a flagship program of the Assam government that aims to promote industrial growth and create jobs. The program provides incentives to new and existing industries, such as tax breaks, land subsidies, and financial assistance.
- Assam Ease of Doing Business Bill:* This bill was passed in 2020 and aims to simplify the process of setting up and doing business in Assam. The bill reduces the number of clearances required for setting up a business and streamlines the approval process.
- Assam Industrial Development Corporation (AIDC): The AIDC is a government agency that promotes industrial growth in Assam. The AIDC provides a range of services to entrepreneurs, such as land acquisition, infrastructure development, and financial assistance.
- Assam Skill University: This University was established in 2016 to provide skill training to the youth of Assam. The university offers a range of courses in various sectors, such as manufacturing, hospitality, and healthcare.
- Assam Tourist Development Corporation (ATDC): The ATDC is a government agency that promotes tourism in Assam. The ATDC develops and maintains tourist infrastructure, such as hotels, resorts, and tourist attractions.

In addition to these initiatives, the Assam government is also investing heavily in infrastructure development, such as roads, railways, and airports. This is expected to improve connectivity and boost economic growth.

5.2.2 Transportation

There are 20.15 Lakhs Motor Vehicles registered in the State as on 30.03.2015, of which 18.58 Lakhs are non-transport vehicles used for personalized purposes and 1.57 Lakhs Transport Vehicles. Out of 18.58 Lakhs Non-Transport Vehicles, 13.06 Lakhs are Motorcycles which constitute 65.79%, Four wheelers (jeeps and motor cars) are 3.76 Lakhs which constitute 19.68%, and 1.76 Lakhs are other vehicles i.e. Tractors, Trailers road rollers, rig mounted, construction equipment ,Fire tenders and others of the Non-Transport segment.

Assam State Transport Corporation was constituted under Road Transport Corporation Act 1950 with effect from 31st March 1970. Before christened as a Corporation, it was a wing of Transport Department of Government of Assam. It came to effect from 16th January 1948 as “Road Transport, Assam” under Home Department. In the early part of 1950, it was transferred to the Transport Department of Government of Assam. It continued as such till it became a Corporation with effect from 31st March 1970. At the time of inception it began with only two buses running between Nagaon and Guwahati for a distance of 123 kms. Since then it has gone through many ups and downs to reach the present vibrant stage.

Now, there are 135 stations and three Inter State Bus Terminals across the state with a fleet of more than 1100 buses with another fleet of more than 1200 Private Owned Buses operated under banner of ASTC ASTC is now the lifeline of Transport Connectivity of the state as it operates buses even in the rural areas besides operation on highways and city roads. ASTC has 10 traffic divisions across the state. These are - Tinsukia Division, Nagaon Division, Silchar Division, Jorhat Division, Sivasagar Division, Bongaigaon Division, Lakhimpur Division, Tezpur Division, Greater Guwahati Region City Service Division and ISBT-Guwahati Division.

5.2.3 Agriculture

Agriculture is the backbone of the Assam economy, with over 70% of the population engaged in agriculture. The sector contributes about 22% to the state's GDP and employs over 60% of the workforce. The major agricultural crops grown in Assam include rice, tea, jute, sugarcane, pulses, oilseeds, vegetables, and fruits. Rice is the most important crop, accounting for over 60% of the cultivated area. Assam is also one of the largest producers of tea in the world.

Here are some specific examples of how agriculture is contributing to state growth in Assam:

- In 2022-23, Assam produced over 60 million tonnes of rice, making it one of the largest rice producers in India. Rice is a major export crop for Assam, and the state earned over ₹1,000 crore in revenue from rice exports in 2022-23.

- Agriculture plays an important role in rural development and poverty alleviation in Assam. The government of Assam has launched a number of schemes to support farmers, such as the Assam Krishi Bhumi Yojana and the Assam Krishi Sahay Yojana. These schemes have helped to increase agricultural productivity and improve the livelihoods of farmers in Assam.

5.2.4 Industry

The industrial sector plays a significant role in the growth of the Assam economy. It contributes to the state's GDP, generates employment, and attracts investment.

Some of the major industries in Assam include:

Assam is the world's largest producer of tea, and the tea industry is a major contributor to the state's economy. The industry employs over 1 million people and contributes over 10% to the state's GDP. It is also a major producer of oil and gas, and the oil and gas industry is a major employer in the state. The industry employs over 50,000 people and contributes over 15% to the state's GDP.

In addition to these major industries, Assam also has a number of other industries, including small-scale industries, cottage industries, and handicraft industries. These industries employ a large number of people and contribute to the state's economy.

Here are some specific examples of how the industrial sector is contributing to state growth:

- The tea industry is a major source of revenue for the state government. In 2022-23, the state government earned over ₹1,000 crore in revenue from the tea industry.
- The oil and gas industry is a major source of employment in the state. In 2022-23, the oil and gas industry employed over 50,000 people in Assam.
- The petrochemical industry is attracting significant investment to the state. In 2022-23, the state government approved an investment of over ₹1,000 crore in the petrochemical industry.
- The food processing industry is helping to reduce food wastage and create value-added products. In 2022-23, the state government launched a food processing park to support the growth of the industry.
- The textile industry is helping to revive the traditional textile crafts of Assam. In 2022-23, the state government launched a scheme to provide financial assistance to textile weavers.

Overall, the industrial sector is playing a significant role in the growth of the Assam economy. It is contributing to the state's GDP, generating employment, and attracting investment. The

government of Assam is committed to promoting the growth of the industrial sector and has introduced a number of policies and incentives to attract investment.

5.2.5 Mines & Geology

Mines and geology play a significant role in the growth of the Assam economy. The state is rich in mineral resources, including coal, limestone, iron ore, and petroleum. Coal is the most important mineral produced in Assam, and the state ranks fourth in India in coal production. Limestone is the second most important mineral produced in Assam, and the state ranks seventh in India in limestone production. Iron ore is also produced in Assam, and the state ranks tenth in India in iron ore production. Petroleum is also produced in Assam, and the state ranks sixth in India in petroleum production.

The mining and geology sector contributes to the Assam economy in a number of ways:

- Revenue generation: The state government earns revenue from the mining of minerals. In 2022-23, the state government earned over ₹1,000 crore in revenue from the mining sector.
- Employment generation: The mining and geology sector employs a large number of people in Assam. In 2022-23, the mining and geology sector employed over 50,000 people in the state.
- Industrial development: The mining sector provides raw materials for a number of industries in Assam, including the power industry, the cement industry, and the steel industry. The growth of these industries is helping to drive economic growth in the state.
- Export earnings: Assam exports a number of minerals, including coal, limestone, and iron ore. In 2022-23, Assam exported over ₹500 crore worth of minerals.

5.2.6 Forest

Assam is one of the most forest-rich states in India, with over 30% of its land area under forest cover. The forests of Assam play a vital role in the state's economy and environment.

Contribution of forests to the state growth of Assam:

- Economic contribution:* The forests of Assam provide a livelihood for millions of people. They provide a source of income from the collection of non-timber forest products (NTFPs), such as bamboo, cane, medicinal plants, and honey. The forests also provide jobs in the timber industry, tourism industry, and wildlife conservation sector.
- Environmental contribution:* The forests of Assam play an important role in regulating the climate, protecting soil and water resources, and providing a habitat for wildlife. They also help to reduce air pollution and mitigate the effects of climate change.

Specific examples of how the forests of Assam are contributing to state growth:*

- The NTFP sector is a major source of income for rural communities in Assam. In 2022-23, the NTFP sector generated over ₹1,000 crore in revenue for the state.
- The timber industry employs over 10,000 people in Assam. In 2022-23, the timber industry contributed over ₹500 crore to the state's GDP.
- The tourism industry is another major beneficiary of the forests of Assam. In 2022-23, over 5 million tourists visited Kaziranga National Park, Manas National Park, and Dibru-Saikhowa National Park. These three national parks are home to a variety of wildlife, including tigers, elephants, and rhinos.
- The wildlife conservation sector also employs a large number of people in Assam. In 2022-23, the state government spent over ₹100 crore on wildlife conservation.

5.2.7 Rivers

Assam is a land of rivers, with over 270 rivers flowing through the state. The Brahmaputra River is the largest and most important river in Assam, and it plays a vital role in the state's economy and environment. Other important rivers in Assam include the Barak River, the Dhansiri River, and the Manas River. The Brahmaputra River has a total catchment area of over 900,000 square kilometers, of which over 100,000 square kilometers is in Assam. The Barak River has a catchment area of over 120,000 square kilometers, of which over 40,000 square kilometers is in Assam. The Dhansiri River has a catchment area of over 20,000 square kilometers, and the Manas River has a catchment area of over 10,000 square kilometers.

- The Brahmaputra River is used to irrigate over 50% of the cultivated land in Assam. This has helped to make Assam the world's largest producer of tea. The Barak River is used to generate hydroelectric power at the Jiribam Hydroelectric Power Plant. This power plant has a capacity of 120 MW, and it meets a significant portion of the state's energy needs.
- The Dhansiri River is home to the endangered Golden Mahseer, which is a popular fish among anglers. Angling tourism is a growing industry in Assam, and it is generating revenue for the state government and local communities.
- The Manas River is home to a variety of aquatic life, including the endangered River Dolphin. The Manas National Park, which is located along the banks of the Manas River, is a UNESCO World Heritage Site and a popular tourist destination.

5.2.8 Tourism

Tourism is a major industry in Assam, and the state attracts a large number of tourists from both India and abroad. The state is home to a variety of tourist attractions, including:

Wildlife: Assam is home to a variety of wildlife, including tigers, elephants, rhinos, and dolphins. Tourists can go on safaris in Kaziranga National Park, Manas National Park, and Dibru-Saikhowa National Park to see these animals.

Culture: Assam has a rich culture and heritage. Tourists can visit the Kamakhya Temple, the Umananda Temple, and the Ahom Buranjis to learn about the state's cultural heritage.

Natural beauty: Assam is known for its natural beauty. Tourists can visit the Majuli Island, the Sualkuchi River, and the Dipor Bil to enjoy the state's scenic beauty.

Assam is also a popular destination for adventure tourism. Tourists can go on trekking, rafting, and kayaking expeditions in the state.

5.3 Profile of Project Influenced Districts

The project road (Section-I, Section-II and Section-III) runs entirely through the districts of Cachar, Hailakandi and Karimganj in the state of Assam. The project road (section-I) mostly carries an inter-state traffic, the project road (section-II) mostly carries a mix of intra-state and inter-state traffic from the adjacent state Tripura. While section-III carries commercial vehicles traffic from adjacent country Bangladesh. The demographics and economic features of project districts are briefly explained below:

5.3.1 Karimganj District

Karimganj is a South West district of Assam which has been carved out of the erstwhile Cachar district in the year 1983. The district is bounded on north by the district of Cachar and Bangladesh, on the west by Bangladesh and Tripura, on the east Hailakandi district and on the south by Tripura and Mizoram. The district is situated between longitude 91° 15' and 93°15' east latitude 24°8' and 25°8' north and covers an area of 1809 km out of the state total areas of 78438 km. The district is comprised of 936 villages with 7 Community Development Blocks. The district possesses 5 Revenue Circles namely, Karimganj, Badarpur, Nilambazar, Patharkandi and Ramkrishna Nagar. There is one Sub-Division namely Karimganj. The district area is divided among 7 Police Stations, namely Karimganj,Badarpur, Patharkandi, Ramakrishana Nagar, Ratabari, Nilambazar and Bazerichera.

Table 5-2 Salient features of Karimganj District

Indicators	Census, 2011
Area (sq. km)	1809
Households (No.)	247714
Population (No.)	1228686
Male Population	50.94
Female Population	49.06
Child Population 0-6	17.25
Male Population 0-6	17.20

Indicators		Census, 2011
Female Population 0-6		17.31
Urban population		8.93
Rural population		91.07
SC Population		12.85
ST Population		0.16
Population growth rate		21.90
Population density (per sq. km.)		679
Sex Ratio (females+ 1000 males)		963
Total Literate		78.22
Total Male Literate		84.12
Total Female Literate		72.09
Work Participation Rate (WPR)		32.49
WPR (Male)		51.10
WPR (Female)		13.17
Main Workers		23.88
Main workers (Male)		40.94
Main workers (Female)		6.16
Main Workers Distribution	Cultivation Ratio	27.30
	Agriculture Ratio	12.48
	Household Ratio	2.79
	Others Ratio	57.43
Marginal workers		8.61
Marginal workers (Male)		10.16
Marginal workers (Female)		7.00
Marginal Workers Distribution	Cultivation Ratio	13.48
	Agriculture Ratio	28.75
	Household Ratio	8.75
	Others Ratio	49.02
Non-Workers Ratio		67.51
Male Non-Workers		48.90
Female Non-Workers		86.83

Source: Census of India, 2011

5.3.1.1 Agriculture

Assam is predominantly an agricultural state. More than 70% of the people of Assam depend on agriculture. In Karimganj, people more particularly in rural areas depend on agriculture. Thus, agriculture is the main stay of the rural economy of the district.

The staple food of this district is rice. The other important crops are mustard, pulse and wheat. Jute is largely grown in higher fields which is an important production of the district. The Joha, Boradhan, Ahu, Boudhan etc. are grown in the district. Wheat is also grown as rabi crop. Mustard is often grown along with Ahu rice.

Cereals (autumn paddy, winter paddy, summer paddy, wheat) were sown in 74441 hectare.

Miscellaneous (matikalai, jute, rape and mustard, potato and sugarcane) were sown in 2914 hectare.

5.3.1.2 Animal Husbandry

Plenty of livestock are found in Karimganj district. Cattles and goats are the main animals for most of the households of the district. People generally graze their domestic animals on the rice fields after harvest of crops. In the night, the animals are kept in sheds by the owners and give them paddy for food which is kept in stock in the courtyard. Besides, there are village grazing reserves where the villagers can graze their animals.

5.3.1.3 Fisheries

Pisciculture is becoming popular among all sections of the people irrespective of caste and creed. Fisheries in Assam are of various types. These are beel, river, swamp, forest derelict and semi derelict and pond and tank fisheries. There are altogether 37 beels covering area 3459 Hect in the district of which 27 are registered and the rest are unregistered. The district has 9 registered river fisheries. In the district, the fish seed production in 2011-2012 was achieved 1021 million nos. and fish production was achieved 14304 tonnes in the same period as recorded in Statistical Handbook Assam, 2012.

5.3.1.4 Industry

Karimganj district is one of the industrially backward district of Assam. There is not a single major public sector industry located in the district, except the age old tea industry. The existing industries can be classified mainly into (I) food and kindred products (II) forest products (III) manufacturing excluding transport equipment and (IV) Cotton textile. Karimganj has a number of factories engaged in manufacture of food products. There are few rice mills in the district. There is a Veeneer mill at Durlavcharra. There are few tea gardens with their factories for processing. They provide employment for the people from outside the district as well as the local people. There are 22 MSME registered units in the district.

5.3.1.5 Demographic Profile

The district of Karimganj with an area of 1809 sq. Km. accounts for about 2.31% of the total geographical area of the state. It has a population of 1.22 million, which accounts for 2.31% of the population of the state. The adverse land-man ratio is reflected in the high density of population, whereas low density with comparison to the state, which is 679 per sq. km. The decadal growth of population for 2001-2011 is 21.90%. According to 2011 census, the literacy rate in the district is 78.22% in which male literacy is 84.12% with respect to the male population and female literacy is 72.09% with respect to the female population, creating a gender gap of 12.03%. The Scheduled Caste population comprises 12.85% whereas tribal population constitutes a mere 0.16% of the total population.

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6. INDICATIVE DESIGN STANDARDS

6.1 GENERAL

Geometric Design of the Highway shall be in accordance with four lane manual IRC-SP 84-2019. Uniformity of design standards will be maintained throughout the length of the project highway. All deficiencies in the existing Highway Geometry will be rectified to meet the minimum standards.

6.1.1 General Cross-Sectional Requirements

The design of cross section of the upgradation of existing two-lane highway to four-lane highway will consider the following general requirements.

The developed cross sections for the carriageway as well as the service road will have operational safety in focus such as segregation, separation, turning radii, gradients etc. and provisions for various types of movements and maneuvers like merge, diverge, weave etc. will be comprehensively considered and provided for.

Provisions will be made in the cross-section for accommodating utilities both over as well as underground. A 2.0 m wide strip of land at the extreme edge of ROW may be kept for accommodating utility services. Provisions contained in IRC: 98-1997 will be followed to accommodate utility services for Project Highway in built up areas.

As far as possible, uniformity of design standards will be maintained throughout the length of the Project Highway. In case of any change, it shall be affected in a gradual manner.

6.1.2 Design Speed

The Design speed given in Table below will be adopted for this project stretch. (The general slope of the ground classifies Terrain across the project Highway)

Table 6-1: Design Speed

Nature of Terrain	Cross Slope of the Ground	Design Speed (Kmph)	
		Ruling	Minimum
Plain & Rolling	Up to 25%	100	80
Mountainous and Steep	More than 25%	60	40

Short stretches (say less than 1 km) of varying terrain in the project stretch will not be taken into consideration while deciding the terrain classification for a given section of Project Highway. In general, the ruling design speed will be adopted for geometric design of the highway. Only in exceptional circumstances, minimum design speed may be adopted where site conditions are extremely restrictive and adequate land width is not available. Abrupt changes in design speed will be avoided.

6.1.3 Right of Way

A minimum Right of Way (ROW) of 45m is required throughout the project length, except at underpass with slip roads in rural sections where ROW will be 55m/60m.

6.1.4 Lane Width of Carriageway

The standard lane width of the project highway shall be 3.50m.

6.1.5 Median

The median shall be either raised or depressed. The width of median is the distance between inner edges of carriageway. The type of median shall depend upon availability of ROW. The minimum width of median, subject to availability of ROW for various locations, shall be as mentioned below.

Table 6-2: Width of Median

Minimum width of Median (m)			
Type of Section	Plain and Rolling Terrain		Mountainous and Steep Terrain
	Raised*	Depressed median (m)	Raised*
Open Country withisolated built-up area	5.0	7.0	2.5
Built-up area	2.5	Not Applicable	2.5
Approach to grade separatedstructures	5.0	Not Applicable	2.5

*Including Kerb shyness of 0.5m on either side. In existing Four to Six lane reaches also minimum kerb shyness of 0.5m shall be maintained.

- The median will have a suitably designed drainage system so that water does not stagnate in the median.
- All median drains will be of RCC type. In case of depressed median, a minimum 0.6 m width adjacent to carriageway in either direction is paved.
- As far as possible, the median will be of uniform width in a particular section of the Project Highway. However, where changes are unavoidable, a transition of 1 in 50 will be provided.
- In the case of depressed median, metal beam type, (thrie beam-one side) crash barriers will be provided on either side of the median.
- Suitable anti-glare measures such as plastic screens shall be provided to reduce headlight glare from opposite traffic.

6.1.6 Width of Shoulder

The shoulder width on either side of the carriageway is given below:

Table 6-3: Width of Shoulder (IRC SP 84-2019)

Type of Section	Width of Shoulder (m)								
	Plain and Rolling Terrain (Either Side)			Mountainous and Steep Terrain					
				Hill Side			Valley Side		
	Paved	Earthen	Total	Paved	Earthen	Total	Paved	Earthen	Total
Open Country with isolated built-up area	1.5	2.0	3.5	1.5	-	1.5	1.5	1.0	2.5
Built up area	2.0	-	2.0	0.25 + 1.5 (Raised)	-	1.75	0.25 + 1.5 (Raised)	-	1.75
Approaches to Grade separated structures	2.0	-	2.0						
Approaches to bridges	1.5	2.0	3.5						

Note: As per circular (NHAI/Bharatmala/EC/DPR/2016/143430) Manual for 4 laning and 6 laning 2019 version has been published recently wherein there are substantial changes in the design of highways. The same shall be adopted for the design of Highways except the width of paved & earthen shoulders. The width of the width of paved & earthen shoulders shall be adopted as per earlier 4 lane manual (IRC: SP-84, 2014).

Complying with above circular, width of paved and earthen shoulder proposed as per IRC SP 84-2014 for the project road.

6.1.7 Roadway Width

The width of roadway will depend upon the width of carriageway, shoulders and the median. On horizontal curves with radius up to 300m, width of pavement and roadway will be increased as given below:

Table 6-4: Extra width of Pavement and Roadway in Each Carriageway

Radius of Curve (m)	Extra Width (m)
75 – 100	0.9
101 – 300	0.6

6.1.8 Cross-Fall

- The camber or cross fall on straight sections of road carriageway and paved shoulders will be 2.5% for bituminous surface and 2% for CC pavement.
- Cross fall will be unidirectional for each carriageway sloping towards the outer edge in straight stretches and towards lower edge on horizontal curves.
- The cross fall for earthen shoulder is 0.5% steeper than that of the carriageway subject to a minimum of 3.0%. On super elevated sections, earthen portion of the shoulder on outer edge of the curve will be provided with reverse cross fall of 0.5% so that earth does not drain on the carriageway.

6.2 GEOMETRIC DESIGN

Geometric design of the highway will be in accordance with IRC: 73-1980, IRC: 38-1988 and IRC SP: 23-1983. Uniformity of design standards will be maintained throughout the length of Project Highway. All deficiencies in the existing highway geometry will be rectified to meet the minimum standards.

6.2.1 Super Elevation

Super Elevation will be limited to 7 percent, if radius of curve is less than desirable minimum radius. It will be limited to 5 percent, if radius is more than desirable minimum.

6.2.2 Radii of Horizontal Curves

The minimum and absolute minimum radii of horizontal curves for various classes of terrain are given below:

Table 6-5: Minimum Radii of Horizontal Curves

Nature of Terrain	Desirable Minimum (m)	Absolute Minimum (m)
Plain and Rolling	400	250
Mountainous and Steep	150	75

6.2.3 Sight Distance

The safe stopping sight distance and desirable minimum sight distance for divided carriageway for various design speeds are tabulated below. A minimum of safe stopping sight distance will be adopted for the improvement of the existing carriageway.

Table 6-6: Safe Sight Distance

Design Speed (km/hr.)	Safe Stopping sight distance (m)	Desirable minimum sight distance (m)
100	180	360
80	130	260
60	90	180
40	45	90

6.3 VERTICAL ALIGNMENT

The vertical alignment will provide for a smooth longitudinal profile. Grade changes shall not be too frequent as to cause kinks and visual discontinuities in the profile. In this regard, directions given in IRC: 73 shall be kept in view.

6.3.1 Gradients

The ruling and limiting gradients are tabulated below. Ruling Gradient shall be adopted as far as possible. Limiting Gradient shall be adopted in difficult situations, and for short lengths.

Table 6-7: Gradients

Nature of Terrain	Ruling Gradient	Limiting Gradient
Plain and Rolling	2.5%	3.3%
Mountainous	5.0%	6.0%
Steep	6.0%	7.0%

- Long sweeping vertical curves will be provided at all grade changes. These will be designed as square parabolas.
- Design of vertical curves and their coordination with horizontal curves, will be in accordance with the IRC: SP:23-1983

6.3.2 Lateral and Vertical Clearances at Underpasses

6.3.2.1 General

- In case of VUP/LVUP/SVUP, the proposed structure base shall be kept 150 mm above the ground level to ensure that these VUPs don't become water accumulation points.

- Guard rails/crash barriers shall be provided for protection of vehicles from colliding with the abutments and piers and the deck of the structures.

6.3.2.2 Vertical Clearance and Horizontal Clearance

S. No.	Type of underpass	Vertical clearance	Horizontal clearance
1	Vehicular Underpass (VUP)	5.5m	20m
2	Light Vehicular Underpass (LVUP)	4.0m	12m
3	Smaller Vehicular Underpass (SVUP)	4.0m	7m

6.3.3 Lateral and Vertical Clearances at Overpasses

Wherever any structure is provided over the Project Highway; the minimum clearances at over passes shall be as follows:

6.3.3.1 Lateral Clearance

Full roadway width shall be carried through the overpass structure unless otherwise specified in Schedule 'B'. Provision shall also be made for future widening of the Project Highway to 6-lane with service roads. The abutments and piers shall be provided with suitable protection against collision of vehicles. Crash barriers shall be provided on abutment side and on sides of piers for this purpose. The ends of crash barriers shall be turned away from the line of approaching traffic. The span arrangement for the overpass structure shall be as specified in Schedule 'B'

The acceleration and deceleration lanes and transition length will be considered as incidental to the project and shall not be counted towards service road length.

6.3.3.2 Vertical Clearance

Minimum of 5.5m will be provided at all points of carriageway and the service roads of the Project Highway

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7 TRAFFIC SURVEYS AND ANALYSIS

7.1 GENERAL

To achieve the desired objectives, the Consultant thoroughly studied the road network during the reconnaissance stage. Keeping in view of the requirements of the TOR, the consultants undertook surveys to assess typical traffic, travel, socio-economic and transport characteristics within the influence area of each survey location. The following traffic surveys were conducted:

- Classified traffic volume count surveys were conducted at Four (4) locations for 7-days using ATCC. (Video graphic Method)
- Origin-destination surveys for passengers and commodity movements at Four (4) locations for one-day (24hrs)
- Axle Load Survey at Four (4) locations for one day (24 hours).
- Turning Movement Count at Twelve (12) Major Junction Locations for one day (24 hours)

Locations for carrying out these surveys were selected after considering the following factors:
The locations should cover all the roads from where the traffic is likely to divert to the proposed project corridor.

- The survey location should be outside urban influence.
- The survey location is in a reasonably level terrain with good visibility.
- The location is in a straight section of road and shall facilitate in reducing the speed of vehicles for easy enumeration of data.

Homogeneous sections were identified for carrying out traffic surveys and all locations of traffic surveys are finalized in consultation with the authority. The map of the same is presented in Figure.7-1. The survey schedule is given in Table 7-1

The following key activities were performed before commencement of actual surveys:

- Reconnaissance and an extensive study of existing traffic characteristic were made before finalizing the survey locations.
- Survey formats were prepared keeping in view of guidelines specified in IRC: SP:19-2001
- Necessary permissions were obtained from police personnel of respective districts before commencing the surveys.
- Automatic Traffic Counter and Classifier (ATCC) system was deployed at site to record the mode wise traffic data.
- Trained enumerators were deployed to capture the OD survey data accurately.
- All necessary precautions were exercised during surveys for the safety of enumerators. Enumerators were provided with traffic cones, reflective jackets, electronic gadgets, and accurate measuring equipment(s).

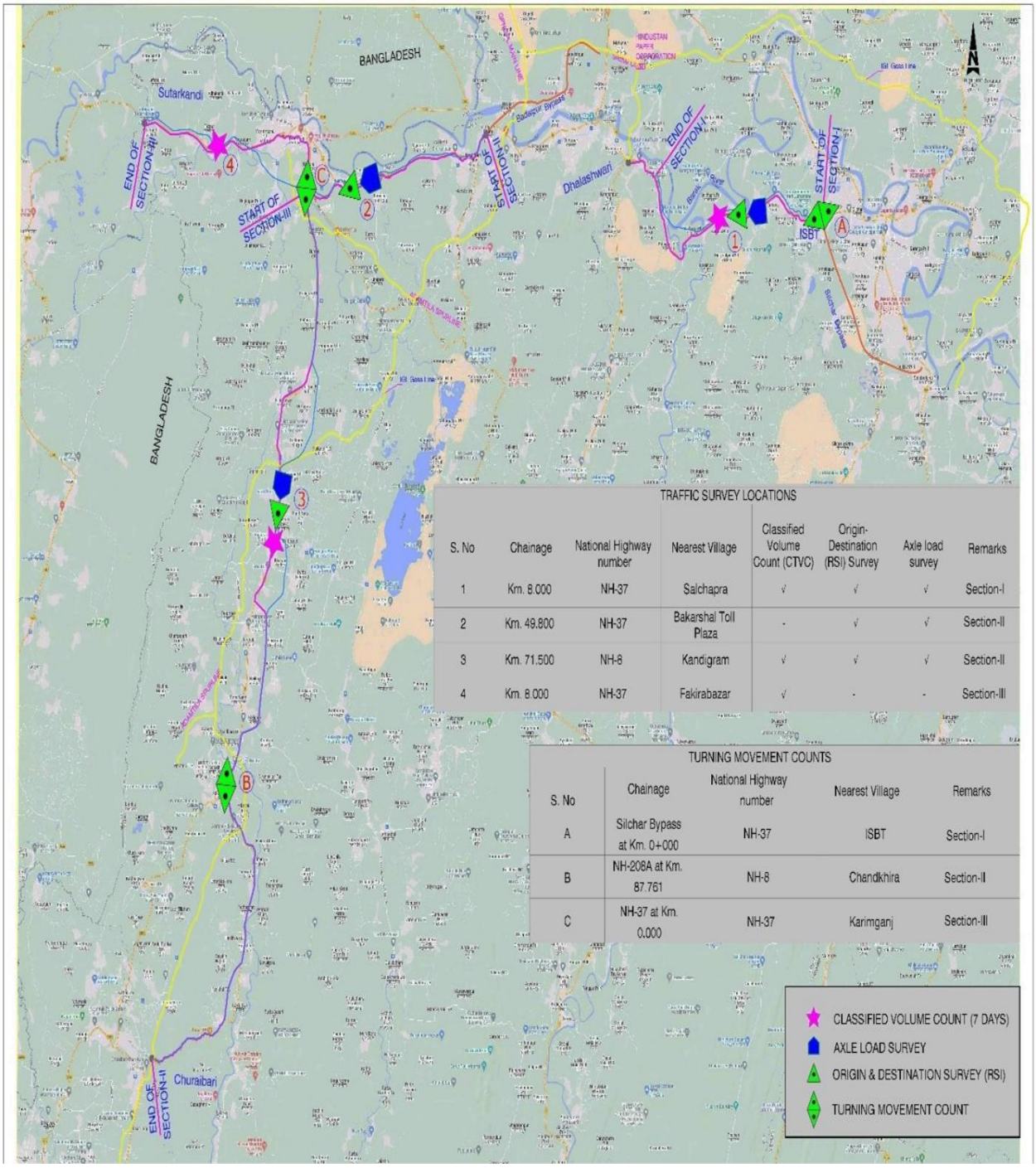


Figure 7-1: Figure Showing Proposed Traffic Survey Locations

7.2 OBJECTIVE

The primary objectives of these traffic studies are to:

- Determine characteristics of traffic movement and to establish base year traffic demand.
- Identify zones of influence for the project stretch and extent of influence based on O-D Survey.
- Determine travel pattern as well as type and weight of commodities carried by goods vehicles.
- Capacity assessment and recommendation for number of lanes based on demand forecast and evolving suitable design.
- Geometric design of intersections
- Determination of Vehicle Damage Factor as an aid to pavement design
- Cost benefit and financial analysis
- Enable preliminary design of the project facilities.

7.3 SCOPE OF THE STUDY

The scope of traffic study includes the analysis of the primary data collected from traffic surveys and collection of secondary sources including petrol sales data, to determine the seasonal variation and truck parking surveys. Vehicle Damage Factor is assessed from the Axle Load Survey to design of pavement layers. To determine the capacity and level of service of the project corridor, the following parameters are assessed:

- Average Daily Traffic, Annual Average Daily Traffic, Peak Hour Factor and Seasonal Correction Factor of the Base Year
- Traffic Growth Rates
- Travel pattern, major origin, and destinations, and influencing zones.
- Axle load survey

7.4 NEED FOR TRAFFIC STUDY

A comprehensive traffic and transportation study for a project corridor involves traffic surveys as an integral component. Appreciation of existing traffic and travel characteristics is extremely important for the development of an effective traffic and transportation plan for the proposed expressway. An accurate estimate of the traffic that is likely to use the project road is very important as it forms the basic input in planning, design, operation, and financing. It provides the basis for determining and justifying the number of traffic lanes to be provided for different road sections having regards to volume, composition and other parameters of traffic.

For existing road networks along the project corridor, traffic analysis provides a means of assessing the traffic conditions. Traffic analysis thus helps further in the evaluation of the investment needed for the future expressway improvements. A thorough knowledge of the travel characteristics of the traffic likely to use the project stretch as well as other major roads

in the influence area of the study corridor is essential for future traffic estimation. The estimation of revenue through toll collection plays a pivotal role in assessing the financial viability of the project and finalizing the financial covenants for the concession agreement. Thus, accurate assessment of the existing traffic and forecasting attains utmost importance.

7.5 OBJECTIVE

The objectives of the current traffic study are listed as under:

- Establish the base year traffic characteristics of existing road networks in and around the project influence area.
- Identify zones of influence for the project stretch and extent of influence based on O-D Survey.
- Determine travel pattern as well as type and weight of commodities carried by goods vehicles.
- Estimate potential traffic diversion from existing road network to project stretch.
- Project the traffic demand on the proposed expressway for a horizon period of 30 years.
- Forecast traffic levels for developing tolling strategies.
- Determine load distribution along proposed expressway and arrive at Vehicle Damage Factors (VDF) to aid in pavement design.
- Benefit-Cost Analysis (BCA) of proposed expressway along with Sensitivity Analysis.

7.6 OUTCOME

The following outcome will be derived from the current report:

- Base year traffic demand of existing road network along the project stretch.
- Traffic forecast along the project stretch considering the generated as well as developmental traffic for a horizon period of 30 years.
- Projected traffic on section-wise breakup of project stretch to provide inputs for tolling strategy.
- Vehicle Damage Factor(s) to provide input for pavement design.
- Justification on provision of 4 lane/ 6 lane carriageway

7.7 METHODOLOGY

Traffic Surveys were carried out strictly as per TOR and within the time frame given for submission. In general, the Specifications and Standards primarily based on the Guidelines for Expressway by Ministry of Road Transport and Highways (MORT&H) have been followed. Specific Codes and Guidelines of the IRC and publications of the MORT&H including circulars & general/special publications, technical Specifications & Standards have been kept in view.

7.7.1 Socio-Economic Profile

Socio-economic profile of the influence area is prepared, after study of data on growth of population and density, human settlement pattern, land use, sub-profiles of agriculture and industries, economic base, trends in socio-economic indicators, development scenarios for various sectors, transport infrastructure and its uses such as use of rail transport etc. The relevant data helpful is collected from the following sources:

- State Statistical Abstracts
- State Year Books
- Census Publications – Districts and State
- Handbooks of Statistics of Districts in the area of influence
- Economic Surveys of the State constituting the zone of influence
- Directorate of Economics & Statistics of Andhra Pradesh

7.8 FLOW CHART OF WORK PLAN

The work plan adopted for the current study is represented in the form of a flow chart as shown below.

7.9 TRAFFIC SURVEYS

To achieve the desired objectives, the Consultant thoroughly studied the road network during the reconnaissance stage. Keeping in view of the requirements of the TOR, the consultants undertook surveys to assess typical traffic, travel, socio-economic and transport characteristics within the influence area of each survey location. The following traffic surveys were conducted:

- The Automatic Classified Traffic Volume Count (ATCC) surveys were conducted at 3 strategic points in 7 days. The surveys were conducted using ATCC(Video graphic) methods.
- Origin-Destination & Commodity Movement Survey by Roadside Interview (RSI) method were conducted at three locations i.e., at Salchapra village on NH-37, at existing toll plaza near Bakarshal on NH-37 and at Nilambazar on NH-8 for 24 hrs.

- Axle load Survey were conducted at three locations i.e., at Salchapra village on NH-37, at existing toll plaza near Bakarshal on NH-37 and at Nilambazar on NH-8 for 24 hrs.
- Locations for carrying out these surveys were selected in consultation with the Authority and based on the following factors:
- Each location being selected near the point from where the possibility of diversion of traffic on the proposed alignment of the expressway is expected.
- The survey location should be outside urban influence.
- The survey location is in a reasonably level terrain with good visibility.
- The location is in a straight section of road and shall facilitate in reducing the speed of vehicles for easy enumeration of data.

Mid-block sections were identified for carrying out traffic surveys and all locations of traffic surveys are finalized in consultation with the Authority. The map of the same is presented in Figure-7.1. The survey schedule is given in Table-7.1.

The following key activities were performed before commencement of actual surveys:

- Reconnaissance and an extensive study of existing traffic characteristics were made before finalizing the survey locations.
- Survey formats were prepared keeping in view of guidelines specified in *IRC:SP:19-2001*
- Necessary permissions were obtained from police personnel of respective districts before commencing the surveys.
- Automatic Traffic Counter and Classifier (ATCC) system was deployed at site to record the mode wise traffic data.
- Trained enumerators were deployed to capture the OD survey data accurately.
- All necessary precautions were exercised during surveys for the safety of enumerators. Enumerators were provided with traffic cones, reflective jackets, electronic gadgets, and accurate measuring equipment(s).

7.10 TRAFFIC SURVEYS PLANNING SCHEDULE

During the reconnaissance survey, the existing road network was studied. As per the details given in TOR traffic locations sections were identified for carrying out traffic surveys and all other locations of traffic surveys were finalized in consultation with the Authority. Traffic Surveys Planning Schedule is presented in Table below:

a) Classified Traffic Volume Count, Axle Load, OD-RSI:

Table 7-1: Traffic Survey Schedule

S. No	Survey Location at	Classified Volume Count (CTVC) – 7 days (24 hours)	Origin-Destination (RSI) Survey-1 day (24 Hours)	Axle load survey-1 day (24 Hours)
1	Bakarshal	-	14/09/2023	14/09/2023

b) Turning Movement Count:

S. No	Cross Road	Survey Location/Village Name	Turning Movement Count	Remarks
1	NH-8 & NH-37 Junction	Bakarshal	14/09/2022	24hrs

Site Photographs

Figure 7-2: Photographs During Traffic Survey

7.11 AVERAGE DAILY TRAFFIC (ADT)

The various vehicle types having different sizes and characteristics were converted into a standard unit called passenger car unit. Passenger Car equivalents for various vehicles are adopted based on recommendations of Indian Road Congress prescribed in “Guidelines for Capacity of Roads in Rural areas”, IRC:64-1990. The passenger car unit values (PCU) which were adopted are presented in Table below. The information derived from the surveys was utilized to obtain traffic intensity, traffic composition, hourly variation and daily variations and peak hour characteristics.

Table 7-2: Passenger Car Unit Factors for various Vehicle Types

S. No	Vehicle Type	PCU factors	S.No.	Vehicle Type		PCU factors
1	Two Wheelers	0.5	12	Two Axle		3.0
2	Three Wheelers	1.0	13	Three Axle		3.0
3	Car / Jeep / Van	1.0	14	Multi Axle		4.5
4	Car (Yellow Board)	1.0	15	Heavy Earth Moving		4.5
5	Tata Magic	1.0	16	LCV/ LGV		1.5
6	RTC Bus	3.0	17	Mini LCV		1.0
7	Private Bus	3.0	18	Tractor		1.5
8	School Bus	3.0	19	Tractor with trailer		4.5
9	College Bus	3.0	20	Non-Motorised	Cycle	0.5
10	Minibus	1.5	21		Cycle Rickshaw	2.0
11	Three-Wheeler (Goods)	1.0	22		Animal Drawn	8.0

Source: IRC:64-1990

The Average Daily Traffic (ADT) is obtained from the Classified Traffic Volume Counts to determine the characteristics of traffic movement and to establish base year traffic demand. The data collected from primary and secondary sources were recorded in worksheets, compiled, checked, and corrected before further proceeding for analysis. Traffic data analysis was carried out, to understand the traffic characteristics and travel pattern in the study area and to provide basic input for pavement design. ADT has been worked out in terms of vehicles per day (VPD) and Passenger Car Units (PCU) by averaging 7 days volume counts. Table below gives the average daily traffic at 3 survey locations based on average of 7 days traffic volume count.

Table 7-3: Average Daily Traffic at Classified Traffic Count Locations

Survey Location No.	1
Name of Location	Near Nilambazar
Two-Wheeler	2045
Three-Wheeler (Passenger)	1823
Car	2270
Car (Y)	109
Tata Magic	16
RTC Bus	75

Survey Location No.		1
Name of Location		Near Nilambazar
Private Bus		86
Minibus		47
School/ College Bus		3
2 Axle		200
3 Axle		94
Multi Axle		494
HEM		3
LCV		367
Mini LCV		499
Tractor		2
Tractor with Trailer		2
Three-Wheeler (Goods)		45
Bicycle		147
Cycle Rickshaw		15
Animal Drawn		1
Government Exempted		17
		8
		5
Others		0
Vehicles	Motorized	8210
	Non-Motorized	163
	Total Traffic	8373
	Tollable Traffic	4263
PCUs	Motorized	10077
	Non-Motorized	112
	Total Traffic	10189
	Tollable Traffic	7128

7.12 SEASONAL VARIATION FACTOR

Monthly sales data from the fuel stations located on the project corridor were collected to estimate the Seasonal Variation Factor (SVF) or Seasonal Correction Factor (SCF). Data collected from fuel stations are found to be with fluctuated and hence adopted average Seasonal Variation Factor are presented in Table below. The SVF was applied to the vehicular traffic volume of ADT to obtain the Annual Average Daily Traffic (AADT) and it was later converted to PCU's. The factor is calculated based on the month of survey conducted, i.e., September 2023, was applied to the ADT to determine the AADT.

Table 7-4: Seasonal Variation Factor

Survey Location No	1
Name of the Location	Near Nilambazar
Petrol driven	1.06
Diesel driven	1.06

7.13 ANNUAL AVERAGE DAILY TRAFFIC (AADT)

The Annual Average Daily Traffic (AADT) at each of the survey location was obtained by multiplying the Average Daily Traffic (ADT) with the Seasonal Correction Factor. The AADT for the year 2023 at survey locations are calculated and tabulated in the below Table below. The AADT values represented in the following table are actual values obtained from the survey.

Table 7-5: Section wise Annual Average Daily Traffic (AADT)

Survey Location No.	1
Name of Location	Near Nilambazar
Two-Wheeler	2168
Three-Wheeler (Passenger)	1932
Car	2406
Car (Y)	116
Tata Magic	17
RTC Bus	80
Private Bus	91

Survey Location No.		1
Name of Location		Near Nilambazar
Minibus		50
School/ College Bus		3
2 Axle		212
3 Axle		100
Multi Axle		524
HEM		3
LCV		389
Mini LCV		529
Tractor		2
Tractor with Trailer		2
Three-Wheeler (Goods)		48
Bicycle		147
Cycle Rickshaw		15
Animal Drawn		1
Government Exempted		18
		8
		5
Others		0
Vehicles	Motorized	8703
	Non-Motorized	163
	Total Traffic	8866
	Tollable Traffic	4519
PCUs	Motorized	10676
	Non-Motorized	112

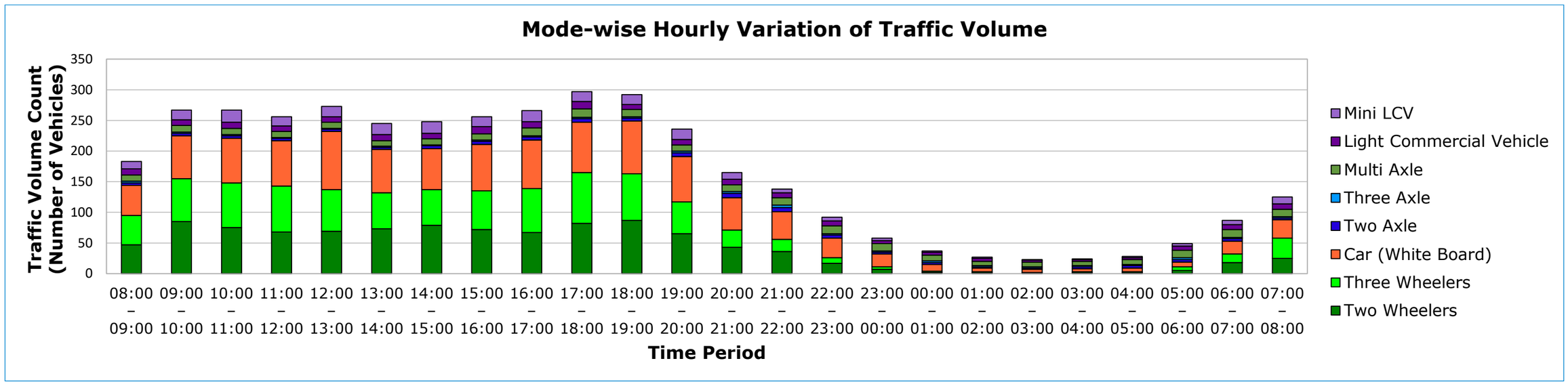
Survey Location No.		1
Name of Location		Near Nilambazar
	Total Traffic	10788
	Tollable Traffic	7552

7.14 PEAK HOUR PROPORTION (PHP)

Peak Hour Proportion is defined as Traffic volume during Peak hour expressed as Percentage of AADT. Peak Hour Traffic is obtained as the highest Hourly traffic volume observed during a typical day (24 hours). Peak Hour proportions of all locations are presented in Table. It is observed that Peak Hour Proportion is in between 6.44 & 8.29.

Table 7-6: Peak Hour Composition

Survey Location	Peak Hour Volume	Total Volume	Peak Hour Composition (%)	Time
1	739	10719	6.89	11:00 – 12:00



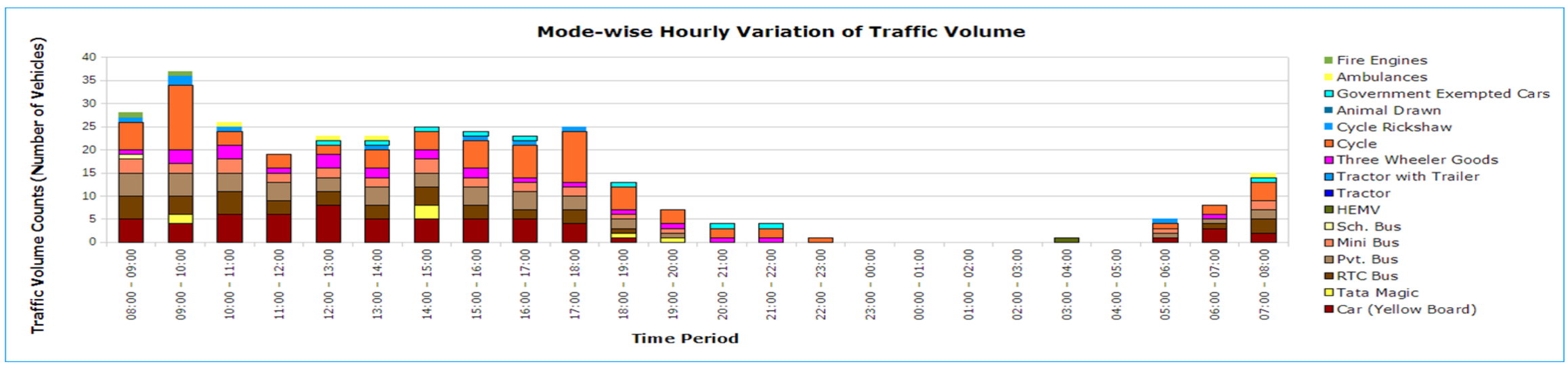


Figure 7-3: Mode-wise Hourly Variation of Traffic Volume at Nilambazar

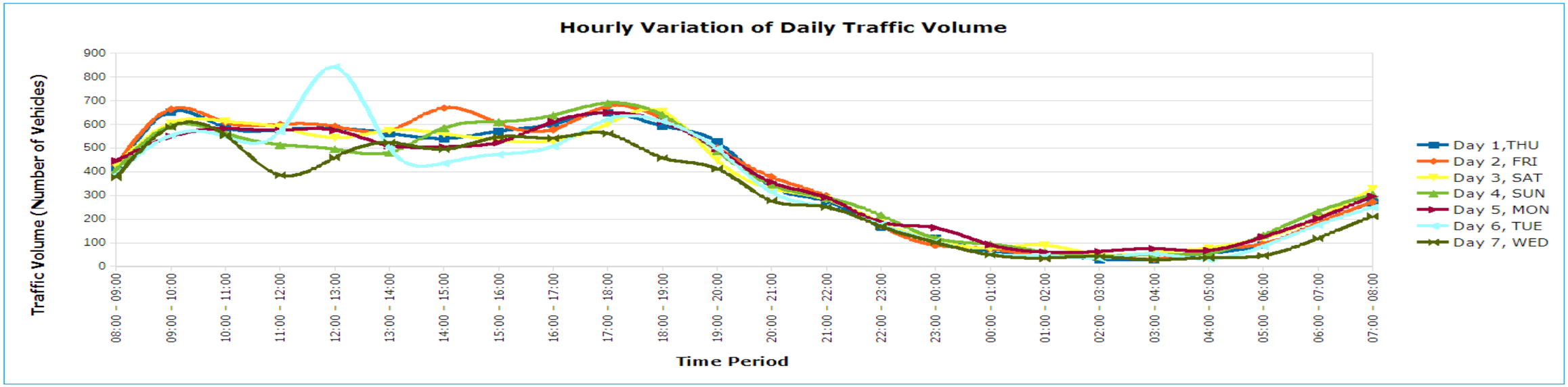


Figure 7-4: Hourly variation of Daily Traffic Volume at Nilambazar

7.15 ORIGIN-DESTINATION AND COMMODITY MOVEMENT SURVEY

The origin – destination survey was carried out at the following locations:

- Location 1: on NH-37 at Km. 222.000 near Bakarshal Toll Plaza

A well-formatted questionnaire was framed containing information regarding origin, destination, distance, purpose and other various details. Separate queries were made for passenger vehicles and goods vehicles. The analysis of daily flow of classified volume counts has been the basis for fixing the sample size of vehicles by type and direction. At all the survey locations, the number of vehicles interviewed are varying around 30% - 50% as sample size. The expansion factors have been worked out based on the average daily volumes to the sample size at each location separately. Sample size collected at each O-D location is shown in Table below.

Table 7-7: Sample Size at each OD Survey Location

Survey Location No	1
Name of the Location	Near Bakarshal Toll Plaza
Car	45%
Bus	25%
LCV	50%
2 Axle	78%
3 Axle	24%
MAV	31%

Commercial and passenger traffic traversing between Silchar – Churaibari - Sutarkandi by using the existing road networks are captured and same has been assigned on to the proposed section.

Traffic assignment is a process of capturing all the possible traffic in the existing corridor of two-lane Sichar-Churaibari-Sutarkandi Highway and same are assigned to proposed corridor. OD data forms basic input for the traffic assignment. Traffic that diverts from Existing corridor from the conventional route is studied in detail between origin and destinations. Accordingly, they are divided into various project influencing zones. Zones of influence are identified in Assam, Tripura, Mizoram, Meghalaya, and Manipur states.

In addition to the through traffic, influence of local traffic was identified by conducting traffic surveys at Major Junctions along the project Corridor. Proper care has been taken such that no vehicle is duplicated or captured twice at any locations.

7.15.1 Zoning System

For analysis of O-D data collected from the field, it is required to code it for origin and destination of trip. The zoning was done at four levels. In first level, all-important towns located along the proposed project stretch were assigned a zone code. Secondly, immediate influence areas of project road were considered, and nearby areas/towns were defined as zones. In the next level, all nearby districts were grouped in zones. Finally, states beyond the influence area were aggregated broadly in terms of direction of project road. Total 53 traffic zones were considered for the project stretch. List of zone numbers and corresponding zone areas are mentioned in the below Table below.

Table 7-8: Zones derived from Origin-Destination Studies

Zone No.	Name of town/city/district/state
1	State of Tripura
2	Hatai Charra, Lowairpoa, Katal Tali, Tibhum, Hatairbond
3	Uttor Chagolmar, Isabheel, Kotamani Bazar, Rangamati, Bazaricherra, Abdullapur
4	Chandkhira, Bairabnagar, Tangibari, Saruchalitha, Baithakhal T.E., Kalkalighat
5	Ramkrishna Nagar, Nayagram, Chamela, Dullabcherra
6	Ratabari, Bazarghat
7	Patharkandi, Ashimganj, Jamirala, Singhariah, Kachubari, Ilashpur
8	Nilambazar, Baraigram, Eragigool, Kayasthagram, Saija Nagar, Barantar
9	Kunapara, Ratanpur, Balirbond, Pankshankar, Barbari, Barkatpur
10	Kanisail, Saidambar, Nagkapan, Humak, Ranigram
11	Medal, Bhatgram, Rampasha, Banamali
12	Karimganj
13	Sarisa, Rarai, Nathupur, Bakarshal
14	Lamajuar, Jabainpur, Arengabad
15	Chargola,Ramkrishna
16	Bhanga, Kandigram malua, Mosli, Kankales, Purbagram
17	Srigouri, Kandigram Chaita, Umarpur
18	Bagargool, Khagail, Mahakal
19	Son beel
20	Badarpur, Panchgram, katakhal, Alakulipur, Kalinagar
21	Sutarkhandi, Ullukandi, Jarapata
22	Akbarpur, Fakirabazar, Tazpur
23	Panaragarh, Maizgram
24	Kapnarpur, Chiparsangan, Chandipur, Uttar Kanchanpur

Zone No.	Name of town/city/district/state
25	Algapur, Narainpur, Bakri howar
26	Hailakandi, Kanchanpur
27	Matijuri, Bandukmara Grant, Sudorshonpur
28	Lala, Jankibazar
29	Madhabpur, Gharmura, Jamira, Duttapur
30	Anipur Grant
31	Salchapara, Kalinagar, Digorsrikona
32	Srikona, Tarapur
33	Silchar, NIT Silchar, Bhaga, Kabuganj, Sonabarighat
34	Barakhola, Udarband, Sonalmukh, Lakhipur, Bankandi
35	Kumbhirgram
36	Katigora, Rajnagar
37	Berenga, Rongpur, Kasipur, Mathinagar, Sonai
38	Kalain, Kalibari
39	Kamrup Metropolitan (Guwahati)
40	Districts of Kokrajhar, Dhubri, Chirang, bongaigaon, Gopalpara, Barpeta, Baksa, Nalbari, Kampur, Udalguri, Darrang
41	Districts of Majuli, Jorhat, Lakhimpur, Sivasagar, Dibrugarh, Dhemaji, Tinsukia
42	Districts of Dima Hasao,Karbi Anglong,Nagaon,Sonitpur,Golaghat, Morigaon, Hojoi
43	State of Meghalaya
44	State of Arunachal Pradesh
45	State of Manipur
46	State of Mizoram
47	State of Nagaland
48	States of West Bengal, Odisha, Bihar, Jharkhand
49	States of Chattisgarh. Madhya Pradesh
50	States of Rajasthan, Gujarat
51	Delhi
52	States of J&k,Himachal, Punjab, Haryana, Uttarakhand, Uttar Pradesh
53	States of Maharastra, Goa, AP, Telangana, Karnataka, Tamil Nadu,Kerela

The O-D data collected has been analysed to study the OD matrix over the entire project stretch at each survey location. The OD matrix of three locations are presented in annexures.

The O-D data collected has been analysed to study the trip frequency distribution over the entire project stretch. The mode wise trip frequency distribution at all survey locations is presented in tables and figures.

Table 7-9: Trip Frequency Distribution at near Bakarshal Toll Plaza

	Daily Once	Daily Twice	> Daily Twice	Weekly once	Weekly Twice	> Weekly Twice	Monthly Once	Monthly Twice	> Monthly Twice	Yearly Once	Yearly Twice	>Yearly Twice
Car	1.34%	84.30%	0.45%	1.47%	0.51%	0.00%	8.87%	1.91%	0.13%	0.96%	0.06%	0.00%
Bus	4.21%	77.89%	10.53%	1.05%	0.00%	0.00%	6.32%	0.00%	0.00%	0.00%	0.00%	0.00%
MiniBus	6.41%	75.64%	10.26%	0.00%	1.28%	0.00%	6.41%	0.00%	0.00%	0.00%	0.00%	0.00%
Tata Magic	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
LCV	17.28%	23.46%	1.23%	3.29%	4.53%	0.00%	19.34%	9.88%	7.82%	13.17%	0.00%	0.00%
2 Axle	7.74%	21.43%	0.00%	2.98%	1.79%	0.60%	19.64%	13.10%	11.31%	21.43%	0.00%	0.00%
3 Axle	13.00%	18.00%	5.00%	1.00%	1.00%	0.00%	24.00%	14.00%	4.00%	20.00%	0.00%	0.00%
Multi Axle	7.00%	14.87%	0.00%	8.75%	1.46%	0.87%	22.45%	10.79%	8.75%	24.78%	0.29%	0.00%

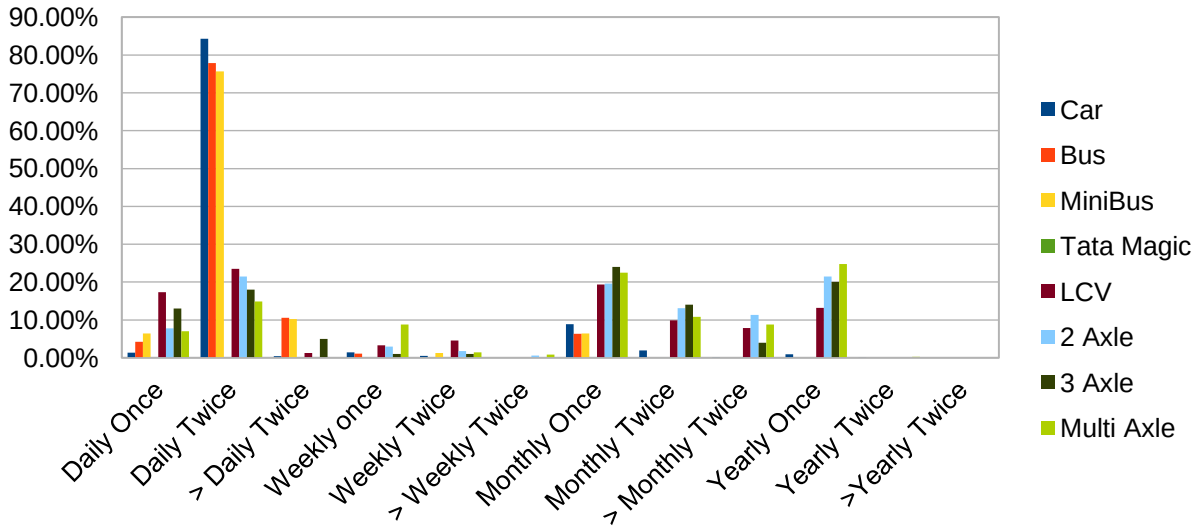


Figure 7-5: Graph Showing Trip Frequency Distribution at Bakarshal Toll Plaza

Table 7-10: Trip Frequency Distribution at Nilambazar

	Daily Once	Daily Twice	> Daily Twice	Weekly once	Weekly Twice	> Weekly Twice	Monthly Once	Monthly Twice	> Monthly Twice	Yearly Once	Yearly Twice	>Yearly Twice
Car	0.72%	33.72%	0.00%	9.11%	0.90%	0.36%	43.28%	7.48%	1.17%	2.98%	0.18%	0.09%
Bus	5.19%	49.35%	0.00%	5.19%	0.00%	0.00%	29.87%	10.39%	0.00%	0.00%	0.00%	0.00%
MiniBus	0.00%	27.78%	0.00%	38.89%	0.00%	0.00%	22.22%	11.11%	0.00%	0.00%	0.00%	0.00%
Tata Magic	10.00%	50.00%	0.00%	20.00%	0.00%	0.00%	10.00%	10.00%	0.00%	0.00%	0.00%	0.00%
LCV	5.75%	24.52%	3.45%	17.62%	0.77%	0.00%	26.44%	7.28%	1.53%	12.64%	0.00%	0.00%

2 Axle	4.03%	17.74%	2.42%	10.48%	0.00%	0.00%	25.81%	12.10%	4.84%	22.58%	0.00%	0.00%
3 Axle	1.82%	14.55%	5.45%	5.45%	0.00%	0.00%	36.36%	18.18%	0.00%	18.18%	0.00%	0.00%
Multi Axle	5.73%	11.47%	2.15%	16.13%	0.72%	0.00%	27.60%	8.96%	3.58%	23.30%	0.00%	0.36%

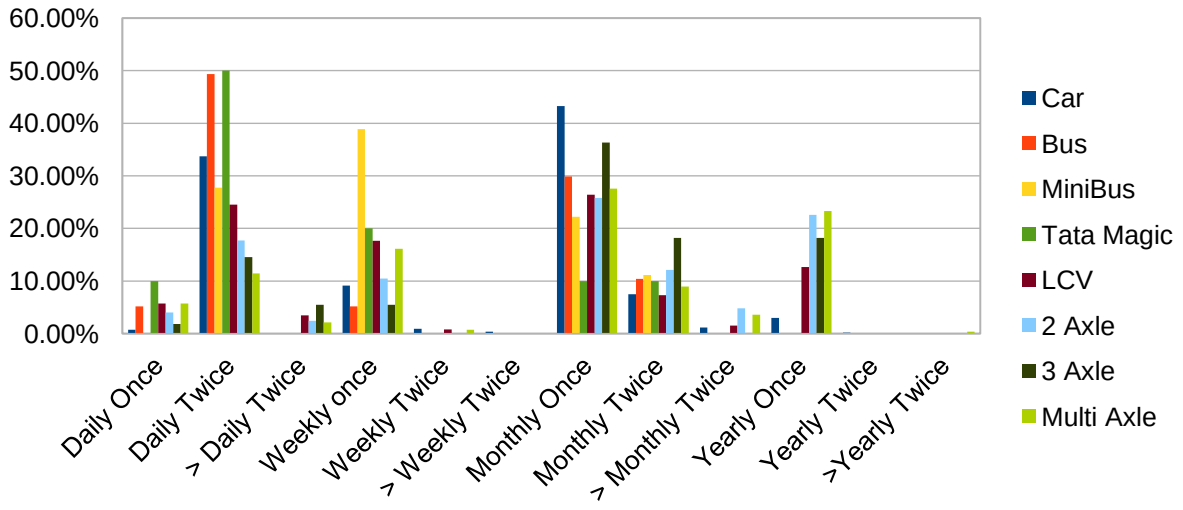


Figure 7-6: Graph Showing Trip Frequency Distribution at Nilambazar

The O-D data collected has been analysed to study the commodity distribution over the entire project stretch. The commodity wise distribution at all survey locations is presented in tables and figures.

Table 7-11: Commodity distribution as per OD at Bakarshal

S. No	Commodity	Number	Percentage
1	Food grains and pulses	31	3.63%
2	Cash crops	1	0.12%
3	Vegetables and Fruits	73	8.55%
4	Processed Food Items	19	2.22%
5	Packed Food Items	23	2.69%
6	Fishery, Poultry and Animal feed	23	2.69%
7	Building Materials	185	21.66%
8	Industrial Raw Materials	8	0.94%
9	Consumer Goods	13	1.52%
10	Fertilizers, chemicals and Pharmaceuticals	11	1.29%
11	Machinery and Automobiles	15	1.76%
12	Petroleum Products	30	3.51%
13	Parcel Goods	56	6.56%
14	Empty	300	35.13%
15	Industrial Outputs	61	7.14%
16	Liquor and Cooldrinks	5	0.59%

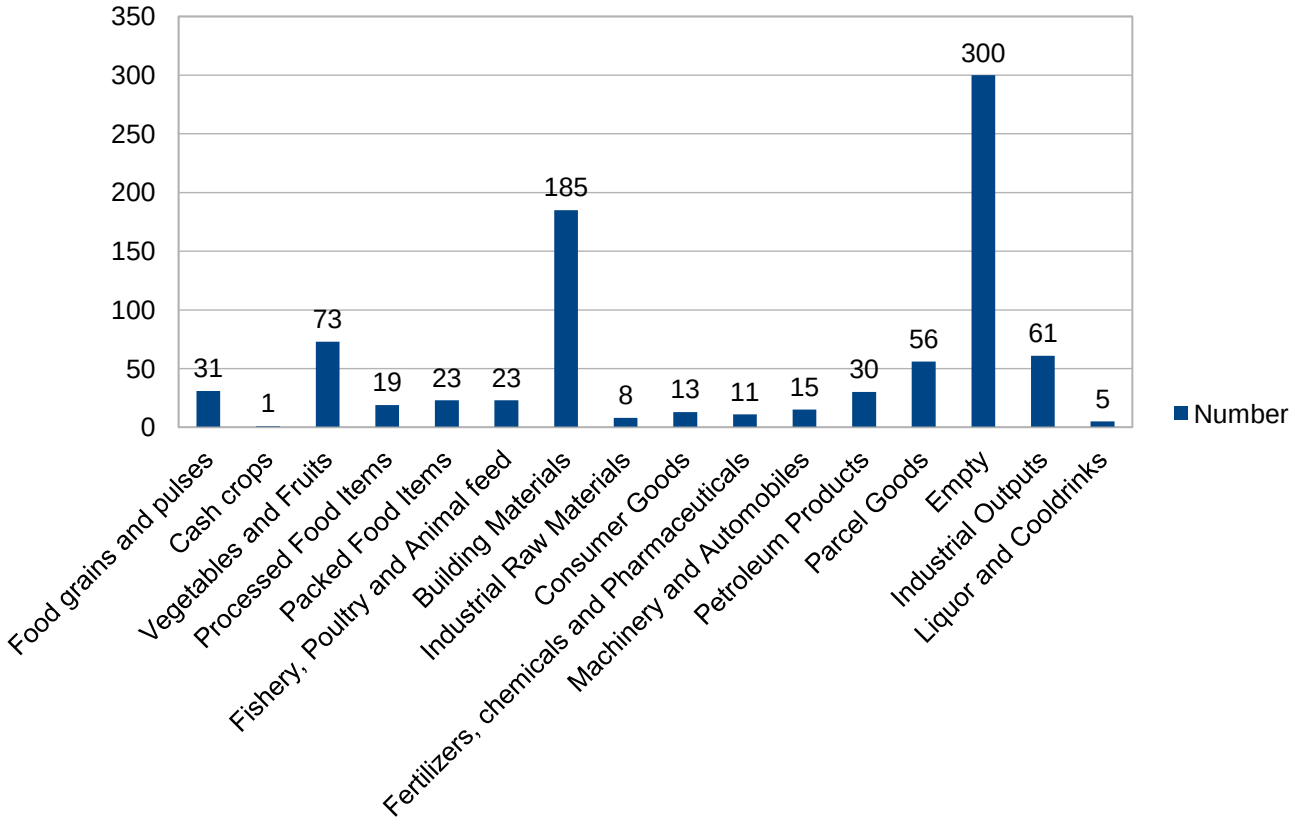


Figure 7-7: Graph showing Commodity distribution as per OD at Bakarshal

7.16 AXLE LOAD SURVEYS AND ANALYSIS

Axle load surveys were conducted at locations mentioned in Traffic Schedule. This survey was conducted for 1 normal day in both directions of traffic simultaneously with volume count of commercial vehicles (Trucks and LCV). The random selection of vehicles for axle load measurement was done, ensuring suitable sample for each category of commercial vehicles consisting of overloaded and empty vehicles.

The Vehicle Damage Factor (VDF) is an index characterizing the traffic loading for a highway and is defined as a multiplier for converting the number of commercial vehicles of different axle loads to Standard Axle Loads (SAL). Equivalency factor (EF) is normally worked out by using the Fourth Power Rule derived by AASHTO and approved by CRRI. With the help of equivalency factors and frequency distribution of axle loads, Equivalent Axle Loads (EAL) are computed.

VDF = Total EAL / Number of vehicles weighed

Table 7-12: Equivalency Factor

S. No	Type of Axle	Standard Axle loads (in kN)
1	Single Axle with single wheel on either side	65
2	Single Axle with dual wheel on either side	80
3	Tandem Axle with dual wheel on either side	148
4	Tridem Axle with dual wheel on either side	224

The VDF calculated for different categories of commercial vehicles are as shown in Table below:

Table 7-13: VDF Values at Survey Locations

S. No	Mode	Near Bakarshal Toll Plaza	
		Towards Badarpur	Towards Karimganj
1	2 Axle	0.47	1.54
2	3 Axle	1.46	5.00
3	M axle	3.10	10.20
4	LCV	0.11	0.12

7.17 TURNING MOVEMENT COUNT:

The traffic volume count stations at Toll Plaza locations of project stretch (TVCs) have been located to capture the pattern of the traffic plying on the project stretch. Apart from these traffic volume counts, for the study of the road network around the project corridor, turning movement count was conducted at 12 major junctions along the project corridor. The traffic pattern is considerably influenced by these junctions, either in case of passenger vehicles or goods or both also. The traffic volume levels and their characteristics at these intersections are presented in the below table. The survey was conducted for a period of 8 hours from 8:00 am to 12:00 pm in the morning peak hours and 16:00 pm to 20:00 pm in the evening peak hours.

7.17.1 NH-37 & NH-8 Junction

Figure 7-8: NH-8 and NH-37 Junction

Junction of NH-37 & NH-8 is a one of the 3-legged intersection on the project corridor. This intersection is formed by connecting the road from Churaibari (NH-8) and with existing corridor (NH-37).

Based on the Survey Analysis, it has been observed that from 11:15 am to 11:30 am is being the morning peak and evening peak is from 18:15 pm to 18:30 pm, the Peak Hour Factor (PHF) 0.94 is observed during the morning peak and 0.93 in the evening peak respectively.

Summary of intersection traffic each direction wise in-terms of volume in numbers and PCUs are given below.

Table 7-14: NH-37 & NH-8 Junction - Direction wise traffic

TIME		Leg 1- Karimganj		Leg 2- Badarpur		Leg 3-Agartala	
		Vehicles	PCU's	Vehicles	PCU's	Vehicles	PCU's
8:00	**9:00**	239	282	549	838	591	559
9:00	**10:00**	273	345	607	899	586	566
10:00	**11:00**	254	338	587	984	668	653

TIME		Leg 1- Karimganj		Leg 2- Badarpur		Leg 3-Agartala	
		Vehicles	PCU's	Vehicles	PCU's	Vehicles	PCU's
11:00	**12:00**	202	264	502	802	576	554
12:00	**13:00**	246	348	581	929	335	1348
13:00	**14:00**	224	340	473	847	251	1282
14:00	**15:00**	252	369	494	813	244	1326
15:00	**16:00**	317	448	550	959	242	1132
16:00	**17:00**	288	392	531	933	589	546
17:00	**18:00**	292	396	565	970	652	591
18:00	**19:00**	293	467	498	862	468	399
19:00	**20:00**	223	337	372	615	343	285
20:00	**21:00**	202	343	312	584	286	248
21:00	**22:00**	149	258	241	459	188	203
22:00	**23:00**	117	269	160	406	109	142
23:00	**0:00**	104	174	157	272	81	99
0:00	**1:00**	77	185	85	249	40	71
1:00	**2:00**	58	165	66	200	21	37
2:00	**3:00**	66	177	86	237	42	62
3:00	**4:00**	73	189	91	246	36	58
4:00	**5:00**	115	262	157	361	83	99
5:00	**6:00**	135	272	221	465	183	198
6:00	**7:00**	161	260	292	559	276	308

TIME		Leg 1- Karimganj		Leg 2- Badarpur		Leg 3-Agartala	
		Vehicles	PCU's	Vehicles	PCU's	Vehicles	PCU's
7:00	8:00	215	287	447	815	542	532
Total		4,575	7,161	8,624	15,299	7,432	11,294

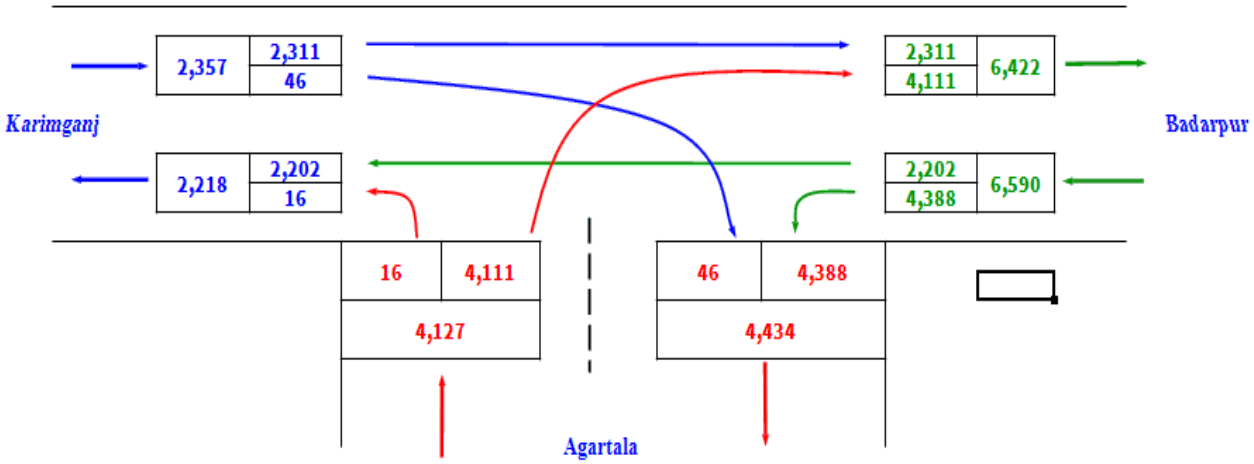


Figure 7-9: Figure Showing Turning Movements at NH-37 & NH-8 Junction

7.17.2 Chandkhira Junction

Chandkhira Junction is a one of the 3-legged intersection on the project corridor. This intersection is formed by connecting the road from Kacharigoan (NH-208A) and with existing corridor (NH-8). Based on the Survey Analysis, it has been observed that from 10:45 am to 11:00 am is being the morning peak and evening peak is from 16:00 pm to 16:15 pm, the Peak Hour Factor (PHF) 0.93 is observed during the morning peak and 0.93 in the evening peak respectively. Summary of intersection traffic each direction wise in-terms of volume in numbers and PCUs are given

Figure 7-10: NH-8 and NH-208A Junction

Table 7-15: Chandkhira Junction - Direction wise traffic

TIME		Leg 1- Churaibari		Leg 2- Karimganj		Leg 3-Kacharigaon	
		Vehicles	PCU's	Vehicles	PCU's	Vehicles	PCU's
8:00	**9:00**	419	612	431	521	248	198
9:00	**10:00**	400	557	432	504	286	239
10:00	**11:00**	448	625	423	508	261	212
11:00	**12:00**	395	582	401	485	272	209
12:00	**13:00**	356	497	368	433	248	204
13:00	**14:00**	429	622	447	537	250	200
14:00	**15:00**	429	600	463	523	272	231
15:00	**16:00**	473	685	449	577	236	176
16:00	**17:00**	542	752	502	567	324	229
17:00	**18:00**	392	566	362	453	188	140
18:00	**19:00**	289	401	284	350	143	118

TIME		Leg 1- Churaibari		Leg 2- Karimganj		Leg 3-Kacharigaon	
		Vehicles	PCU's	Vehicles	PCU's	Vehicles	PCU's
19:00	**20:00**	225	301	210	255	111	82
20:00	**21:00**	147	330	149	306	40	30
21:00	**22:00**	117	260	114	237	23	18
22:00	**23:00**	69	128	65	122	18	22
23:00	**0:00**	80	207	79	192	3	4
0:00	**1:00**	63	162	58	139	9	10
1:00	**2:00**	47	134	48	132	3	3
2:00	**3:00**	42	106	38	97	4	5
3:00	**4:00**	45	126	50	130	11	9
4:00	**5:00**	93	228	102	234	33	32
5:00	**6:00**	149	279	145	264	58	52
6:00	**7:00**	235	381	240	362	105	84
7:00	**8:00**	216	332	372	399	314	249
Total		**6,100**	**9,475**	**6,232**	**8,321**	**3,460**	**2,750**

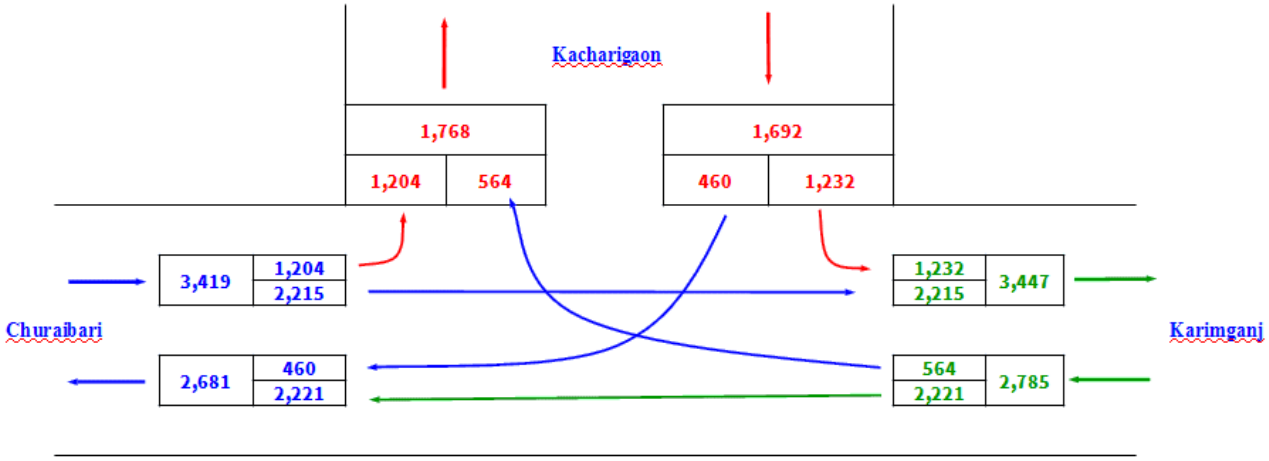


Figure 7-11: Figure Showing Turning Movements at Chandkhira

7.18 TRAFFIC FORECASTING

7.18.1 METHODOLOGY FOR FORECASTING

Investment priorities are governed by traffic demand, assessed benefits, and cost of the project. Demand plays the important role, which governs which type of facility/ infrastructure to be created. This in turn determines likely benefits and costs to develop the same. An expressway project of this magnitude calls for significant investment. Prediction of traffic demand becomes an important task and has to be carried out as accurately as possible. Accurate estimation of traffic has direct bearing on the viability of the project. Recognizing this, efforts need to be made to carefully assess all the parameters that help in predicting the traffic demand in future, which necessitates realistic estimation of traffic growth rates. Traffic growth on a road facility is generally estimated on the basis of historical trends. In the present case, traffic growth rates are estimated using elasticity method as per IRC:108-2015. Demand changes are usually because of shifts in the pattern of economic activities in the surrounding regions. Hence, future traffic estimation necessitates a preview, however imprecise, of the probable pattern of future growth of the economy. In the absence of historical traffic census data on the project road, the future traffic has been forecasted using transport demand elasticity approach by regression of registered vehicles of Andhra Pradesh with respect to socio-economic parameters *viz.,* population, PCI and NSDP as explained below.

The exercise of traffic growth rate estimation has been carried out by us using the elasticity approach. The elasticity method relates traffic growth to changes in the related economic parameters. According to IRC:108-2015, elasticity based econometric model for highway projects could be derived in the following form:

$$\mathbf{Log_e\,(P) = A_0 + A_1\,Log_e\,(EI)}$$

Where:

- P = Traffic volume (of any vehicle type)
- EI = Economic Indicator (GDP/NSDP/Population/PCI)
- A_0 = Regression constant;
- A_1 = Regression co-efficient (Elasticity Index)

The main steps followed are:

- Defining the Project Influence Area from OD analysis of travel pattern
- Estimating the past elasticity of traffic growth from time series of registered vehicles of influencing states
- Assessment of future elasticity values for major vehicle groups, namely, cars, buses and trucks
- Study of past performance and assessment of prospective growth rates of state economies of influence area

- The growth rates are found using the formulae Eqn (a) & (b).
- For Passenger vehicles,
- $G=\Sigma[(R_i*E_i*I_i)$……Eqn. (a)
- Where R_i = Growth in PCI and Population index of Andhra Pradesh
- E_i = Elasticity Value
- For commercial vehicles,
- $G=\Sigma [(R_j*E_j*I_j)$……...Eqn. (b)

  Where, R_j = Growth in Economic index (NSDP) of Andhra Pradesh

  E_j = Elasticity Value

  I_j = Influence factor

7.18.2 SECONDARY DATA COLLECTION

A study of the socio-economic profiles of the regions comprising the project influence area (PIA) provides an overview of the factors likely to influence the pattern of economic development, and hence the flows and volumes of traffic on the proposed highway. The details include population, per-capita Income, NSDP, GDP and targeted growth rates of the economy. The profiles help to generate basic inputs for the estimation of future growth in transport demand based on past scenarios, prospective changes in transport demand elasticity and economic growth rates.

(a) Growth of Registered Vehicles

To analyze the vehicle growth in the state, the vehicle registration data of Assam has been collected from the state handbook of statistics. The Compounded Average Growth Rate (%) of different vehicle types is shown in the table below.

Table 7-16: Growth of Registered Vehicles in Assam

S. No	Year	2 Wheelers	Car	Car (Y)	Goods	Tractor	Tractor with trailor	Mini Bus	Buses	LCV
1	2015	1431933	524793	42024	125215	31180	18288	4324	13202	71233
2	2016	1634157	557364	47759	128684	38787	19595	4502	13674	78496
3	2017	1852067	579082	53490	136807	41310	19667	4622	14633	83908
4	2018	2106900	646534	59909	141718	45796	20289	4882	15511	100202
5	2019	2400197	688919	65096	144896	58112	21008	5523	16442	118255
6	2020	2710763	747980	70509	152141	65874	22007	5808	17429	137586
7	2021	2917380	792871	85522	159748	74438	25079	6156	18475	152894
8	2022	3173011	855731	93075	167735	84115	25885	6525	19584	170140

Source: Statistical HandBook of Assam & further Rationalised the data

(b) Economic Growth

The past performance of the economic indicators for Andhra Pradesh was also collected for the same period (2015-22), with the objective of establishing elasticity of travel demand to the different economic indicators. The economic indicators considered for the analysis include:

- Gross/ Net State Domestic Product
- Per Capita Income (PCI)
- Population

Table below gives the growth of Economic indicators for Assam.

Table 7-17: Growth in Economic Indices of Assam State (2011-12 Prices)

S.No	Year	GSDP (Rs Cr.)	PCI (Rs.)	Population (Cr.)	NSDP (Rs. Cr)
1	2015	156895	48013	3.12	138387
2	2016	179595	54257	3.27	160724
3	2017	192400	56747	3.31	173050
4	2018	211940	62510	3.35	185667
5	2019	234772	68384	3.38	208035
6	2020	248796	72129	3.42	216243
7	2021	273837	77403	3.46	239373
8	2022	289192	80231	3.50	251688
Annual Average Growth Rate		**9.93%**	**9.38%**	**11.55%**	**8.58%**

Source: Statistical Hand Book of Assam & further Rationalised the data

7.18.3 TRANSPORT ELASTICITY DEMAND

Description of Regression Analysis:

The regression analysis tool performs linear regression analysis by using the "least squares" method to fit a line through a set of observations. We can analyze how a single dependent variable is affected by the values of one or more independent variables. In the present case, registered vehicles by type are dependent variables whereas the economic parameters are independent variables.

R Square:

R Square is another measure of the explanatory power of the model. In theory, R square compares the amount of error explained by the model as compared to the amount of error explained by averages. The higher the R-Square, the better it is.

Regression analysis has been carried out by creating econometric models as suggested in IRC: 108–2015, using past vehicle registration data, and economic indicators such as population and PCI for passenger vehicles and NSDP for freight vehicles. All India registered trucks are also regressed with GDP to estimate national level elasticity value for trucks and its growth rate. The elasticity values obtained for each class of vehicle are given in Table below.

The following steps have been adopted to derive the Elasticity and Growth factors:

- Growth rate of registered vehicles of zone of influence (Assam) is found out.
- Growth rates of NSDP/GSDP, GDP, Per Capita Income (at 2011-12 constant prices) and population are obtained.
- For Cars, number of registered vehicles has been regressed with Per Capita Income of Assam State
- For Buses, number of registered vehicles has been regressed with Population of Assam State
- For trucks, the number of registered trucks has been regressed with NSDP of the State for Intra-State movement and GDP for Inter-State movement.
- Mean value of Average growth rate of registered vehicles and the growth rate obtained by Regression Analysis for all categories were found out both at State level and at National level (For trucks only)
- For Cars and Buses, the mean growth rate of registered vehicular growth rate and growth rate from regression analysis is adopted.

Recommended Elasticity Values:

Vehicle registration data represents all vehicles registered in the state but does not indicate actual number of vehicles plying on the road owing to vehicles taken off the road due to lack of fitness certificate. Consequently, the elasticity values based on registration data are usually higher than those based on actual traffic.

Hence, there is a need to moderate values obtained from registration data. In order to arrive at realistic future elasticities for the project road; various factors relating to vehicle technology changes besides character of traffic and travel pattern on the project road have been considered:

High elasticity of cars being witnessed now is because of large demand facilitated by financing schemes and loans. Factors like growth of household incomes (particularly in urban areas), reduction in the prices of entry-level cars, growth of the used car market, changes in lifestyle, growing personal incomes, desire to own a vehicle facilitated by availability of

loans/financing schemes on easy terms, etc. have all contributed to the rapid growth in ownership of cars. However, such a trend would slow down and elasticity can be expected to decline. The elasticity obtained by using registered vehicles is an overestimate for the traffic moving on suburban and inter-city routes. In view of all this, combined with the travel pattern of vehicles moving on the road, elasticity value obtained by using registration data has been moderated for future years.

Over the years, there is a change in passenger movement with more and more persons shifting towards personalized modes. Moreover, buses usually plying on fixed pre-decided routes and thus elasticity values for buses have been considered accordingly. With the changing freight vehicle mix in favor of LCV for short distance traffic and 3-axle/MAV for long-distance traffic, higher elasticity values for these have been considered as compared to 2-axle trucks. Considering the ongoing technical advancements in automobile industry, some of the standard two axle trucks would gradually be replaced by three axle truck and MAVs, leading to reduction in number of trucks. This shift has already started taking place in different parts of the country.

Considering the economic indicators of Andhra Pradesh, the projected elasticity values for various vehicle types are presented in, which have been used to estimate the growth rates of each vehicle type. The transport demand elasticity by vehicle type over a period of time tends to decline and approach unity or even less.

As the economy and its various sectors grow, every region tends to become self-sufficient. Moreover, much of the past growth has been associated with the country's transition from a largely rural, subsistence economy to cash based urban economy, dominated by regional and national linkages.

As the transition proceeds, its impact on transport pattern can be expected to become less dominant. Therefore, the demand for different type of vehicles falls, over time, despite greater economic development. The same is also clear from the relationships of the economy and transport demand elasticity over time nationally and internationally.

Table 7-18: Adopted Elasticity Values for Assam

Mode	Variable	Elasticity	R-Square
Car/Jeep	PCI	1.02	0.99
Bus	POP	2.08	0.97
Truck	NSDP	2.00	0.99

The estimated traffic growth rates are arrived at by multiplying elasticity values and projected growth in economic factors.

Table 7-19: Projected Traffic Growth Rates for Assam

Projected Growth Rates of Assam							
S. No	Period	2W	Car	Truck	Bus	Tractor	Tractor with trailer
1	2023 - 2027	13.5%	14.5%	8.50%	6.5%	12.0%	10.5%
2	2028 – 2032	13.5%	14.5%	7.50%	6.0%	11.0%	9.5%
3	2033 – 2037	13.0%	14.0%	7.0%	5.5%	10.5%	9.0%
4	2038 - 2042	12.5%	13.0%	6.5%	5.0%	10.0%	8.5%
5	Beyond 2043	12.0%	12.0%	6.0%	5.0%	9.0%	8.0%

7.18.4 RECOMMENDED GROWTH RATES

Against this background, any agenda for future growth of the state economies has to take into account past trends, future prospects and the emerging challenges. The growth prospects for the state have been developed taking into consideration the past performance of the state economies and the economic growth envisaged for the future. The pace with which the regional economies grow with the envisaged growth of the state is a major contributing factor in growth of traffic. Final growth rates were obtained for horizon years by considering the projected economic trend of the State. Table below shows the growth rates, which are adopted in finding the future traffic demand estimates.

Table 7-20: Traffic Growth Rates

Projected Growth Rates of Assam							
S. No	Period	2W	Car	Truck	Bus	Tractor	Tractor with trailoer
1	2023 - 2027	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
2	2028 – 2032	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
3	2033 – 2037	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
4	2038 - 2042	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
5	Beyond 2043	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%

7.19 PROJECTED TRAFFIC ON PROJECT CORRIDOR

The project stretch has been divided into 3 homogeneous traffic sections. In view of the same, section-wise (*leg-wise*) traffic is considered for forecasting.

7.20 CAPACITY STANDARDS

The leg wise projected Traffic volume/Design service volume has been compared against the respective capacities of 2/4/6 lanes as per IRC standards and with the 4/6lane manuals and the year during which the projected volume reaches its capacity and the year of requirement of lane upgradation has been given in Tables below.

Land port Authority of India, Sutarkandi has stated that due to some road/bridge repair works in Bangladesh, there are no commodity movement and hence truck movement has reduced in HS-3. They have shared details of approximate truck movement in the section when the repair works is completed.

Table 7-21: Truck data shared by LPI

S. No	Vehicle Movement	Approximate number
1	Total vehicle movement in Day	350-400
2	Total vehicle movement in Night	300-350

So, an average of 375 vehicles during day and 325 vehicles during night time are considered on our section. A total of 700 vehicles are considered to ply on road everyday.

Section wise, year of lane upgradation has been analysed with calculated growth rates and 5% growth rates

Table 7-22: Projected Traffic along HS-II on Project corridor at 5% growth rate

Year	PASSENGER TRAFFIC									GOODS TRAFFIC									Non Motorised			TOLL EXEMPTED			Total Traffic volume in numbers	Total tollable traffic volume in numbers	Total Traffic in PCU's	Allowable Traffic in PCU's
	2W	3W	Car / Jeep	Car / Jeep (YB)	Tata Magic	RTC Bus	Private Bus	Mini Bus	School	2 Axle	3 Axle	Multi Axle	Over sized	LGV/ LCV	Mini LCV	Tractor	Tractor with trailer/ Others	3w Goods	Cycle	Cycle Rickshaw	Animal Drawn	car	MINI BUS	TRUCKS				
2023	2045	1823	2270	109	16	75	86	47	3	200	94	494	3	367	499	2	2	45	147	15	1	17	8	5	8373	4263	10184	7126
2024	2147	1914	2384	114	17	79	90	49	3	210	99	519	3	385	524	2	2	47	154	16	1	18	8	5	8792	4476	10646	7482
2025	2255	2010	2503	120	18	83	95	52	3	221	104	545	3	405	550	2	2	50	162	17	1	19	9	6	9231	4700	11179	7856
2026	2367	2110	2628	126	19	87	100	54	3	232	109	572	3	425	578	2	2	52	170	17	1	20	9	6	9693	4935	11738	8249
2027	2486	2216	2759	132	19	91	105	57	4	243	114	600	4	446	607	2	2	55	179	18	1	21	10	6	10177	5182	12325	8661
2028	2610	2327	2897	139	20	96	110	60	4	255	120	630	4	468	637	3	3	57	188	19	1	22	10	6	10686	5441	12941	9094
2029	2740	2443	3042	146	21	101	115	63	4	268	126	662	4	492	669	3	3	60	197	20	1	23	11	7	11221	5713	13588	9549
2030	2878	2565	3194	153	23	106	121	66	4	281	132	695	4	516	702	3	3	63	207	21	1	24	11	7	11782	5998	14267	10026
2031	3021	2693	3354	161	24	111	127	69	4	295	139	730	4	542	737	3	3	66	217	22	1	25	12	7	12371	6298	14981	10528
2032	3172	2828	3522	169	25	116	133	73	5	310	146	766	5	569	774	3	3	70	228	23	2	26	12	8	12989	6613	15730	11054
2033	3331	2969	3698	178	26	122	140	77	5	326	153	805	5	598	813	3	3	73	239	24	2	28	13	8	13639	6944	16516	11607
2034	3498	3118	3882	186	27	128	147	80	5	342	161	845	5	628	853	3	3	77	251	26	2	29	14	9	14321	7291	17342	12187
2035	3673	3274	4077	196	29	135	154	84	5	359	169	887	5	659	896	4	4	81	264	27	2	31	14	9	15037	7656	18209	12796
2036	3856	3438	4280	206	30	141	162	89	6	377	177	932	6	692	941	4	4	85	277	28	2	32	15	9	15789	8039	19120	13436
2037	4049	3609	4494	216	32	148	170	93	6	396	186	978	6	727	988	4	4	89	291	30	2	34	16	10	16578	8440	20076	14108
2038	4251	3790	4719	227	33	156	179	98	6	416	195	1027	6	763	1037	4	4	94	306	31	2	35	17	10	17407	8862	21079	14813
2039	4464	3979	4955	238	35	164	188	103	7	437	205	1078	7	801	1089	4	4	98	321	33	2	37	17	11	18277	9306	22133	15554
2040	4687	4178	5203	250	37	172	197	108	7	458	215	1132	7	841	1144	5	5	103	337	34	2	39	18	11	19191	9771	23240	16332
2041	4922	4387	5463	262	39	180	207	113	7	481	226	1189	7	883	1201	5	5	108	354	36	2	41	19	12	20151	10259	24402	17148
2042	5168	4607	5736	275	40	190	217	119	8	505	238	1248	8	927	1261	5	5	114	371	38	3	43	20	13	21158	10772	25622	18006
2043	5426	4837	6023	289	42	199	228	125	8	531	249	1311	8	974	1324	5	5	119	390	40	3	45	21	13	22216	11311	26903	18906
2044	5697	5079	6324	304	45	209	240	131	8	557	262	1376	8	1022	1390	6	6	125	410	42	3	47	22	14	23327	11877	28248	19851
2045	5982	5333	6640	319	47	219	252	137	9	585	275	1445	9	1074	1460	6	6	132	430	44	3	50	23	15	24493	12470	29661	20844
2046	6281	5599	6972	335	49	230	264	144	9	614	289	1517	9	1127	1533	6	6	138	452	46	3	52	25	15	25718	13094	31144	21886
2047	6595	5879	7321	352	52	242	277	152	10	645	303	1593	10	1184	1609	6	6	145	474	48	3	55	26	16	27004	13749	32701	22980
2048	6925	6173	7687	369	54	254	291	159	10	677	318	1673	10	1243	1690	7	7	152	498	51	3	58	27	17	28354	14436	34336	24129
2049	7271	6482	8071	388	57	267	306	167	11	711	334	1757	11	1305	1774	7	7	160	523	53	4	60	28	18	29772	15158	36053	25336
2050	7635	6806	8475	407	60	280	321	175	11	747	351	1844	11	1370	1863	7	7	168	549	56	4	63	30	19	31260	15916	37855	26603
2051	8017	7146	8899	427	63	294	337	184	12	784	368	1937	12	1439	1956	8	8	176	576	59	4	67	31	20	32823	16712	39748	27933
2052	8417	7504	9344	449	66	309	354	193	12	823	387	2033	12	1511	2054	8	8	185	605	62	4	70	33	21	34464	17547	41736	29330

Table 7-23: Projected Traffic along HS-II on Project corridor at calculated growth rate

Year	PASSENGER TRAFFIC									GOODS TRAFFIC									Non Motorised			TOLL EXEMPTED			Total Traffic volume in numbers	Total tollable traffic volume in numbers	Total Traffic In PCU's	Allowable Traffic in PCU's
	2W	3W	Car / Jeep	Car / Jeep (YB)	Tata Magic	RTC Bus	Private Bus	Mini Bus	School	2 Axle	3 Axle	Multi Axle	Over sized	LGV/ LCV	Mini LCV	Tractor	Tractor with trailer/ Others	3w Goods	Cycle	Cycle Rickshaw	Animal Drawn	car	MINI BUS	TRUCKS				
	0.50	**1.00**	**1.00**	**1.00**	**1.00**	**3.00**	**3.00**	**1.50**	**3.00**	**3.00**	**3.00**	**4.50**	**4.50**	**1.50**	**1.00**	**1.50**	**4.50**	**1.00**	**0.50**	**2.00**	**8.00**	**1.00**	**1.50**	**3.00**				
2023	2045	1823	2270	109	16	75	86	47	3	200	94	494	3	367	499	2	2	45	147	15	1	17	8	5	8373	4263	10184	7126
2024	2321	2069	2599	124	17	80	92	50	3	217	102	536	3	398	541	2	2	51	148	15	1	19	9	5	9407	4763	11269	7862
2025	2634	2348	2976	140	19	85	98	54	3	235	111	582	4	432	587	3	2	58	150	15	1	22	9	6	10575	5326	12533	8681
2026	2990	2665	3408	159	20	91	104	58	4	255	120	631	4	469	637	3	3	66	151	15	1	26	10	6	11896	5960	13949	9592
2027	3394	3025	3902	181	22	96	111	62	4	277	130	685	4	509	692	3	3	75	153	16	1	29	10	7	13390	6674	15538	10607
2028	3852	3434	4467	205	24	102	117	66	4	298	140	736	4	547	743	3	3	85	154	16	1	33	11	7	15055	7454	17257	11676
2029	4372	3897	5115	233	26	108	124	70	4	320	151	791	5	588	799	4	4	96	156	16	1	38	12	8	16939	8335	19185	12865
2030	4962	4423	5857	264	28	115	132	74	5	344	162	850	5	632	859	4	4	109	158	16	1	44	13	9	19070	9328	21348	14191
2031	5632	5021	6706	300	30	122	140	79	5	370	174	914	6	679	924	5	4	124	159	16	1	50	13	9	21483	10448	23776	15668
2032	6392	5698	7678	341	32	129	148	84	5	398	187	983	6	730	993	5	5	141	161	16	1	58	14	10	24216	11715	26504	17318
2033	7223	6439	8753	385	34	136	156	89	6	426	200	1052	6	781	1062	6	5	159	162	17	1	66	15	11	27191	13088	29439	19074
2034	8162	7276	9979	435	36	144	165	95	6	456	214	1125	7	836	1137	6	6	180	164	17	1	75	16	11	30549	14634	32727	21031
2035	9223	8222	11376	492	39	152	174	101	6	487	229	1204	7	894	1216	7	6	203	166	17	1	85	17	12	34338	16378	36412	23212
2036	10422	9291	12969	556	42	160	183	107	7	522	245	1288	8	957	1301	8	7	229	167	17	1	97	18	13	38615	18344	40546	25646
2037	11777	10499	14784	628	45	169	194	113	7	558	262	1379	8	1024	1392	9	7	259	169	17	1	111	19	14	43445	20563	45186	28365
2038	13250	11811	16706	703	48	177	203	119	8	594	279	1468	9	1091	1483	10	8	292	171	17	1	125	20	15	48608	22888	50093	31186
2039	14906	13288	18878	787	51	186	213	126	8	633	298	1564	9	1162	1579	11	8	328	172	18	1	141	21	16	54404	25494	55572	34319
2040	16769	14949	21332	882	54	195	224	133	8	674	317	1665	10	1237	1682	12	9	369	174	18	1	160	23	17	60913	28414	61693	37800
2041	18865	16817	24105	988	57	205	235	140	9	718	337	1773	11	1317	1791	13	10	415	176	18	1	181	24	18	68226	31688	68533	41671
2042	21223	18919	27239	1106	61	215	247	148	9	765	359	1889	11	1403	1908	14	11	467	178	18	1	204	25	19	76441	35361	76181	45978
2043	23770	21190	30508	1228	65	226	259	155	10	811	381	2002	12	1487	2022	15	12	523	179	18	1	228	26	20	85150	39166	84220	50410
2044	26622	23732	34169	1363	69	237	272	163	10	859	404	2122	13	1577	2144	17	13	586	181	18	1	256	28	21	94877	43401	93158	55310
2045	29817	26580	38269	1513	73	249	286	171	11	911	428	2249	14	1671	2272	18	14	656	183	19	1	287	29	23	105744	48117	103101	60728
2046	33395	29770	42861	1679	77	262	300	179	11	965	454	2384	14	1771	2409	20	15	735	185	19	1	321	31	24	117884	53369	114164	66725
2047	37403	33342	48004	1864	82	275	315	188	12	1023	481	2527	15	1878	2553	22	16	823	187	19	1	360	32	26	131448	59219	126477	73364
2048	41891	37343	53765	2069	87	289	331	198	13	1085	510	2679	16	1990	2706	24	17	922	189	19	1	403	34	27	146607	65737	140185	80719
2049	46918	41824	60217	2297	92	303	348	208	13	1150	540	2840	17	2110	2869	26	19	1032	190	19	1	451	35	29	163548	73003	155452	88869
2050	52548	46843	67443	2550	97	318	365	218	14	1219	573	3010	18	2236	3041	28	20	1156	192	20	1	505	37	30	182484	81102	172458	97906
2051	58854	52465	75536	2830	103	334	383	229	15	1292	607	3191	19	2371	3223	31	22	1295	194	20	1	566	39	32	203651	90133	191408	107930
2052	65916	58760	84600	3141	110	351	402	240	15	1369	644	3382	21	2513	3417	33	23	1450	196	20	1	634	41	34	227315	100205	212528	119055

Table 7-24: Capacity Calculations for the Homogeneous Sections (With calculated Growth rate)

Year	HS-1	HS-2	HS-3	HS-3 (with LPI data)
2023	4 lane)	4 lane	2 lane with PS	2 lane with PS
2024				
2025				
2026				4 lane
2027	6 lane	6 lane	4 lane	
2028				
2029				
2030				
2031				
2032				6 lane
2033				
2034				
2035			6 lane	
2036				
2037				
2038				
2039				
2040				
2041				
2042				
2043				
2044				
2045				
2046				
2047				
2048				

Table 7-25: Capacity Calculations for the Homogeneous Sections (With 5% Growth)

Year	HS-1	HS-2	HS-3	HS-3 (with LPI data)
2023	4 lane)	4 lane	2 lane with PS	2 lane with PS
2024				
2025				
2026				
2027				4 lane
2028				
2029				
2030				
2031	6 lane			
2032				
2033				
2034				
2035				
2036			4 lane	
2037		6 lane		
2038				
2039				
2040				
2041				
2042				
2043				6 lane
2044				
2045				
2046				
2047				
2048				

7.21 CONCLUSIONS

- As per the capacity standards mentioned in the Bharatmala Pariyojana Guidelines, for adopted traffic features the project corridor requires 4 lane configurations by the year of COD for HS – I & II.
- For HS-III, 4 lane configurations can be reached by 2029.
- If we adopt 5% growth rates, as per Bharatmala guidelines, for adopted traffic features the project corridor required 4 lane configurations by the year of COD for HS-I & II and for HS-III, it can be reached by 2036.
- Requirement of 4 laning of project stretch after including data received from LPI is also included.
- Considering the time required for completion of construction, it is recommended that the corridor may be developed with 4 lane capacity for HS-I, II and for HS-III 2 laning may be adopted.

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8 PAVEMENT DESIGN

8.1 GENERAL

8.1.1 General

The design of pavement i.e., calculating the total crust thickness depends on mainly two factors Viz. total cumulative repetitions of standard axle loads for the design life and the strength of sub-grade soils (CBR).

The total cumulative repetitions of standard axles are in turn, a function of the annual average daily traffic (AADT) and applicable growth rate (r) of vehicles for forecasting the traffic after a certain period and Vehicle Damage Factor (VDF) for converting the mixed volume of traffic in terms of standard axle load repetitions. Further, lane distribution factor is applied to account for the vehicle load distribution across the width of pavement depending on the available carriageway width.

8.1.2 Design Guidelines

- Clause 5.3 of “Manual of Specifications and Standards for Four laning of Highways through Public Private Partnership by – IRC: SP:84-2019” states that “new pavements shall be designed in accordance with IRC:37(flexible).
- Clause 5.4.1 of IRC: SP:87-2019, states that “Flexible pavement shall be designed for a minimum design period of 15 years, subject to the condition that design traffic shall not be less than 20msa. Stage construction shall not be permitted.
- Clause 4.3.1 of IRC:38-2018, states: “A design period of 20 years may be adopted for the structural design of pavements for National Highways, State Highways and Urban Roads “
- Clause 5.4 of IRC: 58-2015, states: Cement concrete pavements may be designed to have a life span of 30 years or more.
- Clause 5.7.4 of IRC: 58-2015, states: A subbase of Dry Lean Concrete (DLC) having a 7-day average compressive strength of 7 MPa determined as per IRC:SP:49 over GSB is recommended for highways. The minimum recommended thickness of DLC for major highways is 150 mm. The DLC shall extend beyond the PQC by 0.5 m on either side.
- Clause 5.7.5 of IRC: 58-2015, states: A de-bonding interlayer of polythene sheet white or transparent having a minimum thickness of 125 micron is recommended as per the current practice in India.

Alternative strategies or combination of initial design, strengthening and maintenance can be developed by the concessionaire to provide the specified level of pavement performance over the operation period subject to satisfying the following minimum design requirements.

8.2 TRAFFIC

The project stretch is divided into 3 homogeneous sections. Below table gives information regarding the HS in project corridor

Table 8-1: Homogeneous Sections

S. No	Homogeneous Section	From (Km.)	To (Km.)	Length (Km.)
1	II	38.600	106.730	68.130

Traffic surveys are conducted in these sections and the Traffic volume in each section is as given in Table 8-2

Table 8-2: Traffic along Homogeneous Sections

Year	PASSENGER TRAFFIC									GOODS TRAFFIC									Non Motorised			TOLL EXEMPTED			Total Traffic volume in numbers	Total tollable traffic volume in numbers	Total Traffic In PCU's	Allowable Traffic in PCU's
	2W	3W	Car / Jeep	Car / Jeep (YB)	Tata Magic	RTC Bus	Private Bus	Mini Bus	School	2 Axle	3 Axle	Multi Axle	Over sized	LGV/ LCV	Mini LCV	Tractor	Tractor with trailer/ Others	3w Goods	Cycle	Cycle Rickshaw	Animal Drawn	car	MINI BUS	TRUCKS				
2023	2045	1823	2270	109	16	75	86	47	3	200	94	494	3	367	499	2	2	45	147	15	1	17	8	5	8373	4263	10184	7126

8.2.1 Growth rates

Past trends in the growth rates along the proposed project corridor provide valuable information to the likely future traffic. But in most cases, the past traffic data from the statistical department is inconsistent and cannot be taken as a basis for future traffic growth rate. Alternatively, the motor vehicle registration data at the state level during the recent past provides more consistent information regarding the trends in traffic growth and thus presents a better tool for estimating future growth rates of different categories of vehicles. A more rational method is to establish a relationship between the socio - economic variables such as population, Net State Domestic Product and Per-capita income on one hand and the past registration data of different categories of vehicles on the other to determine the Elasticity of Transport Demand with respect to different categories of vehicles. The detailed calculations of growth rates are given in the traffic report. The computed traffic growth rates are given in the below Table 8-3.

Table 8-3: Actual growth rates in percentages

Projected Growth Rates of Assam							
S. No	Period	2W	Car	Truck	Bus	Tractor	Tractor with trailer
1	2023 - 2027	13.5%	14.5%	8.50%	6.5%	12.0%	10.5%
2	2028 – 2032	13.5%	14.5%	7.50%	6.0%	11.0%	9.5%
3	2033 – 2037	13.0%	14.0%	7.0%	5.5%	10.5%	9.0%
4	2038 - 2042	12.5%	13.0%	6.5%	5.0%	10.0%	8.5%
5	Beyond 2043	12.0%	12.0%	6.0%	5.0%	9.0%	8.0%

8.2.2 Axle Load Surveys

The Vehicle Damage Factor (VDF) is an index characterizing the traffic loading for a highway and is defined as a multiplier for converting the number of commercial vehicles of different axle loads to Standard Axle Loads (SAL). Equivalency factor (EF) is normally worked out by using the Fourth Power Rule derived by AASHTO. However, TRRL has suggested a factor of 4.5 for developing countries. In the present study, the Fourth Power Rule given by CRRI has been adopted. With the help of equivalency factors and frequency distribution of axle loads, Equivalent Axle Loads (EAL) are computed. The standard axle loads, and the

legal axle loads considered while calculating the equivalency factors for various axles are furnished below.

Table 8-4: Standard and legal Axle loads

S.No	Type of Axle	Standard Axle Load (Tonnes)	Legal Axle Load (Tonnes)	Reference
1	Single Axle (1le wheel)	6.60	6.60	IRC-3
2	Single Axle (2al wheel)	8.16	10.20	IRC-37/IRC-3
3	Tandem Axle	15.09	19.00	IRC-37/IRC-3

VDF depends on the composition of commercial traffic, the load carried and the actual sample collected. The following table gives the VDF's adopted in design.

Table 8-5: Vehicle Damage Factor (VDF) at different Survey Locations

S. No	Mode	At Nilambazar	
		Towards Karimganj	Towards Churaibari
1	2 Axle	1.54	7.08
2	3 Axle	2.58	6.23
3	M axle	2.61	9.05
4	LCV	0.39	1.16

Anticipating heavy commercial traffic movement on the proposed highway due to the future developments, average VDFs are adopted and the values are given in the Table 8-6.

Table 8-6: Vehicle Damage Factor (VDF) adopted

S. No	Mode	At Nilambazar
1	2 Axle	7.08
2	3 Axle	6.23
3	M axle	9.05

S. No	Mode	At Nilambazar
4	LCV	1.16

8.2.3 Million Standard Axles (MSA)

Design traffic in terms of Million Standard Axles (MSA) is determined at location, where both volume count and axle load surveys were conducted.

The traffic loading in terms of the cumulative number of standard axles for the design period is computed using the following relationship.

$N = 365 * [(1+r)^n – 1] * A * D * L * F / r$

Where,

N: The cumulative number of standard axles to be catered for in the design in terms of MSA.

A: Initial traffic in the year of completion of construction in terms of the number of commercial vehicles per day

L: Lane Distribution Factor

D: Directional Distribution Factor

n: Design Life in years

r: Annual Growth rate of commercial vehicles (5 %).

F: Vehicle Damage Factor

8.3 PRELIMINARY INVESTIGATIONS

8.3.1 General

The flexible pavement is modeled as an elastic multi-layer structure. Stresses and strains at critical locations are computed using a linear layered elastic model. The stress – strain analysis software IITPAVE has been used for the computation of stress and strain in flexible pavements as mentioned below.

Horizontal Tensile Strain at bottom of bituminous layer, which can cause fatigue failure of bituminous layer.

Vertical Compressive Strain at the top of subgrade, which can cause rutting failure of pavement layers.

Horizontal Tensile Strain at bottom of Cement treated base, which can cause fatigue failure of cement treated layer.

The flexible pavement has low flexural strength and hence layers reflect the deformation of the lower layers/sub-grade on to the surface layer after the withdrawal of wheel load. To control the deflections in the sub-grade so that no permanent deflections result the pavement thickness is so designed that the stresses on the subgrade soil are kept within its bearing power. Loading of bituminous pavement requires the stiffest layers to be placed at the surface with successive weaker layers down to subgrade. To structural design, only the

number of commercial vehicles of laden weight of 3 tonnes or more and their axle loading will be considered.

8.3.2 Fatigue Model

Due to repetition of loads, tensile strain develops cracks at the bottom of bituminous layers which is a problem for long term serviceability. The phenomenon is called fatigue of the bituminous layer and the number of load repetitions in terms of standard axles that causes fatigue denotes the life of the pavement. Two fatigue equations are considered, one in which the computed strains correspond to 80% reliability level and the other corresponding to 90% reliability level.

The 80% reliability equation is used for the pavement where VG30 grade bitumen is used and 90% reliability equation is used for the pavement where VG40 grade bitumen is used. The two equations for the conventional bituminous mixes designed by Marshall method are given below.

$$N_f = 2.21 \times 10^{-4} \times (1/E_t)^{3.89} \times (1/M_R)^{0.854} \text{ ---------1 (80\% Reliability)}$$

$$N_f = 0.711 \times 10^{-4} \times (1/E_t)^{3.89} \times (1/M_R)^{0.854} \text{ --------2 (90\% Reliability)}$$

N_f = Fatigue life in number of standard axles

E_t = Maximum tensile strain at the bottom of Bituminous layer.

M_R = Resilient Modulus of the Bituminous layer

The ***equation 2*** is modified by considering 90% reliability with air voids around 3% and the volume of bitumen about 13%.

8.3.3 Rutting Model

Rutting is the permanent deformation in pavement usually occurring longitudinally along the wheel path. The rutting may partly be caused by deformation in the subgrade and other non-bituminous layers which would reflect to the overlying layers to take a deformed shape. The 80% reliability equation is used for the pavement where VG30 grade bitumen is used and 90% reliability equation is used for the pavement where VG40 grade bitumen is used. The rutting model considers the vertical strain in subgrade and the two equations are given below by considering 80% & 90% reliability.

$$N = 4.1656 \times 10^{-8} \times (1/E_v)^{4.5337} \text{ ------3 (80\% Reliability)}$$

$$N = 1.41 \times 10^{-8} \times (1/E_v)^{4.5337} \text{ ---------4 (90\% Reliability)}$$

N = Number of cumulative standard axles to produce 20 mm rutting.

E_v = Maximum Vertical subgrade strain (micro strain)

8.3.4 Pavement Layers

In accordance with IRC:37-2018 the following base and sub-base options are available.

Granular base and sub-base.

Cementitious bases and sub-bases with a crack relief layer of aggregate inter-layer below bituminous surfacing.

Cementitious bases and sub-bases with SAMI in between bituminous surfacing and the contentious base layer for retarding the reflection cracks into the bituminous layer.

Cemented base and granular subbase with crack relief inter-layer of aggregate above Cemented base.

Bituminous surfacing over treated RAP and cemented subbase.

Stage construction is not permitted when we are using cemented base and sub-bases according to the guidelines of the code as it may lead to cracking of the stabilized layer leading to failure of the pavement. Hence, the consultants adopt Granular Base & Granular Sub-base for main carriageway pavement with stage construction.

8.3.4.1 Sub-base layer

The sub-base layer serves three functions like to protect the sub-grade from over stressing, to provide a platform for the construction traffic and to serve as drainage and filter layer. Material passing through 0.425 mm (425 micron), LL & PI shall not more than 25 and 6 %. Material shall have a minimum 10% fines when tested in compliance with BS:812. The water absorption value (as per IS 2386) of the coarse aggregate shall be less than 2%, if not soundness test shall be carried out as per IS 383. 100% sample should pass through 75mm sieve and only 3-10% sample should pass through 0.075mm sieve for all the three grades. When coarse graded subbase is used as a drainage layer, Los Angeles abrasion value should be less than 40, so that there is no crushing during the rolling and the permeability is retained. The sub-base should be composed of two layers, the lower layer forms the separation/filter layer to prevent intrusion of subgrade soil into the pavement and upper layer forms the drainage layer to drain away any water that may enter through surface cracks.

Strength Parameter: Resilient Modulus (M_{Rgsb})

M_{Rgsb}= 0.2 X $h^{(0.45)}$ X $M_{R\ subgrade}$, where h is thickness of subbase layer in mm.

M_R value of subbase is dependent on M_R value of subgrade since weaker subgrade does not permit higher modulus of the upper layer because of deformation under loads.

$M_{R\ subgrade}$ = 10 X CBR if Subgrade CBR is <=5

$M_{R\ subgrade}$ = 17.6 X $(CBR)^{0.64}$ if Subgrade CBR is >5

8.3.4.2 Base layer

The base layer consists of WMM, WBM, Crusher run macadam, reclaimed concrete etc. Relevant specifications of IRC/MORTH are to be adopted for the construction.

Strength Parameter: Resilient Modulus ($M_{R\ granular}$)

When both sub-base and base layers are made up of unbound granular layers, the composite resilient modulus of the granular subbase and base are as follows:

$M_{R\ granular}$= 0.2 X $h^{0.45}$ X $M_{R\ subgrade}$,

where h is combined thickness of subbase and base layers in mm.

8.3.4.3 Bituminous layers (Binder and Surface)

The binder layer consists of DBM and BM are to be adopted for construction. It acts like a load distribution and supporting layer.

Strength Parameter: Resilient Modulus ($M_{RBC/DBM}$)

The strength of bituminous mix based on extensive laboratory testing of Resilient Modulus Test. Based on the study data of India, IRC:37-2018 recommended resilient modulus for different mix types and temperatures are given below.

Table 8-7: Resilient Modulus of Bituminous Mixes, Mpa

Mix Type	Temperature °C				
	20	25	30	35	40
BC and DBM for VG10 bitumen	2300	2000	1450	1000	800
BC and DBM for VG30 bitumen	3500	3000	2500	2000	1250
BC and DBM for VG40 bitumen	6000	5000	4000	3000	2000
BC with Modified bitumen (IRC:SP:13)	5700	3800	2400	1650	1300
BM with VG10 bitumen	-	-	-	500	-
BM with VG30 bitumen	-	-	-	700	-
RAP treated with 4% bitumen	-	-	-	800	-

8.3.5 Flexible pavement design for Greenfield corridor

Design of flexible pavement is carried out in accordance with IRC:37-2018 for Granular base and sub-base. The standard designs given in plate-6, 14 and 22 of clause 12.1, 12.2 & 12.2 of IRC:37-2018 specify the minimum thickness and specifications of various component layers for different options for the given traffic in terms of cumulative standard axles and the 10% subgrade CBR. Cumulative standard axles calculated for the 20 year design life for leg wise is given in Table-7.

Anticipating heavy commercial traffic movement on the proposed highway due to the future developments flexible pavement is adopted for **70 MSA**. Along with the flexible pavement composition with conventional layers option, layer composition with alternate materials have been considered and given in the following tables:

Table 8-8: Conventional Pavement Composition (Option-1)

Section	Eff. CBR (%)	MSA for 20 yrs design life	Bitumen Grade	Crust Composition (mm)				
				BC	DBM	WMM	GSB	Total
Section-II	8	70	VG-40	50	105	250	200	**605**

Table 8-9: Composition details Bituminous pavement with Cemented base and subbase with Crack Relief Interlayer of aggregate (Option-2)

Section	Eff. CBR (%)	MSA for 20 yrs design life	Bitumen Grade	Crust Composition (mm)					
				BC	DBM	AIL	CTB	CTSB	Total
Section-II	8	70	VG-40	40	65	100	100	200	**505**

Table 8-10: Composition details Bituminous pavement with Cemented base and Granular Subbase with AIL (Option-3)

Section	Eff. CBR (%)	MSA for 20 yrs design life	Bitumen Grade	Crust Composition (mm)					
				BC	DBM	AIL	CTB	GSB	Total
Section-II	8	70	VG-40	60	60	100	150	100	**560**

Table 8-11: Composition details Bituminous pavement with Cemented base and Cemented Sub base with SAMI Layer (Option-4)

Section	Eff. CBR (%)	MSA for 20 yrs design life	Bitumen Grade	Crust Composition (mm)					
				BC	DBM	SAMI	CTB	CTSB	Total
Section-II	8	70	VG-40	40	60	SAMI	150	200	450

8.4 Final Flexible Pavement design Option for Main carriageway

As per the equations mentioned in 2.3.2 and 2.3.3 of IRC 37-2018: Following are the results observed from the IIT-PAVE Software for crust composition mentioned in the below table.

Calculation of Allowable Strains at Critical Locations:

Allowable Horizontal Tensile Strian (Et): At Bottom of the Bituminous layer

Nf = 2.021 X 10-4 X (1/Et)3.89 X (1/MR)0.854 ---------> 1 (90% Reliability)

Tensile Strian(Et) = 149.10 Micro Strain (Allowable Tensile Strain)

Allowable Horizontal Tensile Strian(Et): At Bottom of Cement Treated Base layer

Tensile Strian (Et) = 66.99 Micro Strain (Allowable Tensile Strain)

$$N = RF\left[\frac{\left(\frac{113000}{E^{0.804}}+191\right)}{\varepsilon_t}\right]^{12} \longrightarrow \mathbf{2}$$

Where,

RF = reliability factor for cementitious materials for failure against fatigue

= 1 for Expressways, National Highways, Sate Highways and Urban Roads and for other categories of roads if the design traffic is more than 10 msa

= 2 for all other cases

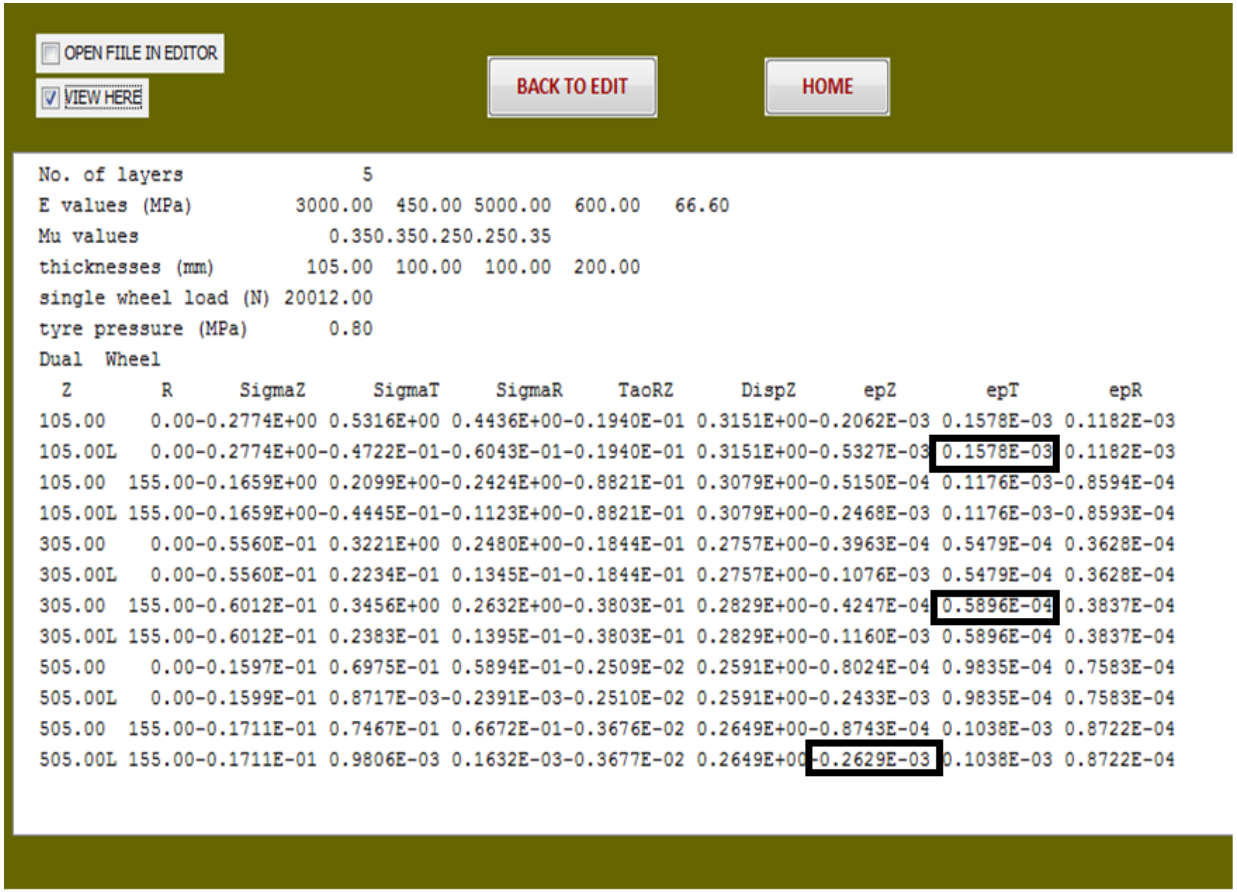
N = No of standard axle load repetitions which the CTB can sustain

Allowable Vertical Compressible Strian(Ev): At top of the sub-grade layer

N = 1.41 X 10-8 X (1/Ez)4.5337 --------> 3 (90% Reliability)

Compressive Strian(Ev) = 319 Micro Strain.

Calculation of Maximum Strains at Critical Locations by IIT-PAVE:




```
No. of layers                5
E values (MPa)         3000.00  450.00 5000.00  600.00   66.60
Mu values                 0.350.350.250.250.35
thicknesses (mm)         105.00  100.00  100.00  200.00
single wheel load (N) 20012.00
tyre pressure (MPa)       0.80
Dual  Wheel
  Z        R      SigmaZ      SigmaT     SigmaR     TaoRZ      DispZ      epZ        epT        epR
105.00    0.00-0.2774E+00 0.5316E+00 0.4436E+00-0.1940E-01 0.3151E+00-0.2062E-03 0.1578E-03 0.1182E-03
105.00L   0.00-0.2774E+00-0.4722E-01-0.6043E-01-0.1940E-01 0.3151E+00-0.5327E-03 0.1578E-03 0.1182E-03
105.00  155.00-0.1659E+00 0.2099E+00-0.2424E+00-0.8821E-01 0.3079E+00-0.5150E-04 0.1176E-03-0.8594E-04
105.00L 155.00-0.1659E+00-0.4445E-01-0.1123E+00-0.8821E-01 0.3079E+00-0.2468E-03 0.1176E-03-0.8593E-04
305.00    0.00-0.5560E-01 0.3221E+00 0.2480E+00-0.1844E-01 0.2757E+00-0.3963E-04 0.5479E-04 0.3628E-04
305.00L   0.00-0.5560E-01 0.2234E-01 0.1345E-01-0.1844E-01 0.2757E+00-0.1076E-03 0.5479E-04 0.3628E-04
305.00  155.00-0.6012E-01 0.3456E+00 0.2632E+00-0.3803E-01 0.2829E+00-0.4247E-04 0.5896E-04 0.3837E-04
305.00L 155.00-0.6012E-01 0.2383E-01 0.1395E-01-0.3803E-01 0.2829E+00-0.1160E-03 0.5896E-04 0.3837E-04
505.00    0.00-0.1597E-01 0.6975E-01 0.5894E-01-0.2509E-02 0.2591E+00-0.8024E-04 0.9835E-04 0.7583E-04
505.00L   0.00-0.1599E-01 0.8717E-03-0.2391E-03-0.2510E-02 0.2591E+00-0.2433E-03 0.9835E-04 0.7583E-04
505.00  155.00-0.1711E-01 0.7467E-01 0.6672E-01-0.3676E-02 0.2649E+00-0.8743E-04 0.1038E-03 0.8722E-04
505.00L 155.00-0.1711E-01 0.9806E-03 0.1632E-03-0.3677E-02 0.2649E+00-0.2629E-03 0.1038E-03 0.8722E-04
```

Figure 8-1: IITPAVE Output for Section-I & II

Table 8-12: Comparison of Strains With IIT-PAVE (Section I &II)

S. No	Allowable Strains			IIT-PAVE Results		
	Tensile Strain below BT layer (E_t)	Tensile Strain below CTB lyer (E_t)	Vertical Compressive (E_v)	Tensile Strain below BT layer (E_t)	Tensile Strain below CTB (E_t)	Vertical Compressive Strain (E_v)
1	163.4	69.02	345.1	157.8	58.96	262.9

Note: Bituminous mixes are carried out based on MS-2 and MoRT&H Clause 505.3.2 provisions, it was assumed 3% air voids and 13% binder content by volume of the mix for DBM, and the crust thickness were worked out using eq 3.4 as given in IRC:37-2018.
However, contractor/concessionaire shall carry out the actual mix design of DBM with proposed aggregates and binder to get the best properties. Properties such as air voids and optimum binder content thus arrived shall be used for determining the actual pavement Composition. Hence, the crust composition given above is for indicative purposes only.

8.5 Recommended Pavement Option

Considering the use of the alternate materials in the composition of flexible pavement, due to the lack in the significant practical experience while adopting the mix design and performance after laying, flexible pavement option with the cemented base, cemented sub base and AIL is adopted for flexible pavement.

Table 8-13: Recommended Pavement Composition (BT, Crack Relief Interlayer of Aggregate, CTB & CTSB)

Section	Eff. CBR (%)	MSA for 20 yrs design life	Bitumen Grade	Crust Composition (mm)					
				BC	DBM	AIL	CTB	CTSB	Total
Section-II	8	70	VG-40	40	65	100	100	200	**505**

8.6 Preliminary Design of Rigid Pavement

Rigid pavement has been designed in accordance with IRC:58-2015. The area of toll plaza including the flared portion shall be provided with concrete pavement. Rigid pavement for entire project corridor including toll plaza is considered as second alternative in accordance with IRC:58-2015.

(a) Design Life and Traffic parameters

30 years design period has been considered. The cumulative number of commercial vehicles over 30 years design life is estimated and considered as design traffic. The design Tyre pressure has been taken as 0.80 Mpa cemented base and 0.56 MPa for granular layers.

(b) Wheel Base Characteristics

Axles with spacing of less than 4.5m (transverse joint spacing) are considered for estimation of top-down cracking damage analysis. The percentage of axles with less than 4.5m wheelbase is estimated from the axle load survey.

(c) Temperature Differential

According to Table-1 of IRC:58-2015, the temperature differential is a function of geographical location of the project road and the temperature differential to be adopted for the project area (Assam) is given below:

Table 8-14: Temperature Differential

Concrete Thickness	150 mm	200 mm	250 mm	300 mm – 400 mm
Temperature Differential (^{0}C)	15.6	16.4	16.6	16.8

(d) Modulus of Subgrade reaction

Dry Lean Concrete (DLC) subbase is generally recommended for modern concrete pavements, particularly those with high intensity of traffic.

- CBR of the subgrade soil is considered 10 % and k-value becomes 55 Mpa/m.

150 mm DLC layer is provided as sub-base.
Effective k-value, after providing DLC layer is 300 MPa/m

(e) Concrete Strength

The 90 days flexural strength for the pavement quality concrete (PQC) has been taken as 4.95 Mpa for the purpose of design.

(f) Modulus of Elasticity, Poisson's Ratio & Coefficient of Thermal Expansion

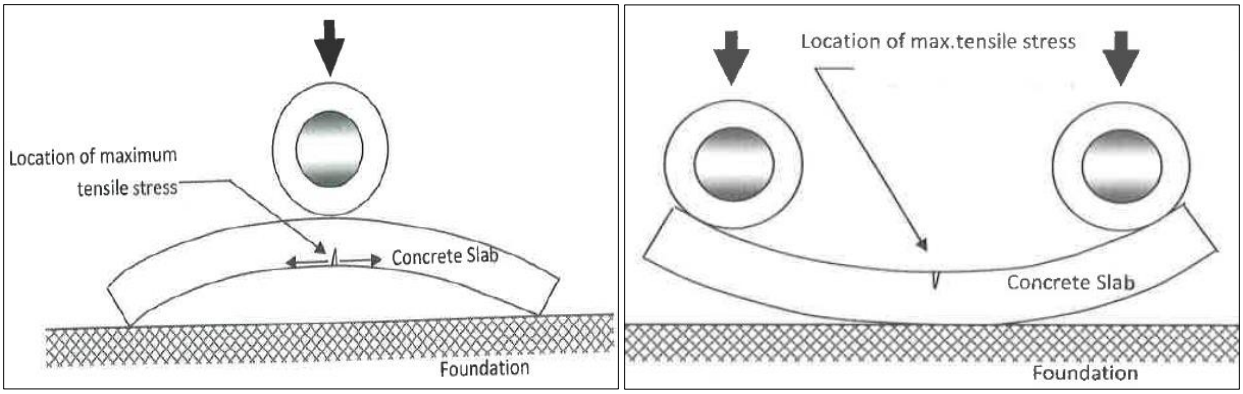
The modulus of elasticity (E) and Poisson's Ratio (μ) of the cement concrete vary with concrete materials and strength. The elastic modulus increases with increase in strength, and Poisson's ratio decreases with increase in the modulus of elasticity. The coefficient of thermal expansion of concrete is dependent to a great extent on the type of aggregates used in concrete.
The values of the various parameters adopted are:

Modulus of Elasticity (E) = 30,000 MPa
Poisson's Ratio (μ) = 0.15
Coefficient of thermal expansion (a) = 10 x 10^{-6}/ ^{o}C

(g) Design of slab thickness

The flexural stress due to the combined action of traffic loads and temperature differential between the top and bottom fibers of the concrete slab is considered for design of pavement thickness. Positive temperature during day time will create bottom-up cracking and negative temperature during night will create top-down cracking in concrete slab. Hence analysis has been done for these two cases. For bottom-up cracking case, the combination of load and positive non-linear temperature differential has been considered where as for top-down cracking analysis, the combination of load and negative linear temperature differential has been taken.

For a trial slab thickness and other design parameters, the pavement will be checked for cumulative bottom-up and top-down fatigue damage. Cumulative fatigue damage (CFD) for bottom-up cracking is significant only during 10 AM to 4 PM because of higher stresses, hence the day traffic during the six hour (10 AM to 4 PM) is considered for bottom-up cracking analysis. Where as CFD for top-down cracking is significant only during 12 AM to 6 AM, hence the six hour night time traffic (12 AM to 6 AM) is considered for top-down cracking analysis.



(h) Design Thickness

Following Rigid Pavement design elements are proposed for the project road and details are provided in ***Appendix-2***.

Table 8-15: Rigid Pavement Composition

S.No	Item	Rigid Pavement Crust Composition Details
1	PQC of M40 grade (mm)	300
2	DLC of M10 grade (mm)	150

S.No	Item	Rigid Pavement Crust Composition Details
3	GSB (mm)	150
4	Dia. of Dowel bar (mm)	38
5	Length of Dowel bar (mm)	500
6	Spacing of Dowel bar (mm)	300
7	Dia. of Plain tie bar (mm)	12
8	Length of Plain tie bar (mm)	580
9	Spacing of Plain bar (mm)	370
10	Dia. of Deformed bar (mm)	12
11	Length of Deformed bar (mm)	640
12	Spacing of Deformed bar (mm)	595

8.7 Design of Shoulders

Earthen Shoulder: Earthen shoulders shall be covered with 150 mm thick layer of granular material confirming to the requirements given in Clause 401.2.1 of MoRT&H specifications.

8.8 Flexible Pavement Composition for Service Road

Service road pavement composition is designed for a minimum of 10 MSA traffic loading. Design MSA for service road shall be considered as 10 MSA The crust composition and thickness of component layers as worked out and given below in **Table 8-17**.

Table 8-16: Pavement Composition for Service Roads

S.No	Pavement composition	Design thickness for 10 MSA (mm)
1	Bituminous Concrete (BC)	30
2	Dense Bituminous Macadam (DBM)	50
3	Wet Mix Macadam (WMM)	250
4	Granular Sub-Base (GSB)	200
Total (mm)		**530**

8.9 LIFE CYCLE COST ANALYSIS

Life Cycle Cost Analysis has been conducted during the project development stage. The levels of detail in the analysis are consistent with the level of investment. Basically, the process involves following steps:

- Develop rehabilitation and maintenance strategies for the analysis period.

Establish the agency costs for construction, rehabilitation and maintenance strategies.

Estimating the agency costs for construction, rehabilitation, and maintenance

Estimate user and non-user costs

Develop expenditure streams

Compute the Net present value (NPV)

The primary purpose of LCCA is to quantify the long-term economic implications of initial pavement decisions. Various rehabilitation and maintenance strategies can be employed over the analysis period. The next step is to obtain estimates of expected lives for the various rehabilitation and maintenance strategies. Agency costs include all costs incurred directly by the agency over the life of the project. The costs typically include expenditures for preliminary engineering, contract administration, construction, including construction supervision, and all future maintenance (routine and periodic), resurfacing and rehabilitation. These are generally developed for each pavement design strategy to visualize the extent and timing of expenditures. LCCA is a form of economic analysis used to evaluate the cost efficiency of various investment options. Once all costs and their timings have been established, the future costs must be discounted to the base year and added to the initial cost to determine net present value (NPV). NPV is calculated as follows.

Inputs for the Life Cycle Cost Analysis:

$$NPV_O = (B_O - C_O) + [(B_1 - C_1)/(1+i)^1] + [(B_2 - C_2)/(1+i)^2] + \ldots\ldots\ldots\ldots + [(B_t - C_t)/(1+i)^n]$$

Where,

NPV_O = Net Present Value in the year 0.

B_t = Value of benefits which occur in the year 1.

C_t = Value of costs which occur in the year 1.

I = Discount rate per annum in decimals.

n = Number of years taken for analysis.

8.9.1 Methodology

Life Cycle Cost (LCC) has been carried out with the following options, for the sections as mentioned below.

Flexible Pavement Option (Alternate-1)

Rigid Pavement Option (Alternate-2)

In the Life Cycle Cost Analysis, the present values of all the costs for each of the alternative have been computed. The alternative giving the lowest present value of the costs is to be considered as the most advantageous option from economic perspective.

Net Present value has been computed for Flexible as well as Rigid Pavement option.The Net Present values of both options are given in Table-15.

The options for Life cycle cost analysis are,

Option A : Flexible pavement with Cement Treated base and cement treated sub base

Option B : Rigid pavement

Routine maintenance for Flexible and Rigid pavements have been considered from the MORT&H guidelines 1997 prices, cost for the year 2021 has been computed with an

escalation of 5.0% (whole sale index price). It is calculated based on the Guidelines given in 'Report of the Committee on Norms for Maintenance of Roads in India, MORT&H, published by IRC, 2001.The ordinary repair costs and periodic renewal costs for the configurations with flexible and rigid pavement options are given in Tables below The calculations whole stretch are shown below as a sample. Samples for total cost per year are given in Table 8-18.

Table 8-17: Costs for Ordinary Repairs

S.No	Item	1997 Prices (in Rs)		2023 Prices (in Rs)	
		Flexible Pavement	Rigid Pavement	Flexible Pavement	Rigid Pavement
1	Ordinary Repairs	187020	231168	664983	821957

Table 8-18: Periodic renewal costs-Flexible Pavement (at every 5th year)

Flexible Pavement Overlay (Functional) - at every 5th year							
Layer	Thickness (mm)	m	Width (m)	Total Length (m)	Quntity (cum)	Rates (INR)	Cost(INR)
BC	**40**	0.04	18	24900	17928	14130.84	253337699.52
Total (INR)							**253337699.52**

Table 8-19: Periodic renewal costs-Flexible Pavement (at every 10th year)

Flexible Pavement Overlay (Structural) - at every 10th year							
Layer	Thickness (mm)	m	Width(m)	Total Length (m)	Quntity (cum)	Rates (INR)	Cost(INR)
BC	**40**	0.04	18	24900	17928	14130.84	253337699.52
DBM	**65**	0.065	18.08	24900	29262.48	12826.98	375349245.7104
Total(INR)							**628686945.2304**

Table 8-20: Periodic renewal costs-Rigid Pavement (at every 10th year)

Replacement of Cracked Slabs 20% of total Length of the project- at every 10th year							
Layer	**Thickness (mm)**	**m**	**Width(m)**	**Total Length(m)**	**Quntity (cum)**	**Rates (INR)**	**Cost(INR)**
PQC	**300**	0.3	18	4980	26892	10048	270212698.44
Total(INR)							**270212698.44**

Table 8-21: Total Cost per year

S.No	Item	2024 Prices (in Rs)		2036 Prices (in Rs)		2031 Prices (in Rs)	
		Flexible Pavement	Rigid Pavement	Flexible Pavement	Rigid Pavement	Flexible Pavement	Rigid Pavement
1	Initial cost	1764615268	2011210908			-	-
2	Ordinary Repairs	-	-	-	-	-	30238669
3	Periodical Renewal	-	-	1185482999	509526343	-	-

In the Life Cycle Cost Analysis, the present values of all the costs for each of the alternatives have been computed.

Net Present value per Km has been computed for Flexible as well as Rigid Pavement option. Net Present Values for Flexible and Rigid Pavement are given in Table 8-22.

Table 8-22: Net Present Values

Package	Flexible pavement (BC+DBM+AIL+CTB+CTSB) (in. Cr)	Rigid Pavement (in. Cr)
V	9.6	8.85

MoRTH circular no. RW/NH-33044/31/2014-S&R(R) Pt. dated 04th August, 2014 states that "The price of cement vis-à-vis bitumen varies widely in different parts of the country depending upon the lead from the production centers/refineries etc. This variation would be required to be mapped out and unless there is price comparison within an acceptable limit up to 20%, the use of flexible pavements may perhaps required to be continued."

It means that rigid pavement could be considered when the cost comparison between Cement (PQC layer) used at the time of construction doesn't exceed that of Bitumen (BC & DBM layers) by more than 20%. (In this case, the cost of construction of PQC layer is 46.5% more than the cost of construction of BC+DBM layers. So Flexible pavement can be considered)

Also, as per MoRTH circular no. RW/NH-35079/01/2018-S&R(P & B) dated 21st June 2018,due to the constraints of limited/non-availability of sand in certain areas/states,and certain restrictions imposed by the Hon'ble Courts or for other reasons came to be highlighted by contractors,it has been decided to provide flexible pavement in place of rigid pavement.

Recommended option: Flexible Pavement with Cement Treated Base (CTB) and Cement Treated subbase (CTSB).

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9 PROJECT PROPOSALS

9.1 GENERAL

The proposed project corridor is widening of existing 2-lane stretch NH-8 to 4-lane and Greenfield alignment in the state of Assam. Cross Sections have been developed based on existing section and Geometry of the project corridor. Details of proposed cross sections are provided below:

9.2 LIST OF TYPICAL CROSS SECTION

Table 9-1: Typical Cross Sections

S. No	Description	TCS No.
1	4 Lane Divided Carriageway with Flushed Median (Bypass)	I
2	4 Lane Divided Carriageway for Approaches To VUP With Slip Roads on Both Sides (Bypass)	II
3	4 Lane Divided Carriageway with Eccentric Widening (RHS)	III
4	4 Lane Divided Carriageway with Eccentric Widening (LHS)	IV
5	4 Lane Divided Carriageway with Service Road on Both Sides (Existing Road)	V
6	4 Lane Divided Carriageway with Service Road on Both Sides (LHS Widening)	VA
7	4 Lane Divided Carriageway with Service Road on Both Sides (RHS Widening)	VB
8	4 Lane Divided Carriageway with Service Road on Both Sides (Re Construction)	VC
9	4 Lane Divided Carriageway for Approaches To VUP With Slip Roads on Both Sides (Existing Road)	VI
10	Cross Section of Bridge/ROB At Deck Level – With Footpath for 4-Lane Divided Highway(4-Lane Bridge)	VII
11	Cross Section of Structure At Deck Level - Without Footpath for 4 - Lane Divided Highway (4-Lane Bridge)	VIII
12	Cross Section of Structure At Deck Level - With Footpath for Slip/Service road For 4 - Lane Divided Highway (4-Lane Bridge)	IX

S. No	Description	TCS No.
13	Cross Section of Structure At Deck Level - Without Footpath for Slip/Service Road For 4 - Lane Divided Highway (4-Lane Bridge)	X

9.3 TYPICAL CROSS SECTIONS

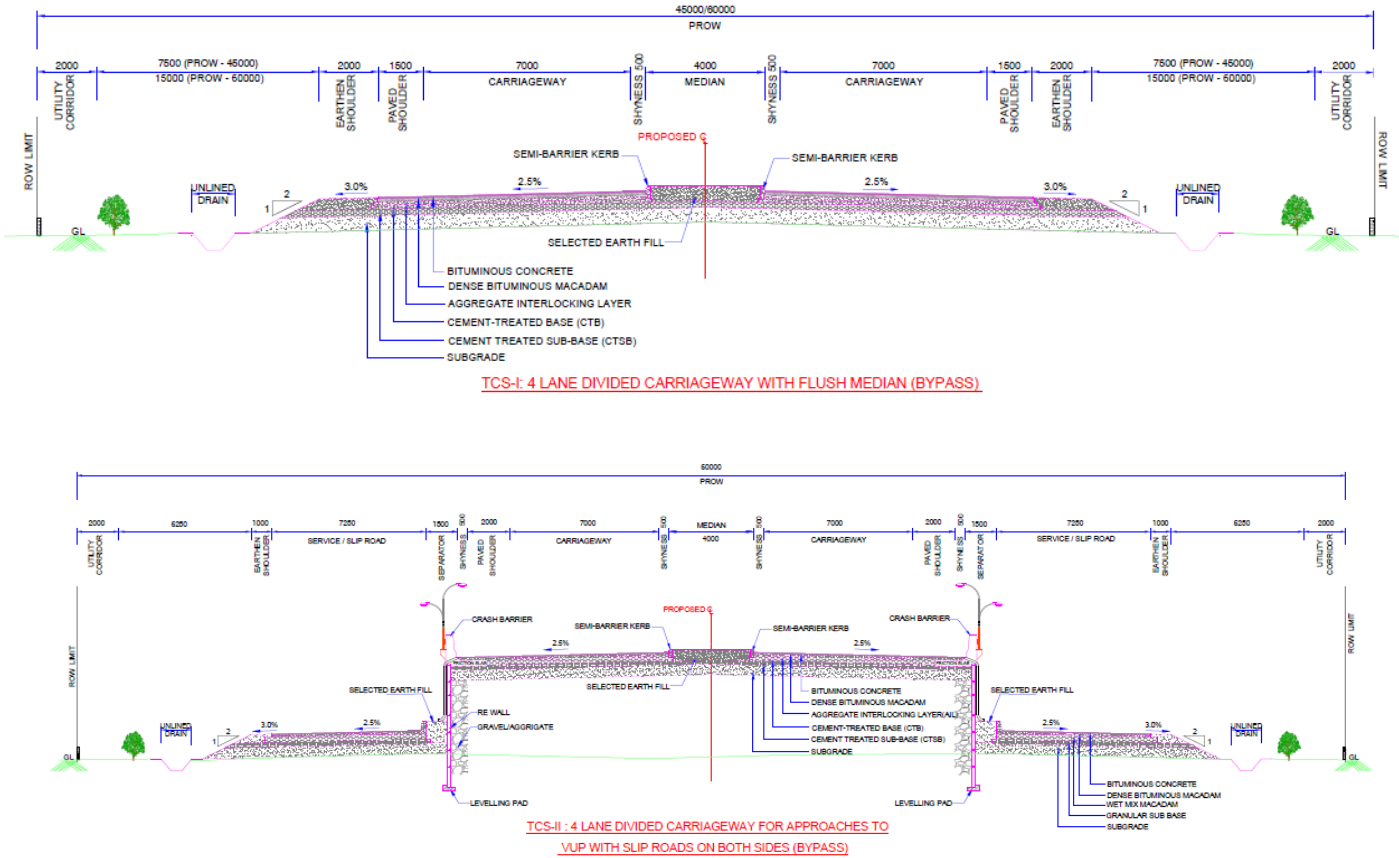


Figure 9-1: TCS-I & TCS-II

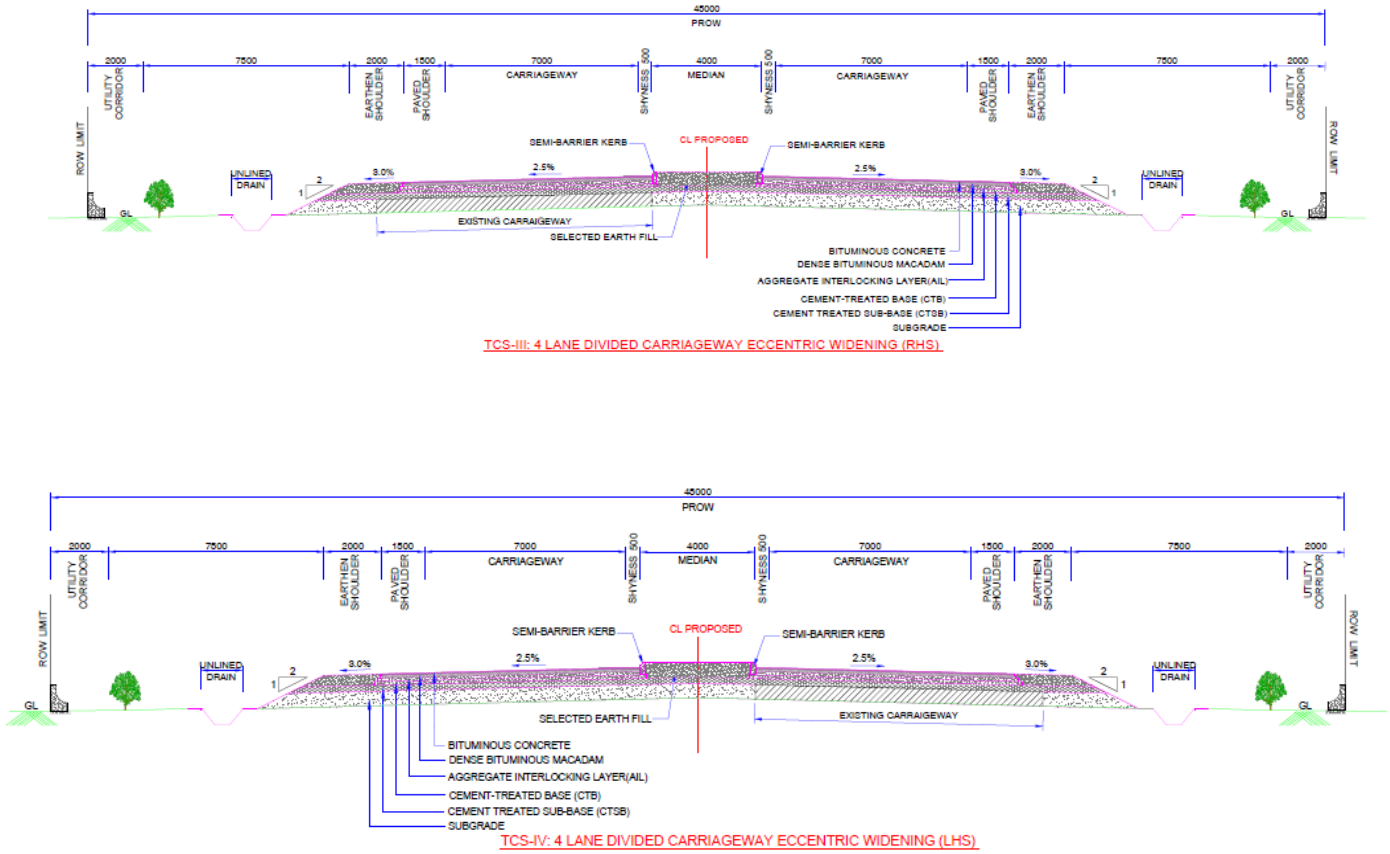


Figure 9-2: TCS-III & TCS-IV

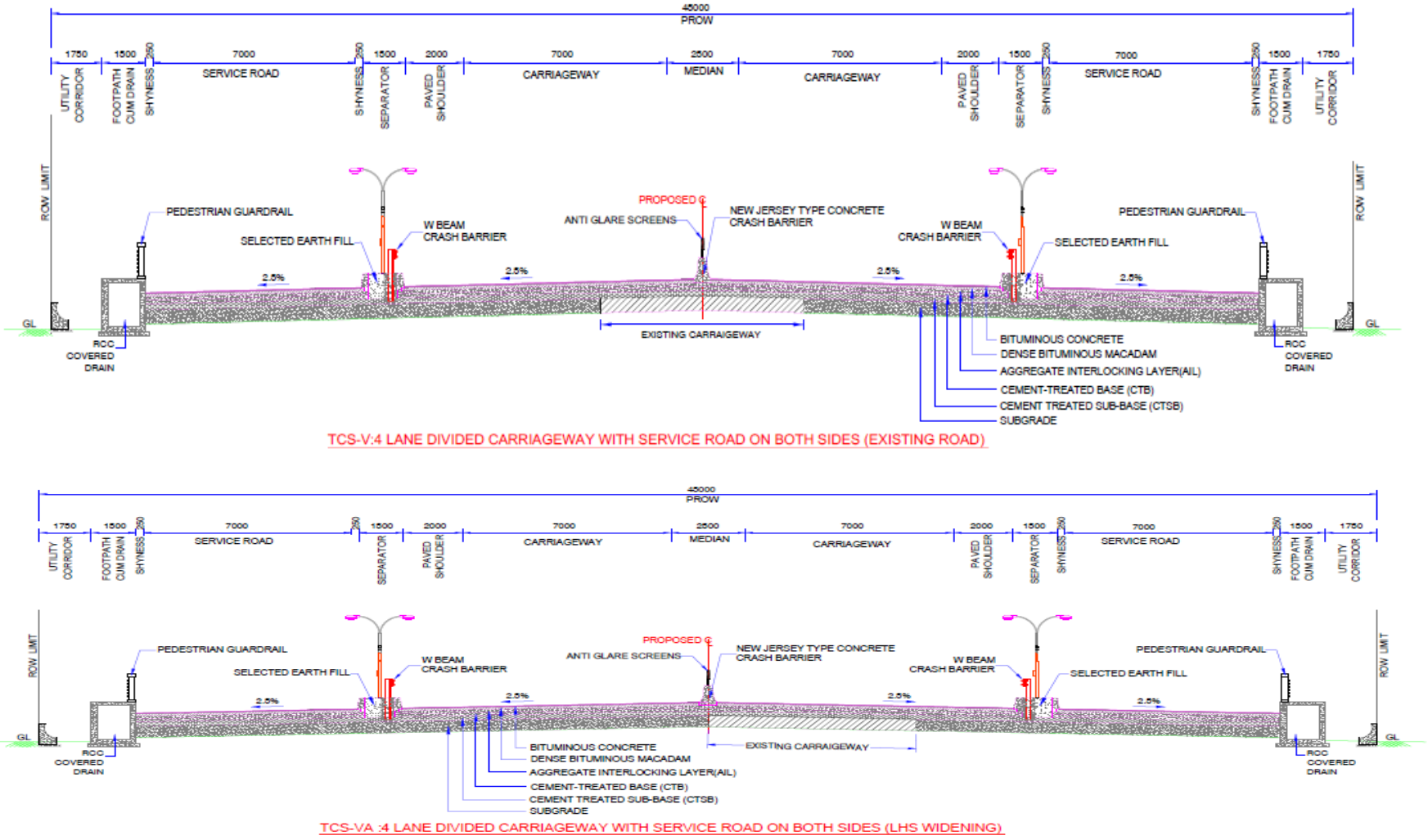


Figure 9-3: TCS-V & TCS-VA

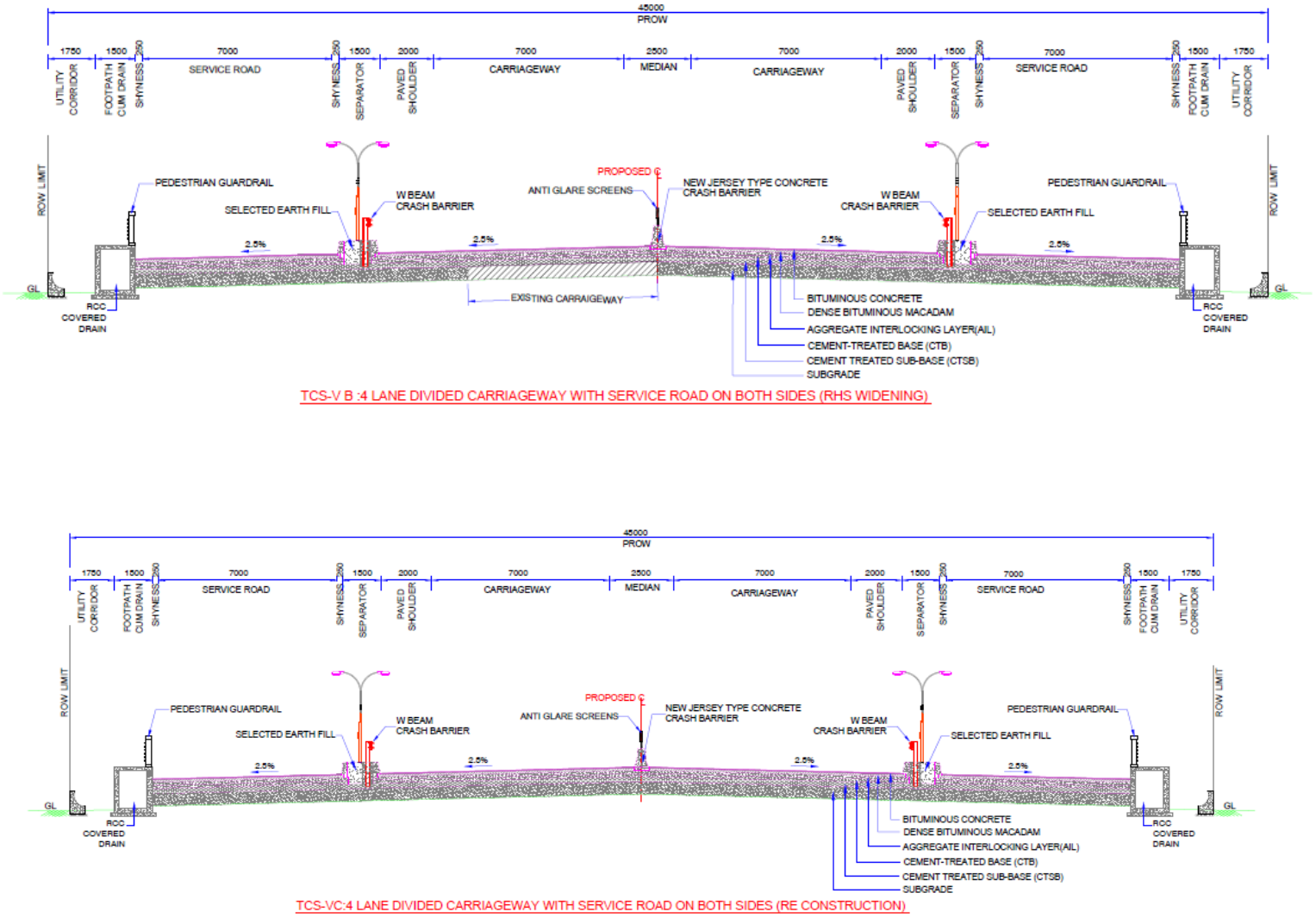
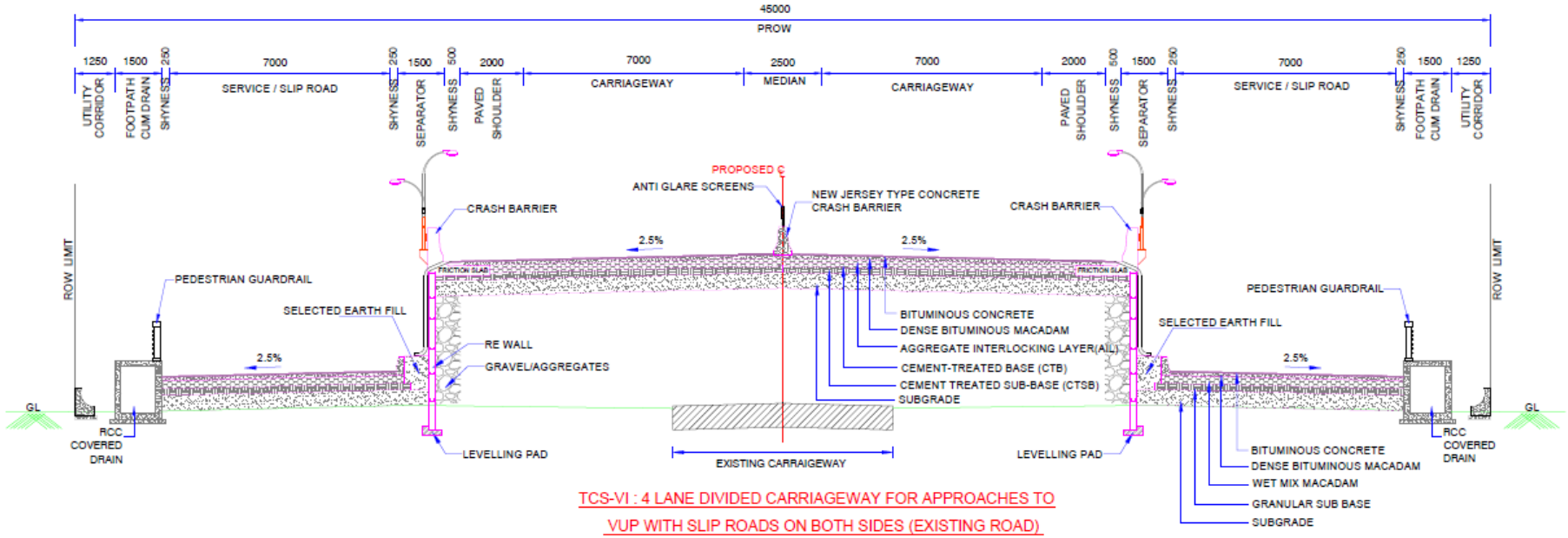
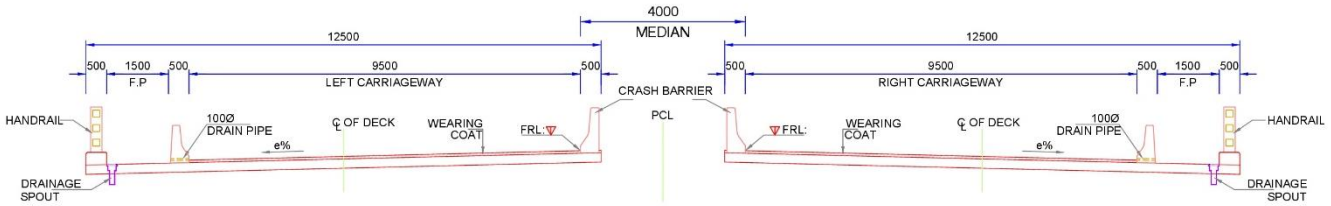


Figure 9-4: TCS-VB & TCS-VC

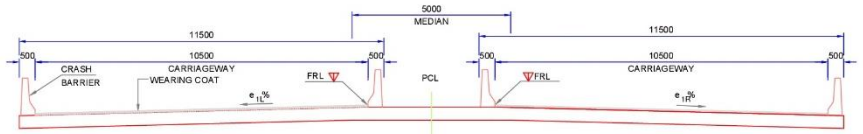


TCS-VI : 4 LANE DIVIDED CARRIAGEWAY FOR APPROACHES TO VUP WITH SLIP ROADS ON BOTH SIDES (EXISTING ROAD)

Figure 9-5: TCS-VI

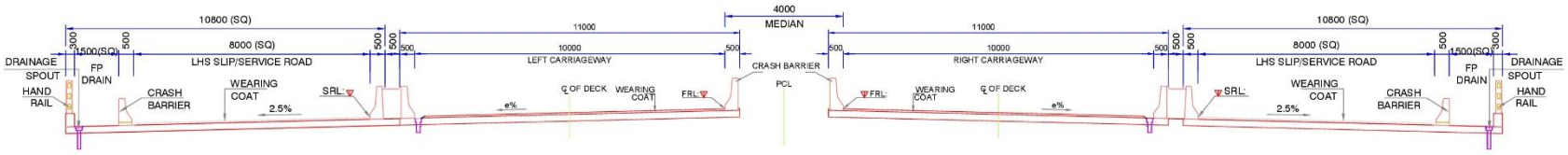


TCS:VII CROSS SECTION OF BRIDGE / ROB AT DECK LEVEL - WITH FOOTPATH
FOR 4 - LANE DIVIDED HIGHWAY (4-LANE BRIDGE)

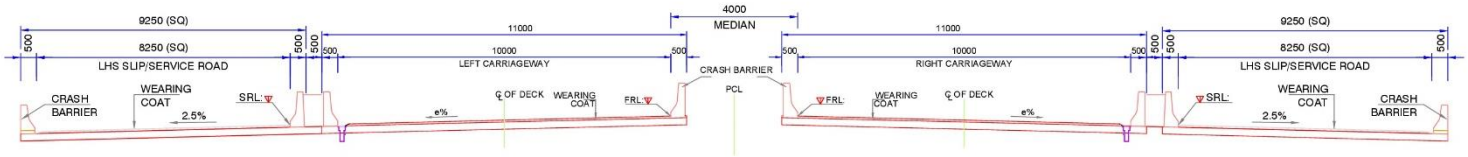


TCS:VIII CROSS SECTION OF STRUCTURE AT DECK LEVEL - WITHOUT FOOTPATH
FOR 4 - LANE DIVIDED HIGHWAY (4-LANE BRIDGE)

Figure 9-6: TCS-VII & TCS-VIII



TCS:IX CROSS SECTION OF STRUCTURE AT DECK LEVEL - WITH FOOTPATH FOR SLIP/SERVICEROAD
FOR 4 - LANE DIVIDED HIGHWAY (4-LANE BRIDGE)



TCS:X CROSS SECTION OF STRUCTURE AT DECK LEVEL - WITHOUT FOOTPATH FOR SLIP/SERVICE ROAD
FOR 4 - LANE DIVIDED HIGHWAY (4-LANE BRIDGE)

Figure 9-7: TCS-IX & TCS-X

9.4 TYPICAL CROSS SECTION SCHEDULE

The project stretch under study has multi-dimensional facets in terms of geometry, pavement condition, existing utilities, religious structures, etc. and considering all these aspects the section-wise policy is adopted based on the initial investigations. The applicable typical cross-sections along the project corridor are summarized in Table below:

9.4.1 Typical cross section schedules

Table 9-2: Applicable Typical Cross Sections Schedules

Sl No.	Chainage (Km)		Length(km)	TCS Type
	From	To		
1	38.600	40.170	1.570	I
2	40.170	40.530	0.360	II
3	40.530	52.360	11.830	I
4	52.360	53.100	0.740	II
5	53.100	54.380	1.280	I
6	54.380	54.520	0.140	IV
7	54.520	54.700	0.180	I
8	54.700	55.550	0.850	VI
9	55.550	56.100	0.550	III
10	56.100	58.950	2.850	IV
11	58.950	59.380	0.430	V
12	59.380	60.610	1.230	VI
13	60.610	62.450	1.840	IV
14	62.450	62.660	0.210	III
15	62.660	62.800	0.140	VI

9.5 AT-GRADE INTERSECTIONS

a) Major Junctions

Table 9-3: Major Junctions

Sr. No.	Design Chainage (Km)	Junction Type	Leads to		Median Opening	Category of Cross Road	Carriage way width of crossroad	Length of crossroad to be developed (m)	
			LHS	RHS				LHS	RHS
1	38.850	T	-	Bhanga bazar	No	Y	9.40	50	50
2	52.750	T	-	Karimganj	No	T	10.00	50	50
3	55.046	T	-	Sutarkandi	No	T	15.00	50	50

b) Minor Junctions

Table 9-4: Minor Junctions

Sr. No.	Design Chainage (Km)	Junction Type	Leads to		Median Opening	Category of Cross Road	Carriage way width of crossroad	Length of crossroad to be developed (m)		Remarks
			LHS	RHS				LHS	RHS	
1	54.759#	Y		Karimganj	No	MDR	7.00	15.0	15.0	Connected to Slip road
2	55.228#	T	-	Saif Nagar	No	VR	6.0	15.0	15.0	
3	56.294	T	Karimganj Substation	-	No	VR	6.50	15.0	-	
4	57.895	T	Bhojendra Nagar	-	No	VR	5.5	15.0	-	
5	58.964#	T	Nairgram	-	No	VR	5.5	15.0	-	Connected to Service road
6	59.984#	Staggered	Suprakandi Railway station	Suprakandi	No	VR	5.00	15.0	15.0	Connected to slip road
7	60.968	T	Rampasha Pt I	-	No	VR	4.00	15.0	-	

9.6 EXISTING/PROPOSED STRUCTURES

9.6.1 Details of ROB's

There are 4 ROB's, all along the project stretch, out of those 4 two are located in package-IV. Details of existing/proposed ROB's and recommendations are provided in table below:

Table 9-5: List of ROB's

S. No	Design Chainage (Km)	Package	Existing Span Arrangement	Proposed Span Arrangement (m)	TCS Type	Recommendation
1	40.978	IV	-	1 x 25 +1 x 37.280 + 1 x 25	VII	New Construction
2	53.328		1 x 11 +1 x 24.5 +1 x 11	1 x 25 +2 x 37.280	VII	Retained + New Construction(RHS)

9.6.2 Details of Major Bridges

All along the project stretch of Section-II there are 3 major bridges out of this 2 are in package-IV Details of existing/proposed Major bridges are provided in table below:

Table 9-6: list of Major Bridges

S. No	Design Chainage (Km)	Package	Existing Span Arrangement(m)	Proposed Span Arrangement(m)	TCS Type	Recommendation
1	48.557	IV	-	3 x 35	VII	New Construction
2	54.460		1 x 80.0	2 x 40	VII	Retained + New Construction

9.6.3 Details of Minor Bridges

A total of 37 existing/proposed minor bridges are present along the project corridor of section-II out of these 13 are located in package-IV. Proposals for the minor bridges are provided in Table 9-7

Table 9-7: List of Minor Bridges

S. No	Design Chainage (Km)	Package	Existing Span Arrangement(m)	TCS Type	Proposed Span (m)	Recommendation	Remarks
1	40.344	IV	-	X	1 x 20.0	New Construction	MIB
2	42.120		-	VIII	1 x 6 x 3.0	New Construction	Box MIB
3	44.798		-	VIII	1 x 10.0	New Construction	Box MIB
4	46.572		-	VIII	1 x 20.0	New Construction	MIB
5	49.807		-	VIII	1 x 6 x 3.0	New Construction	Box MIB
6	51.988		-	VIII	1 x 6 x 3.0	New Construction	Box MIB
7	53.067		-	X	1 x 6 x 3.0	New Construction	Box MIB
8	53.200		-	VIII	1 x 6.0	New Construction	Box MIB
9	55.742		-	VIII	1 x 20.0	New Construction	MIB - Gas Pipe Line
10	56.998		1 x 6.0	VIII	1 x 6 x 3.0	R & W	Box MIB
11	58.103		1 x 6.0	X	1 x 6.0	R & W	Box MIB
12	59.732		1 x 6.0	IX	1 x 6 x 3.0	D & R	Box MIB
13	61.029		1 x 6.0	VIII	1 x 6 x 3.0	R & W	Box MIB

9.6.4 Details of Grade Separator Structures

Underpasses are provided at locations where roads such as National Highways, State Highways & Major District Roads etc. are intersected with project corridor and locations where movement of local traffic is observed. List of Existing & Proposed Grade Separator Structures are provided below:

a) Vehicular Under Passes (Existing):

There is no existing VUPs along proposed alignment in package-IV

b) Vehicular Under Passes (VUP's New Proposals):

Table 9-8: List of VUP's

S. No	Design Chainage (Km)	Package	Existing Span Arrangement(m)	Proposed Span (m)	Recommendation	Remarks
1	40.522	IV	-	1 x 20.0	New Construction	VUP
2	52.750		-	1 x 20.0	New Construction	VUP

S. No	Design Chainage (Km)	Package	Existing Span Arrangement(m)	Proposed Span (m)	Recommendation	Remarks
3	54.117		-	1 x 20.0	New Construction	VUP
4	55.046		-	1 x 30.0	New Construction	VUP
5	59.983		-	1 x 20.0	New Construction	VUP

b) Light Vehicular Under Passes (LVUP's New Proposals):

Table 9-9: List of LVUP's

S. No	Design Chainage (Km)	Package	Existing Span Arrangement(m)	Proposed Span (m)	Recommendation	Remarks
1	41.468	IV	-	1 x 12.0	New Construction	LVUP
2	42.811		-	1 x 12.0	New Construction	LVUP
3	46.878		-	1 x 12.0	New Construction	LVUP
4	50.858		-	1 x 20.0	New Construction	LVUP Cum Culvert

c) Box Structures (New Proposals):

Table 9-10: List of Box Structures

S. No	Design Chainage (Km)	Package	Existing Span Arrangement(m)	TCS Type	Proposed Span (m)	Recommendation	Remarks
1	39.123	IV			1 x 4.0	New Construction	Box UP
2	39.360				1 x 4.0	New Construction	Box UP
3	42.165				1 x 4.0	New Construction	Box UP
4	43.430				1 x 4.0	New Construction	Box UP

S. No	Design Chainage (Km)	Package	Existing Span Arrangement(m)	TCS Type	Proposed Span (m)	Recommendation	Remarks
5	48.695				1 x 4.0	New Construction	Box UP
6	49.508				1 x 4.0	New Construction	Box UP
7	51.725				1 x 4.0	New Construction	Box UP

9.6.5 Details of Proposed Culverts

(a) Box Culverts:

Details of the exiting/propose Box Culverts along the project corridor are provided as below:

Table 9-11: List of Box Culverts

S. No	Design Chainage (Km)	Proposed Type	Proposed Span Arrangement(m)	Recommendation
1	38.823	BC	1 x 3 x 2.0	New Construction
2	39.194	BC	1 x 2.0	New Construction
3	39.726	BC	1 x 2.0	New Construction
4	40.040	BC	1 x 2.0	New Construction
5	40.240	BC	1 x 2.0	New Construction
6	40.780	BC	1 x 2.0	New Construction
7	41.166	BC	1 x 2.0	New Construction
8	41.300	BC	1 x 2.0	New Construction
9	41.666	BC	1 x 2.0	New Construction
10	41.903	BC	1 x 2.0	New Construction
11	42.300	BC	1 x 2.0	New Construction

S. No	Design Chainage (Km)	Proposed Type	Proposed Span Arrangement(m)	Recommendation
12	42.577	BC	1 x 3 x 3.0	New Construction
13	43.028	BC	1 x 2.0	New Construction
14	43.165	BC	1 x 2.0	New Construction
15	43.506	BC	1 x 5 x 5.0	New Construction
16	43.872	BC	1 x 2 x 2.0	New Construction
17	43.959	BC cum UP	2 x 4.0 x 5	New Construction
18	44.105	BC	1 x 2.0	New Construction
19	44.488	BC	1 x 2.0	New Construction
20	44.670	BC	1 x 2.0	New Construction
21	44.945	BC	1 x 2.0	New Construction
22	45.184	BC	1 x 2.0	New Construction
23	45.340	BC	1 x 2.0	New Construction
24	45.606	BC	1 x 2.0	New Construction
25	45.855	BC	1 x 2.0	New Construction
26	46.195	BC	1 x 3 x 2.0	New Construction
27	46.406	BC	1 x 2.0	New Construction
28	46.980	BC	1 x 2.0	New Construction
29	47.211	BC	1 x 3 x 2.0	New Construction
30	47.483	BC	1 x 2.0	New Construction

S. No	Design Chainage (Km)	Proposed Type	Proposed Span Arrangement(m)	Recommendation
31	47.714	BC	1 x 2.0	New Construction
32	48.232	BC	1 x 2.0	New Construction
33	48.930	BC	1 x 2.0	New Construction
34	49.364	BC	1 x 2.0	New Construction
35	49.635	BC	1 x 3.0	New Construction
36	50.288	BC	1 x 2.0	New Construction
37	50.471	BC	1 x 5 x 5.0	New Construction
38	50.700	BC	1 x 2.0	New Construction
39	51.045	BC	1 x 2.0	New Construction
40	51.294	BC	1 x 5.0	New Construction
41	52.130	BC	1 x 2.0	New Construction
42	52.390	BC	1 x 2.0	New Construction
43	53.804	BC	1 x 3.0	New Construction

(b) Pipe Culverts:

S. No	Design Chainage (Km)	Existing Type	Existing Span Arrangement (m)	Proposed Type	Proposed Span Arrangement(m)	Recommendation
Nil						

9.7 SUMMARY OF STRUCTURES

Summary of Existing/Proposed Structures in package-IV are provided below:

Table 9-12: Summary of Existing/Proposed Structures

S. No	Type of Structure	Existing No's	Proposed No's	Total
1	Box Culvert	0	43 on MCW, 12 on CR	55
2	Box Structure	0	7	7
3	LVUP	0	4	4
4	VUP	0	5	5
5	MIB	4	9	13
6	MJB	1	1	2
7	ROB	1	1	2
8	Pipe Culverts	0	22 on CR	22
9	Slab Culverts	0	0	0
Total		**6**	**104**	**110**

*- Existing here represents the number of existing structures in our proposed alignment that needs to be widened or reconstructed

9.8 SLIP ROADS & SERVICE ROADS

Slip roads and service roads were proposed at following locations to move the local traffic along the proposed highway.

Table 9-13: Service Road locations

S. No	Design Chainage (Km.)		Package	Design Length (kms)	Width of carriageway	Remarks
	From	To				
1	58.950	59.380	IV	0.430	7.500	BHS

Table 9-14: Slip Roads locations

S. No	Design Chainage (Km.)		Package	Design Length (kms)	Width of carriageway	Remarks
	From	To				
1	40.170	40.530	IV	0.360	7.250	BHS
2	52.360	53.100		0.740	7.250	LHS

S. No	Design Chainage (Km.)		Package	Design Length (kms)	Width of carriageway	Remarks
	From	To				
3	52.360	52.750		0.390	7.250	RHS
4	54.700	55.550		0.850	7.500	BHS
5	59.380	60.610		1.230	7.500	BHS
6	62.660	62.800		0.14	7.500	BHS

9.9 REALIGNMENTS

Realignments were proposed at the following locations where the existing road has substandard curves.

Table 9-15: Realignment Locations

S. No	Design Chainage (Km.)		Package	Design Length (kms)	Remarks
	From	To			
Nil					

9.10 BYPASSES

Bypasses were proposed at following locations where existing road is passing through built-up area.

Table 9-16: Bypasses Locations

S. No	Design Chainage (Km.)		Package	Design Length (kms)	Remarks
	From	To			
1	38.600	53.100	IV	15.655	Bhanga Bypass

9.11 TOLL PLAZAS

Toll plazas have been proposed at mid-block sections of the proposed project corridor and the same mentioned in the table

Table 9-17: Toll Plaza Location

S. No	Package	Design chainage (Km)	Remarks
1	IV	44.300	4 +4 lane

9.12 BUS-BAYS AND BUS SHELTERS

Bus bays/shelters are proposed at built up areas. The proposed bus bays/ shelters are given in Table 9-18,Table 9-19

Table 9-18: Location of Bus-Bays

S. No	Design chainage LHS(Km)	Design chainage RHS(Km)	Village
1	38.650	38.620	Kandigram Chaintanyanagar
2	62.100	62.160	Alam Khani Pt I

Table 9-19: Location of Bus Shelters

S. No	Design chainage LHS(Km)	Design chainage RHS(Km)	Village
1	54.960	54.960	Saidambar
2	59.03	59.07	Humak
3	59.93	60.03	Barijal

9.13 REST AREA

Table 9-20: Rest Area Locations

S. No	Package	Design chainage (Km)	Side	Remarks
1	IV	43.300	LHS	
2		51.600	RHS	

9.14 RETAINING WALLS

Table 9-21: Retaining Wall locations

S.No.	Design Chainage (Km)	Length (m)	Side	Height (m)	Retaining	Remarks

	From	To				Structure/Toe wall	
1	40.540	40.930	390	LHS	4.50	Retaining Structure/Toe wall	Average Height is mentioned
2	41.030	41.480	450	LHS	4.50	Retaining Structure/Toe wall	
3	48.300	48.500	200	LHS	1.50		
4	48.620	48.800	180	LHS	1.50		
5	53.100	53.290	190	LHS	5.00		
6	53.360	53.700	340	LHS	5.00		
7	54.300	54.400	100	LHS	5.50		
8	54.500	54.700	200	LHS	4.00		
9	55.550	56.020	470	LHS	3.00		
10	56.850	57.120	270	LHS	2.00		
11	57.660	57.880	220	LHS	1.50		
12	58.090	58.220	130	LHS	1.50		
13	40.540	40.930	390	RHS	5.50		
14	41.030	41.480	450	RHS	4.00		
15	48.300	48.500	200	RHS	2.00		
16	48.620	48.800	180	RHS	1.50		
17	52.760	53.200	440	RHS	3.50		
18	53.360	54.400	1040	RHS	6.50		
19	54.500	54.700	200	RHS	5.00		
20	55.550	56.020	470	RHS	2.50		

9.15 RE WALLS

Table 9-22: Location of RE Walls

S. No	Chainage (Km.)		Length (m)	TCS Type	Remarks
	From	To			
1	40.170	40.530	360	II	
2	52.360	53.100	740	II	LHS- 52+360 to 53+100 & RHS- 52+360 to 52+750
3	54.700	55.550	850	VI	
4	59.380	60.610	1230	VI	

5	62.660	62.800	140	VI	

9.16 LINED DRAINS

Table 9-23: Location of Lined Drains

S. No	Chainage (Km.)		Length (m)	TCS Type
	From	To		
1	54.700	55.550	850	VI
2	58.950	59.380	430	V
3	59.380	60.610	1230	VI
4	62.660	62.800	140	VI

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10. ENVIRONMENT SCREENING AND PRELIMINARY ENVIRONMENT ASSESSMENT

10.1 INTRODUCTION

NHIDCL has appointed M/s Aarvee Associates Architects Engineers & Consultants Pvt. Ltd. for the work of consultancy services for preparation of DPR and Pre-construction services from – (i) Silchar ISBT (Start point of Silchar Bypass) to junction of NH-37 & NH-6 at Dhaleshwari, (ii) End of proposed Badarpur bypass to Churaibari (Assam-Tripura border), (iii)Spur from NH-8 near Karimganj to Sutarkandi

The LOA for the project was awarded to M/s Aarvee Associates Architects Engineers & Consultants Pvt. Ltd vide Letter No. NHIDCL / Assam / DPR / Silchar Churaibari / 222542 / 2581 and the agreement was signed on 1st September 2023.

10.2 PROJECT DESCRIPTION

As per ToR, the scope of the consultancy services comprises of "preparation of DPR and Pre-construction services from – (i) Silchar ISBT (Start point of Silchar Bypass) to junction of NH-37 & NH-6 at Dhaleshwari, (ii) End of proposed Badarpur bypass to Churaibari (Assam-Tripura border), (iii) Spur from NH-8 near Karimganj to Sutarkandi"

Table 10-1: Details of Package-IV

S. No	Section No.	Package	From (Km.)	To (Km.)	Length (km0	Geographic Coordinates	
						Start	End
1	II	IV	38.6	62.8	24.2	24°52'6.14"N, 92°30'5.34"E	24°46'0.82"N, 92°22'21.40"E

10.3 PRELIMINARY ENVIRONMENTAL ASSESSMENT

This Report describes the proposed work plan related to environmental aspects and makes desirable modifications, keeping in view the requirement of the Project Road. Standard methods / procedures will be adopted during environmental monitoring analysis and report preparation. The exact sampling locations and number will be finalized during field studies. However, tentative sampling number is provided at this stage. The methodology for carrying out the study and specifications pertaining to environment to be adopted in this project are as follows:

10.3.1 Objectives

The major objective of this study is to establish present environmental condition along the project corridor through available data/ information supported by field studies to evaluate the

impacts on relevant environmental attributes due to the construction & operation of the proposed project; to recommend adequate mitigation measures to minimize/ reduce adverse impacts and to prepare an Environmental Management Plan (EMP) for timely implementation of the mitigation measures to ensure that the project will result in a high quality and safe road to users in a sustainable and environment-friendly manner. An Environmental Impact Assessment (EIA) study basically includes:

- Establishment of the present environmental scenario.
- Study of the specific activities related to the project;
- Evaluation of the potential environmental impacts.
- Undertake an analysis of alternatives by bringing in environmental considerations into the upstream stages of sub-project planning and design;
- Preparation of Environmental Management Plan that specifies the measures to mitigate adverse impacts and enhance positive impacts of the sub-project on the environment, along with the monitoring, capacity building and institutional arrangements.

10.3.2 Need for Environment Impact Assessment

Highway developmental activities should be planned and executed after considering the potential environmental impacts. To minimize these adverse impacts that may be created by highway development projects, the techniques of Environmental Impact Assessment (EIA) become necessary. Identification and assessment of potential environmental impacts should be an integral part of the project life cycle. It should commence early in the planning process of the project to enable a full consideration of alternatives and to avoid later delays and complications.

10.3.3 Legal and Environmental Clearance requirements

The increase of environmental concerns has necessitated appropriate tools to protect the environment. India has developed a comprehensive regulatory framework to address environmental and social concerns in relation to development projects. Its wide-ranging enactments cover almost all major issues that need to be addressed in the course of development of infrastructure from a social and environmental perspective. This section describes the institutional set-up and key legislation pertaining to environmental issues.

Institutional Framework

The Ministry of Environment, Forest and Climate Change (MoEF&CC) to serve as the focal point in the administrative structure for the planning, promotion and coordination of environmental and forestry programmes. The Ministry of Environment and Forests (MoEF) has been renamed recently in the year 2014 as Ministry of Environment and Forest and Climate Change (MoEF&CC). The MoEF&CC has overall authority for the administration and implementation of government policies, laws and regulations related to the environment,

including conservation, environmental assessment, sustainable development and pollution control. MoEF&CC identifies the need to enact new laws and amend existing environmental legislation when required, in order to continue to conserve and protect the environment. At the state level, the MoEF&CC authority is implemented by the Department of the Environment and the Department of Forest.

In 1976, the 42nd Constitutional Amendment created Article 48A and 51A, placing an obligation on every citizen of the country to attempt to conserve the environment. As a result, a number of laws related to environmental conservation were passed to strengthen existing legislation. Environment (Protection) Act, 1986 is the landmark legislation as it provides for the protection of environment and aims at plugging the loopholes in the other related acts.

The Government of India through specific legislation regulates the environmental management system in India. The Ministries / Statutory Bodies responsible for ensuring environmental compliance by project proponents include:

- The Ministry of Environment & Forests and Climate Change (MoEF&CC).
- Central Pollution Control Board (CPCB).
- Department of Environment in the States.

10.4 APPLICABLITY OF INTERNATIONAL, NATIONAL AND STATE ENVIRONMENTAL NORMS

The proposed highway development project is attracting various International, National, State, and World Bank environmental laws, rules and regulations. These regulations and rules are helpful in impact mitigation and improvement of the environment. The environmental assessment study will be carried out as per the requirement of the National/State/World Bank environmental guidelines. The applicability of the regulatory norms is given in table below:

Table 10-2: Applicability of Environmental Regulatory Norms for the Project

Project	Project Components	Applicability of Environmental Laws, Policies and Notifications	Remarks
"preparation of DPR and Pre-construction services from – (i) Silchar ISBT (Start	• Right of Way • Land Acquisition • Protected Social Forestry throughout the Right of	The Environment (Protection) Act, 1986 and further notifications issued under this Act.	Any act during implementation causing damage to environment. As per the Environment

Project	Project Components	Applicability of Environmental Laws, Policies and Notifications	Remarks
point of Silchar Bypass) to junction of NH-37 & NH-6 at Dhaleshwari, (ii) End of proposed Badarpur bypass to Churaibari (Assam-Tripura border), (iii)Spur from NH-8 near Karimganj to Sutarkandi"	Way (RoW) • Quarries • Borrow Areas • Establishment of Hot Mix Plants and Batch mix Plants • Sensitive Locations (Schools, hospitals, etc.,) • Archaeological Sites		(Protection) Act (EP) 1986, ambient noise levels are to be maintained as stipulated by the Central Pollution Control Board (CPCB) for different categories of areas like, commercial, residential and silence zones, etc., during sub-project construction and operation. Section -3 (2)(iii & iv).
		Water (Prevention and Control of Pollution) Cess Act, 1977 including Rules	Applicable to all activities, which discharge effluents as a result of process or operations. Section 3 (2)(a) of the Act and Cess to the Govt. of India as per Table -I & II for consumption of water for domestic, commercial and industrial purposes.
		Water (Prevention and Control of Pollution) Act, 1974 – as amended in 1978 & 1988.	
		Forest (Conservation) Act, 1980 – as amended in 1988.	Applicable if the project involves any activities in the reserved forests, village forests,

Project	Project Components	Applicability of Environmental Laws, Policies and Notifications	Remarks
			protected forests and other areas as declared by the state Government. Forest Conservation Act –Chapter –2.4 and Chapter –3.0.
		The Ancient Monuments and Archaeological Sites and Remains Act, 1958, as amended in 2010. Ancient Monuments and Archaeological Sites and Remains Rules, 1959.	Applicable if the project involves any activities in the close proximity (less than 200m) of Ancient Monuments and Archaeological Sites
		Wildlife Protection Act, 1972, amended thereof. The Wildlife (Protection) Rules, 1995.	The act prohibits picking, uprooting, damaging, destroying, acquiring any specified plant from any forest land. It bans the use of injurious substances, chemicals, explosives that may cause injury or endanger any wildlife.
		Coastal Regulation Zone (CRZ) Notification 1991 as amended till January 2011	Not Applicable
		The Hazardous Wastes (Management and Handling) Rules, 1989 and subsequent amendments thereof till date.	Materials such as heavy metals, toxic inorganic, oils, emulsions, spent chemicals and Metal-

Project	Project Components	Applicability of Environmental Laws, Policies and Notifications	Remarks
			finishing wastes emanating during construction and operation shall be stored and disposed of as per the Rules. Rule 17, 18 & 19 of the Act.
		The Public Liability Insurance Act, 1991.	Act enables the people to access legal aid to claim compensation in the event of an accident occurred while handling any hazardous substance. So insurance needs to be taken up by the project implementing agencies or contractors. PLI Act: Act 6 of 1991 as amended by Act 11 of 1992.
		Ministry of Environment Forests & Climate Change (MoEF&CC) EIA Notification (New) issued on 14th September, 2006 and subsequent amendments thereof till date.	The proposed project stretch is less than 100 Kms in length. Hence, the project does not attract the Environmental Clearance from MoEF&CC.

Project	Project Components	Applicability of Environmental Laws, Policies and Notifications	Remarks
		World Bank Operational Directive and Operational Policies for Environmental Impact Assessment OP:4.01, OP 4.04: Natural Habitats, OP 4.36: Forests, OP 4.11: Operational Policy on cultural property and OP 4.12: Involuntary Resettlement for roads & highways projects.	Applicable in preparation of Environmental assessment report, protection of cultural property, forest clearances etc.
		Noise Pollution (Regulation and Control) Rules, 2000	Applicable Under Rule 3(1) & 4 (1) - Clause 2, 3 & 6.
		Land Acquisition Act 1894 Land Acquisition Act 1989 & RFCTLARR Act, 2013.	Applicable. To set out rules for the acquisition of land by Government.
		Motor Vehicles Act, 1988 Rules of Road Regulations, 1989	Applicable. To enforce highway codes during construction and operation.

A brief description of the relevant laws is given below:

EIA Notification, 2006

This is the Indian Government's Guidelines for environmental impact assessment governing all of the development interventions that takes place within the boundaries of India. EIA notification was issued by the Ministry of Environment, Forests and Climate Change (MoEF&CC) in 2006. Under this EIA Notification, the projects listed in Schedule-1 of the Notification require prior environmental clearance. The objective of the notification is to formulate a transparent, decentralized and efficient regulatory mechanism to:

- Incorporate necessary environmental safeguards at planning stage.
- Involve stakeholders in the public consultation process
- Identify developmental projects based on impact potential instead of the investment criteria

As per EIA Notification, 2006 and amendment thereafter, "Expansion of National Highways greater than 100 Km involving additional Right of Way or land acquisition greater than 40 m on existing alignment and 60 m on re-alignments or bypasses" may require clearance from EAC, MoEF&CC. As per Honorable Supermen court's direction, 10 km radius from the boundary of wildlife sanctuary will be considered as eco-sensitive zone till the actual radius of the Eco-sensitive zone around the wildlife sanctuary boundary is notified by the state government. The MDR and ODRs do not come in the purview of EIA Notification, 2006.

Forest (Conservation) Act, 1980

This Act is of particular significance in case the project corridors require acquisition of forest land outside the RoW of the road corridors as a result of the rehabilitation work proposed. The Indian Forest Act (1927) was amended in 1980 in an attempt to check the rapid deforestation occurring throughout India and the Forest (Conservation) Act, 1980 came into existence. At the state level, the government was empowered to declare reserves and protected forest and was also given the authority to acquire land for extension and preservation of the forests. An advisory Committee was formed to supervise compliance, within other government departments. In December 1996, a Supreme Court Judgment further defined the types of forests to be protected. The Ministry of Environment and Forests in their Corrigendum to Part II, Section 3, Sub-section (i) of Forest (Conservation) Amendment Rules, 2004 issued vide G.S.R. 107(E) dated 9th February, 2004, which explains the procedure for application for diversion of forests land depending on the area involved as follows:

- The proposal involving forest land up to 40 hectares shall be forwarded by the concerned State Government along with its recommendations, to the Chief Conservator or Forests or the Conservator of Forests of the Regional Office of the Ministry of Environment and Forests Government of India.
- The Chief Conservator of Forests/ Conservator of Forests of the Regional Office shall within a period of 45 days of the receipt of the proposal from concerned, decide the diversion of proposal upto 5 Ha.
- If the forest land is more than 5 and upto 40 hectare, The Chief Conservator of Forests/ Conservator of Forests of the Regional Office process, scrutinize and forward diversion proposal along with the recommendations, if any, to Ministry of Environment and Forests, New Delhi for obtaining decision of the Central Government and inform the State Government and the User Agency concerned.

- The proposal involving more than 40 ha of forest area, shall be forwarded by the concerned State Government along with its recommendations, to the Ministry of Environment and Forests, New Delhi

Guidelines for Diversion of Forest Land for Widening or Realignment of Road

As per Forest (Conservation) Act, the roadside plantation within the ROW notified as protected forests for management purposes will need approval from the Central Government under Forest (Conservation) Act, 1980.

The Regional Offices shall be competent to finally dispose of all such proposals irrespective of the area, preferably within 30 days from the date of receipt of the proposal. While the approval, in place of normal provisions for compensatory afforestation, the Regional Offices will stipulate a condition that for every tree cut at least two trees should be planted.

However, if the decision is not ordered by the concerned Regional Office within 30 days of the receipt of fully completed application, the Central Government / State may proceed with the widening/modernization under intimation to the local State Forest Department and Central Government.

All the cases for forest clearance are now required to be applied online on the MoEF&CC website. From there the application will be forwarded to the Nodal Officer of respective state for further processing of application. The user agency will submit the proposal in the prescribed format through the State Forest Department to the concerned Regional Office of the Ministry.

Wildlife Protection Act, 1972

The Wildlife Protection Act, 1972 has allowed the government to establish a number of National Parks and Sanctuaries over the past 25 years, to protect and conserve the flora and fauna of the state.

The Water (Prevention and Control of Pollution) Act, 1974

The act resulted in the establishment of the Central and State level Pollution Control Boards whose responsibilities include managing water quality and effluent standards, as well as monitoring water quality, prosecuting offenders and issuing licenses for construction and operation of any facility. This will include generation of liquid effluent during construction of road from civil engineering activities or from domestic activities in workers colony. There are specific penalties for violation, which include imprisonment for responsible officials.

The Air (Prevention and Control of Pollution) Act, 1981

The act empowers Central and State Pollution Control Boards for managing air quality and emission standards, as well as monitoring air quality, prosecuting offenders and issuing licenses for construction and operation of any facility. Air quality includes noise level standards. There are specific penalties for violation, which include imprisonment for responsible officials. This act has notified National Ambient Air Quality Standard for different regions e.g. Industrial, Residential and Sensitive. Air quality during construction and operation phases will be guided by this specific act.

Environment (Protection) Act, 1986

This act was passed as an overall comprehensive act "for protection and improvement of environment" Under this act rules have been specified for discharge/emission of effluents and different standards for environmental quality. These include Ambient Noise Standard, Emission from Motor Vehicles, Mass Emission standard for Petrol Driven Vehicles, General Effluent Standards etc. especially important for road project.

Fly ash Notification, 2016

According to the Notification No. S.O. 763 (E), dated 14.09.1999 and its amendment thereafter on 27.08.2003 and notification S.O. 2804 (E) dated 3rd November 2009 by Ministry of Environment and Forests, it is mandatory to use fly ash within a radius of 300 kilometers of Thermal Power Plant. No agency, person or organization shall within a radius of 300 kilometers of Thermal Power Plant undertake construction or approve design for construction of roads of flyover embankments in contravention of the guidelines/ specification issued by the Indian Road Congress (IRC) as contained in IRC specification No. SP: 58: 2001. Any deviation from this direction can only be agreed to a technical reason if the same is approved by Chief Engineer (Design) or Engineer-in-chief of the concerned agency or organization or on production of certificate of "Pond ash not available" from the Thermal Power Plant(s) located within 100 kilometers of the site construction. This certificate shall be provided by TPP within two working days from the date of making request for fly ash.

Soil required for top or side cover of embankment of roads or flyovers shall be excavated from the embankment site and it is not possible to do so, only the minimum quantity of the soil required for the purpose shall be excavated from soil borrow area. In either case, the topsoil should be kept or stored separately. Voids created due to soil borrow area shall be filled up with ash with proper compaction and covered with topsoil kept separately as mentioned above. No agency, person or organization shall within a radius of 100 kilometres of coal or lignite based Thermal Power Plant allow reclamation and compaction of low-lying areas with soil. Only pond ash shall be used for compaction. They shall also ensure that such reclamation and compaction is done in accordance with the byelaws, regulation and specification laid down by Authorities.

World Bank Safeguard Policies

Environmental Assessment – OP 4.01 Requirements

Operational Policy 4.01 (OP 4.01) is one of the ten safeguard policies of the World Bank, which provides the Environmental Assessment (EA) guidance for the lending operations. The OP 4.01 requires the borrower to screen projects upstream in the project cycle for potential impacts. Thereafter, an appropriate EA approach to assess, minimize, enhance and mitigate potentially adverse impacts is selected depending on nature and scale of project. The EA needs to be integrated in the project development process such that timely measures can be applied to address identified impacts. The policy requires consultation with affected groups and NGOs to recognize community concerns and the need to address the same as part of EA.

Cultural Property – OP 4.11 Requirements

The World Bank's Operational Policy Note 4.11 aims at preserving and avoiding the elimination of structures having archaeological (prehistoric), paleontological, historical, religious and unique natural values. Projects that could significantly damage non-replicable cultural properties are declined for funding and the Bank will in turn assist protection and enhancement of cultural properties encountered in the project rather than leaving that protection to chance.

Natural Habitats – OP 4.04 Requirements

Operational Policy 4.04 sets out the World Bank's policy on supporting and emphasizing the precautionary approach to natural resource management and ensuring opportunities for environmentally sustainable development. As per this policy, projects that involve significant conversion or degradation of critical natural habitats are not supported by the Bank. Projects involving noncritical habitats are supported if no alternatives are available and if acceptable mitigation measures are in place.

Forests – OP 4.36 Requirements

OP 4.36 sets out specific policy on protection of forests through consideration of forest related impacts of all investment operations, ensuring restrictions for operations affecting critical forest conservation areas, and improving commercial forest practice through use of modern certification systems. The policy requires consultation with local people, the private sector and other stakeholders in forest area.

Involuntary Resettlement OP 4.12

This policy describes Bank policy and procedures on involuntary resettlement as well as the conditions the borrowers are expected to meet in operations involving resettlement. The objective of the Bank's policy is to ensure that populations displaced by a project also benefit from the project and that livelihood and standards of living are improved, or at, least restored to earlier levels.

Indigenous People OP 4.20 Requirements

The World Bank policy on indigenous peoples, OP/BP 4.20, Indigenous Peoples, underscores the need for Borrowers and Bank staff to identify indigenous peoples, consult with them, ensure that they participate in, and benefit from Bank-funded operations in a culturally appropriate way- and that adverse impacts on them are avoided, or where not feasible, minimized or mitigated.

As per the World Bank's Environmental Safeguard policy, the project coordinating entity or implementing institution carries out Environmental Assessment (EA) during the preparation of each proposed sub-project according to country requirements and the requirements of this policy. The Bank appraises and recommends to strengthen the capabilities of the coordinating entity or the implementing institution to (a) screen sub-projects, (b) obtain the necessary expertise to carry out EA, (c) review all findings and results of EA for individual sub-projects, (d) ensure implementation of mitigation measures (including, where applicable, an EMP), and (e) monitor environmental conditions during project implementation. If the Bank is not satisfied that adequate capacity exists for carrying out EA, all Category A sub-projects and, as appropriate, Category B sub-projects including any EA reports are subject to prior review and approval by the Bank.

The purpose of conducting an environmental assessment (EA) is to identify environmental and social consequences of the proposed sub-projects or components, in order to:

- Ensure the identification of potential environmental issues and social concerns early in the implementation of a proposed project to incorporate necessary safeguards in project design to prevent potential adverse impacts by determining appropriate mitigation and compensation measures.
- Minimize risks and enhance positive impacts/benefits;
- Avoid delays and extra costs which may subsequently arise due to unanticipated environmental problems.
- Identify the potential for maximizing environmental resources management and socio-economic benefits to local communities within the scope of the sub project;
- The EA should cover physical-chemical, biological, socio-economic and cultural issues that are likely to arise during upgrading and widening of roads safety risks and appurtenance structures and associated activities as appropriate.

The World Bank has classified the type of projects into following categories depending on the extent of the impact on environment:

(i) Category A: A proposed project is classified as Category A, if it is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. Such project requires full EIA study.

(ii) Category B: A proposed project is classified as Category B if its potential adverse environmental impacts on human populations or environmentally important areas— including wetlands, forests, grasslands, and other natural habitats—are less adverse than those of Category A projects. These impacts are site-specific; few if any of them are irreversible; and in most cases mitigatory measures can be designed more readily than for Category A projects.

(iii) Category C: A proposed project is classified as Category C if it is likely to have minimal or no adverse environmental impacts. Beyond screening, no further EA action is required for a Category C project.

(iv) Category FI: A proposed project is classified as Category FI if it involves investment of Bank funds through a financial intermediary, in sub projects that may result in adverse environmental impacts.

Thus, for Category-A project detail Environmental Assessment would be required. For the project requiring Environmental Clearance from the MoEF&CC, detailed Environmental Impact Assessment would be required in accordance with the Environmental Impact Assessment Notification, 2006 and amended thereafter. For Category-B projects site specific EA is required and a generic environmental management plan (EMP) would be required to be prepared for such project. For Category C projects no study beyond environmental screening is required.

Statutory Clearance for Borrow area and stone quarry

Mining of minor minerals such as sand, gravel, clay, marble and other stones will not be allowed in the country without the approval of the Central government. The Honorable Supreme Court, vide its order dated 27.02.2012 in I.A.No.12-13 of 2011 in SLP (C) No.19628-19629 of 2009 titled Deepak Kumar etc. Vs. State of Haryana & Ors. has inter alia ordered that leases of minor mineral including their renewal for an area less than 5 ha be granted by the State / Union Territory only after getting environment clearance (EC) from the Ministry of Environment, Forests and Climate Change (MoEF&CC). In order to ensure compliance of the aforesaid order of the Hon'ble Supreme Court, MoEF&CC issued an OM No.L-11011/47/2011-IA.II(M) dated 18.05.2012 stating inter alia that all mining projects of minor minerals including their renewal, irrespective of the size of the lease would require prior EC and that the projects of minor minerals with lease area less than 5 ha would be treated as Category "B" as defined in EIA Notification, 2006 and will be considered by the respective State Environment Impact Assessment Authorities (SEIAAs) notified by MoEF&CC and following the procedure prescribed under the EIA Notification, 2006. The mining projects having more than 5 Ha of lease area will be categorised as Category A project and will be appraised by Central Committee of MoEF&CC.

Regarding the borrow area for ordinary soil, the Contractor has to obtain environmental clearance from State Environmental Impact Assessment Authority (SEIAA) of MoEF&CC in compliance to the Supreme Court's order and MoEF&CC conditions vide their circular no. L-11011/47/2011-IA.II(M) dated 20th June, 2013. If the area of a borrow area is less than 5 Ha then this will be treated as Category-B-2 Project and will be appraised and approved based of only Form-1. No EIA study will be required for such area. However if the size of the borrow area is more than 5 Ha then it will be categorized as "Category-B1" and therefore will require EIA study, based on which the SEIAA will give clearance for the same.

Applicability of Clearances:

Environmental Clearance

Environmental Impact Assessment (EIA) Notification issued on 14th September 2006 (amended) by the MoEFCC, Govt., of India and as per the amended Notification of the MoEF&CC on 22nd August 2013 on Highway projects. New, expansion or modernization of any activity falling within the 32 categories of developmental and industrial activities shall be undertaken in any part of India only after it has been accorded environmental clearance by the MoEF&CC in accordance with the procedures specified in the notification. Among the 32 categories listed in Schedule -1 of Notification, the proposed project will not attract the Environmental Clearance from MoEF&CC since the project stretch does not require land acquisition and the packages are less than 100 Kms in length (See Box -1).

Box -1:
Categorization of projects and activities
i) All projects and activities are broadly categorized into two categories – Category A and Category B
ii) Category A: Expansion of National Highways greater than 30 km involving additional right of way greater than 20m involving land acquisition.
ii) Category B: All State Highway Projects & State Highway expansion projects in hilly terrain (above 1000m AMSL)
iii) & / or ecologically sensitive areas.
iv) All projects or activities included as Category 'A' shall require prior environmental clearance from the Central Government in the MOEF on the recommendations of an Expert Appraisal Committee (EAC).
v) All projects or activities included as Category 'B' will require prior environmental clearance from the State/Union territory Environment Impact Assessment Authority (SEIAA).

Amended Notification:

As per the amended Notification of the MoEF & CC on 22nd August 2013 on Highway projects - "Expansion of National Highways greater than 100 Km involving additional Right of Way or land acquisition greater than 40 m on existing alignment and 60 m on re-alignments or bypasses" may require clearance from EAC, MoEF & CC.

Also, the proposed highway project needs to get approvals from Andhra Pradesh Pollution Control Board are i.e., No Objection Certificates (NOC), Consent for Establishment (CFE) and Consent for Operation (CFO) for establishment and operation of Hot mix plants, batch mix plants, quarries etc. during the construction phase of the project.

Forest Clearance

Forest (Conservation) Act, 1980 (amended in 2003) enacted by Government of India, restricts the de-reservation of forests for use of non-forest purposes. According to the Act, State Government requires prior approval of GoI for the use of forest land for non-forest purposes (means the breaking up or clearing of any forest land) or for assigning least to any private person or agency not controlled by government. The Forest (Conservation) Rules, 2003 issued under this Act, provide specific procedures to be followed for conversion of forest land for non-forest purposes.

Limited sub-projects may require acquisition of forest land. The forest land conversion will follow the "Guidelines for Diversion of Forest Lands for Non-Forest Purpose" under Forest (Conservation) Act, 1980. Compensatory afforestation is one of the most important conditions stipulated for diversion of forest land. The conditions of forest diversion proposals are summarized in Table 10-3.

Table 10-3: Conditions of Forest Diversion Proposals

S. No	Condition of Forest Diversion	Submission of Proposal and seeking permission from
1	Diversion of forest land for small development and public utility projects up to 5 hectares	State Government may authorize the Nodal Officer or any other Officer to submit the proposals directly to the Regional Offices.
2	Diversion of forest land up to 40 hectares and proposals for clearing of naturally grown trees for reforestation	Central Zone, Regional Office of the MoEF&CC, Lucknow.
3	All other proposals (> 40 hectares)	The Secretary, Ministry of Environment & Forests, Government of India.

The other conditions of Forest diversion are:

- Compensatory afforestation is compulsory for conversion.
- Afforestation will be done over an equivalent area of non-forest land.
- As far as possible, the non-forest land for compensatory afforestation should be identified contiguous to or in the proximity of Reserved Forest or Protected Forest. If non-forest lands are not available in the same district other non-forest land may be identified elsewhere in the state.
- Where non-forest lands are not available, compensatory afforestation may be carried out over degraded forest twice in extent to the area being diverted. Conversion of forest lands that are part of National Parks/Sanctuaries and Tiger Reserve areas (notified under Indian Wildlife (Protection) Act, 1972) is not permitted. In exceptional case, the State Government requires consent of the National Board of Wildlife for obtaining approval of the State Legislature for de-notification of the area as a sanctuary.
- Cutting of trees in non-forest land, irrespective of land ownership, also requires permission from the State Forest Department. Afforestation to the extent of two trees per each tree felled is mandatory.

10.5 METHODOLOGY TO BE ADOPTED FOR EIA STUDY

The methodology to be adopted for the EIA study is shown below as Flow chart as below:

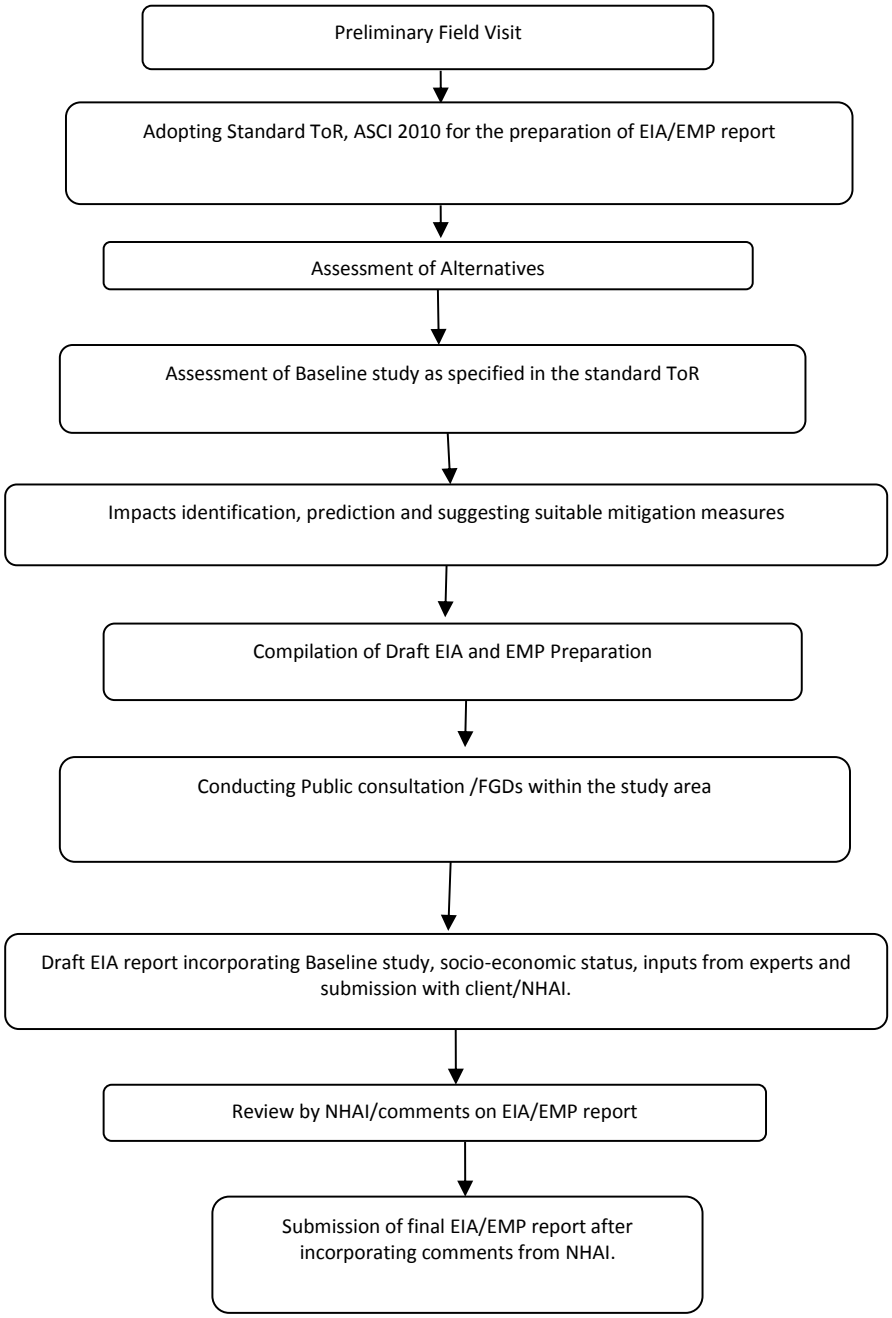

Figure 10-1: Flow Chart of Environmental Clearance Process

10.6 SCOPE OF ENVIRONMENTAL IMPACT ASSESSMENT (EIA) STUDY

The EIA/EMP report encompasses the findings of the study to identify, predict and evaluate the likely impacts due to the proposed activity and suitable measures to mitigate and minimize the adverse impacts and ameliorate environmental quality in the surrounding region. The environmental safety concerns which can be internalized in the project planning and implementation stages have been identified and suitable measures needed are elicited as Environmental Management Plan (EMP).

Detailed baseline data collection prior to project implementation is under progress for air, noise, water, land, biological and socio-economic environment within the project area. The baseline data for pre-project environmental status will be presented along with identification, prediction and evaluation of impacts due to project activities.

The published literature will be collected from different Govt. Organizations / Institutions, NGOs etc. to assess the baseline environment. The aim will be to collect secondary information to the maximum extent possible. The information on flora like roadside plantation and fauna within the study area will be collected from the Forest Dept., Botanical survey of India, Zoological survey of India and through field verification. Information on wetland, grassland and other ecologically important areas will also be collected.

The information on geology and soil within the study area will be collected from Geological Survey of India. The information on ground water i.e. depth of water table, yield etc. will be collected from the Central Ground Water Authority, Central Water Commission, Survey of India.

District Planning Maps etc. The land use pattern within the study area in general and adjacent to the road in particular will be established through collection of maps/documents from Survey of India, Agriculture Department and Forest Dept. and through field verification.

The climate and meteorology data i.e. temperature, wind speed, wind direction, rainfall, relative humidity, cloud cover and cyclone will be collected from the Meteorological Department. Available information on ambient air quality and water quality will be collected from Central Pollution Control Board (CPCB), Andhra Pradesh Pollution Control Board, Reputed Research Laboratory and Universities. The information on archaeological and historical places, if any, will be collected from Archaeological Survey of India, Dept. of Tourism etc.

Primary/Secondary Data Collection

A) Field Reconnaissance Survey

- Preliminary field survey will be undertaken to identify the critical issues and to examine different alignment options. The following information/documents will be collected during reconnaissance survey.

- Information on location, type and sensitivity of all critical natural habitats such as reserved/protected forest, wildlife sanctuaries/ wildlife migratory route across the road, wetlands, grass land, sacred groves etc.
- Information on sensitive such as location of schools, hospitals, religious, archaeological and historical places.
- Assessment of air quality, noise level, water quality and soil quality monitoring stations as per BIS, CPCB, IRC and MoEF Guidelines.
- Details of roadside plantation i.e. Chainage wise and girth size wise no. of trees.
- Information on industries i.e. pollution status, discharge point/disposal site of effluent/solid waste along the corridor, if any.
- Information on flora and fauna within the study corridor will be collected and verified in the field.

B) Environmental Impact Assessment

It will include the following:

- The collected primary and secondary data will be compiled to assess the existing baseline environmental condition.
- Prediction of significant impacts
- The assessment of impact during construction and operation phase
- Suggestion of mitigation measures

10.6.1 Generic Structure of EIA report

In terms of the EIA Notification of the MoEFCC dated 14th September 2006, the generic structure of the EIA document shall be as under:

1. Introduction
2. Project Description
3. Approach & Methodology
4. Environmental Regulatory Framework
5. Analysis of Alternatives (Technology and Site)
6. Description of the Environment
7. Anticipated Environmental Impact & Mitigation Measures
8. Environmental Management Plan
9. Environmental Monitoring Pla
10. Environmental Cost Estimates
11. Summary & Conclusions
12. Disclosure of Consultants engaged.

10.6.2 Baseline Environmental Conditions

The description of environment presents the Baseline Environmental Status of the project area in terms of its physical, micro-meteorological, chemical, biological, Social and cultural description. The baseline data would help to establish the pre-project environmental status in the project corridor. The possible impacts due to proposed activity will be predicted based on the quantification of project activities.

For the study area, primary Environmental baseline data will be collected by M/s. Aarvee Associates, Hyderabad through laboratory Recognized by Ministry of Environment & Forests, Government of India who will be engaged for the field study of air, water, noise, soil etc. The environmental attributes will be covered for the study include ambient air quality, ground and surface water quality, noise levels, land environment including soil quality, land-use pattern, forest cover, biological environment, socio-economic and health status of the population, demography and quality of life. The primary and secondary data of the stated parameters are being collected and analyzed as per the MoEF EIA Manual for Highways, 2010. References adopted from MoEF EIA Manual for Highways are tabulated below The Details of monitoring station of different environmental attributes is given below

The proposed project is “Consultancy services for preparation of DPR and Pre-Construction services from – (i) Silchar ISBT (Start point of Silchar Bypass) to junction of NH-37 & NH-6 at Dhaleshwari, (ii) End of proposed Badarpur bypass to Churaibari (Assam-Tripura border), (iii) Spur from NH-8 near Karimganj to Sutherkandi.” In the State of Assam The references adopted for baseline monitoring and the monitoring stations are provided in the table below. The baseline study is being carried out. The monitoring results shall be detailed out in the EIA report.

Table 10-4 : References adopted from MoEF&CC EIA Manual for Highways

S. No	Characteristics	No. of Monitoring Stations	Selection of the parameters
1	Ambient Air Quality Monitoring (Particulate Matter (size less than 10µm) or PM10, Particulate Matter (size less than 2.5µm) or PM2.5, Sulphur dioxide (SO2), Oxides of Nitrogen	08	EIA Guidance Manual for Highways – Prepared by MoEF, 2010 (Page – 17, Section 4.4: Air Environment) • Baseline data for the parameters – particulate matter size less than 10µm or PM10 µg/m3, particulate matter size less than 2.5µm or PM2.5 µg/m3, Sulphur dioxide (µg/m3), nitrogen dioxide (µg/m3) and carbon

S. No	Characteristics	No. of Monitoring Stations	Selection of the parameters
	(NOX), Carbon Monoxide and Hydrocarbons)		monoxide (µg/m3) in the study area should be generated for one season other than monsoon as per CPCB norms.
2	Water Quality Monitoring – Surface and Ground water (Physico-Chemical, bacteriological and heavy metals analysis)	8+ 8	EIA Guidance Manual for Highways – Prepared by MoEF, 2010 (Page – 17, Section 4.3: Water Environment) • Details of surface water bodies within right of way and within 500mts from the right of way should be documented along with the present usage. • The samples should be collected and analyzed as per the standard procedures
3	Noise Quality Monitoring (Leq day, Leq night, Leq min, and Leq max)	15	EIA Guidance Manual for Highways – Prepared by MoEF, 2010 (Page – 17, Section 4.5: Noise Environment) • While selecting the monitoring locations specific importance is to be given for sensitive environmental receptors like thickly populated areas, hospitals, schools, wildlife corridors etc. • Hourly monitoring of noise levels (Leq) should be recorded for 24 hours by using integrated noise meter. Noise standards have been designated for different types of land use, i.e. residential, commercial, industrial areas and silence zones as per the Noise Pollution (Regulation and Control) Rules 2000
4	Soil Quality Monitoring (Physico-Chemical and heavy metals analysis)	8	EIA Guidance Manual for Highways – Prepared by MoEF, 2010 (Page – 17, Section 4.2: Land Environment) • The soil profile of the highway alignment should be presented based on the soil series maps of National Bureau of Soil Survey and Land Use. • The suggested parameters for soil analysis

S. No	Characteristics	No. of Monitoring Stations	Selection of the parameters
			are pH, Electrical conductivity, sand (%), silt (%), clay (%), texture, moisture retention capacity (%), infiltration rate (mm/hour), bulk density (gm/ cc), porosity (%), organic matter (%), nitrogen (mg/1000g), potassium (mg/1000g), phosphorous (mg/1000g), sulphates and sodium sulphates.

Table 10-5: Details of different Environmental attributes monitoring stations

Code	Location	Coordinates	
		Latitude	Longitude
Micro Meteorology & Ambient Air Quality Monitoring Locations			
AES	Medal Pt-II	24°50'30.24"N	92°22'3.67"E
AAQ1	Bajantipur Pt-I	24°49'52.43"N	92°45'3.81"E
AAQ2	Sripur Pt-I	24°50'53.69"N	92°37'42.75"E
AAQ3	Kandigram Chaita	24°52'3.19"N	92°30'3.40"E
AAQ4	Medal Pt-II	24°50'30.24"N	92°22'3.67"E
AAQ5	Inathpur	24°50'57.30"N	92°20'35.35"E
AAQ6	Jarapata	24°52'21.11"N	92°15'15.93"E
AAQ7	Patharkandi	24°35'49.29"N	92°19'47.88"E
AAQ8	Ichchailchara	24°26'12.35"N	92°14'52.50"E
Noise Quality Monitoring Locations			
N1	Silchar Bypass	15° 53' 06.30" N	78° 01' 00.99" E
N2	Karimganj-Silchar Road	24°49'50.80"N	92°45'6.79"E
N3	Kalinagar Pt-IV	24°50'0.14"N	92°43'42.09"E
N4	Kandigram Chaita	24°49'45.99"N	92°38'3.63"E
N5	Sarif Nagar Road	24°52'7.33"N	92°30'7.03"E

Code	Location	Coordinates	
		Latitude	Longitude
N6	Longai Road	24°49'56.05"N	92°22'1.23"E
N7	Border Road, Jarapata	24°50'52.17"N	92°20'38.87"E
N8	Umarpur Pt-II	24°52'18.58"N	92°14'54.89"E
N9	Unamgaon	24°44'44.62"N	92°22'27.29"E
N10	Dr APJ Abdul Kalam Road	24°38'41.07"N	92°20'14.98"E
N11	Baithakal TE	24°35'38.30"N	92°19'45.96"E
N12	Chandkhira	24°34'38.62"N	92°18'53.58"E
N13	Shillong-Agartala-Sabrum Road	24°33'35.12"N	92°18'35.22"E
N14	Sibergool	24°32'21.31"N	92°19'41.14"E
N15	Ichailalchhara	24°27'33.43"N	92°18'26.89"E
Surface Water Monitoring Locations			
SW1	Indragarghant	24°50'0.98"N	92°43'41.54"E
SW2	Kushiyara River	24°51'44.34"N	92°29'3.60"E
SW3	Kakra Canal	24°42'23.24"N	92°21'55.99"E
SW4	Bhurguna	24°37'34.01"N	92°20'12.99"E
SW5	Pailamuli	24°36'27.09"N	92°20'1.08"E
SW6	Dewlakal Bridge, Chandkhira	24°33'35.60"N	92°18'36.16"E
SW7	Ankapai Punjee	24°32'58.36"N	92°18'55.77"E
SW8	Hatikhira T.E	24°30'12.60"N	92°19'23.78"E
Groundwater Monitoring Locations			
GW1	Bajantipur Pt-1	24°49'52.26"N	92°45'3.85"E
GW2	Sripur Pt-1	24°50'53.47"N	92°37'42.65"E
GW3	Kandigaram Chaita	24°52'2.68"N	92°30'3.45"E
GW4	Medal Pt-II	24°50'29.49"N	92°22'3.72"E
GW5	Inathpur	24°50'56.69"N	92°20'35.48"E

Code	Location	Coordinates	
		Latitude	Longitude
GW6	Jarapata	24°52'20.79"N	92°15'15.93"E
GW7	Patharkandi	24°35'48.78"N	92°19'47.91"E
GW8	Ichailalchhara	24°26'12.04"N	92°14'52.47"E
Soil Monitoring Locations			
S1	Bajantipur Pt-1	24°49'52.26"N	92°45'3.85"E
S2	Sripur Pt-1	24°50'53.47"N	92°37'42.65"E
S3	Kandigaram Chaita	24°52'2.68"N	92°30'3.45"E
S4	Medal Pt-II	24°50'29.49"N	92°22'3.72"E
S5	Inathpur	24°50'56.69"N	92°20'35.48"E
S6	Jarapata	24°52'20.79"N	92°15'15.93"E
S7	Patharkandi	24°35'48.78"N	92°19'47.91"E
S8	Ichailalchhara	24°26'12.04"N	92°14'52.47"E

10.6.3 Climatic Conditions and Temperature

Assam

Assam has a tropical monsoon climate, characterized by warm summers and mild winters. The state receives heavy rainfall during the monsoon season, which lasts from June to September. The average temperature in Assam ranges from 24°C to 33°C, but can reach up to 40°C in the summer months. The humidity is also high, especially during the monsoon season.

Relative Humidity

The relative humidity of Assam is high throughout the year, but it is especially high during the monsoon season (June to September). The average annual relative humidity in Assam is 76.6%, and the average monthly relative humidity ranges from 57% in March to 83% in July.

The high relative humidity in Assam is due to its geographical location. Assam is located in the foothills of the Eastern Himalayas, and it is surrounded by rivers and wetlands. This creates a humid environment, with a lot of water vapor in the air.

Floods & Droughts

Floods by nature depend on several factors, one being incessant rains, cyclonic rains in a short period of time crippling natural drainage. However, other factors such as nature of the collecting

basin, nature of the streams, type of soil, natural and man-made vegetation, amount of rainfall, obstruction to natural drainage etc. determine the type and extent of floods. The Brahmaputra and the Barak rivers have well-defined stable courses; their natural and manmade banks are capable of carrying flood discharges, with the exception of their delta areas. Floods are often caused by unplanned growth, improper upkeep of drainage systems and mismanagement of discharges from dams, though floods are erroneously thought to be always of natural origin.
Assam has historically been prone to drought conditions especially in Barpeta and Cachar. The reasons might be Deficient rainfall during pre-monsoon season, Sandy soils with low water retention capacity.

Rainfall

Assam receives an average annual rainfall of 2352 mm, but the distribution of rainfall is uneven across the state. The eastern part of the state, including the districts of Mawsynram, Cherrapunji, and Dhemaji, receives the highest rainfall, with an average of over 4000 mm per year. The western part of the state, including the districts of Goalpara, Dhubri, and Kokrajhar, receives less rainfall, with an average of less than 2000 mm per year. The monsoon season in Assam lasts from June to September, and accounts for over 80% of the state's annual rainfall. The heaviest rainfall occurs during the months of July and August. The non-monsoon season (October to May) is relatively dry, with occasional rainfall from thunderstorms.

The rainfall in Assam is influenced by a number of factors, including the state's geographical location, topography, and vegetation. The eastern part of the state is located on the windward side of the Meghalaya Plateau, which forces the monsoon winds to rise. This leads to condensation and heavy rainfall. The western part of the state is located on the leeward side of the Meghalaya Plateau, which receives less rainfall.

10.6.4 Air Environment

Standard methods / procedures will be adopted during environmental monitoring analysis and report preparation. After a preliminary reconnaissance of the study region and taking into account the meteorological (predominant wind directions, wind speed), topographic conditions, major settlements & its traffic volume and details on existing industrial activities in the study region, 1 Micro-Meteorology station and different stations has been identified to carry out Ambient Air Quality Monitoring (AAQM) in the study area. The parameters are being monitored in the study area are PM10, PM2.5, SO2, NO2 and CO. The monitoring results will be described with reference to the NAAQ Standards, 2009 and will be presented in draft EIA & EMP (Draft Feasibility) Report.

Methodology to be Adopted.

In assessing the environmental impact, collection and interpretation of baseline data is of prime importance. The primary data for the study period is being collected for 24 hourly, twice a week

for all the 4 weeks as per national guidelines. The criteria followed for selecting the AAQM stations is recommended by IS: 5182 and CPCB.
They are:

- The sampling station had free exposure so that it did not collect air from stagnant pockets.
- It was not obstructed by large structures including hills.
- The sampling point was not directly influenced by any local source of emission.
- It was located at a minimum height of 1.5 m from the ground level.

Monitoring and Analytical Procedure

Ambient air quality was monitored for the presence of contaminants existing in the air. In order to evaluate and quantify the air pollution problem, measurements are being carried out for various air pollutants mentioned above. This data will be used not only to evaluate the air quality in the study region but also as the basis to develop programs aiming at preventing the spread of pollutants leading to a risk to human health and general environment. Fine Dust Samplers (FDS) were used for ambient air sampling of selected parameter. The method for the selected parameter are based on the methods recommended by IS: 5182.

10.6.5 Water Environment

Selected physico – chemical parameter along with bacteriological indicators of pollution will be used for describing the baseline status of water environment. Generation of baseline data for water quality covers sources of ground and surface water. The Assessment of water quality in the study area includes

- Surface water quality (IS 2296)
- Ground water quality (IS 10500)

Surface Water Quality

During the study period multiple samples will be collected for assessing the water quality. These were identified considering proximity to the project site, their activities and depending upon its utility by the people in the region.The samples are being collected at this stage.

Surface water samples will be analyzed for Temperature, pH, Turbidity, EC, Colour, TSS, TDS, Odour, DO, BOD, COD, TKN, Total Hardness, Sodium, Potassium, Calcium, Magnesium, Ammonia, Chloride, Sulphate, Phosphate, Nitrate, Fluoride, Surfactants, Dissolved Iron, Copper, Zinc, Manganese, Arsenic, Lead, Mercury, Boron, Chromium, Phenols, Cadmium, Total Coliform, Faecal Coliform. The detail analysis will be given after approval of Preliminary EIA Report.

Ground Water Quality

Ground Water is one of the main sources of water in the project corridor for domestic, commercial and other irrigation use hence the rate of extraction of ground water is at a massive scale. For assessing the ground water quality in the study area, multiple samples will be collected from the identified bore wells/ dug wells. Selection of samples considered as per the utilization of the people along the proposed widening and improvement project.

Ground water samples will be analysed for Temperature, pH, Turbidity, EC, Colour, TSS, TDS, Odour, DO, BOD, COD, TKN, Total Hardness, Sodium, Potassium, Calcium, Magnesium, Ammonia, Chloride, Sulphate, Phosphate, Nitrate, Fluoride, Surfactants, Dissolved Iron, Copper, Zinc, Manganese, Arsenic, lead, Mercury, Boron, Chromium, Phenols, Cadmium, Total Coliform, Faecal Coliform. The detail analysis will be given after approval of Preliminary EIA report.

10.6.6 Noise Environment

Keeping in view of the proposed improvement and widening project, noise monitoring will be carried out at various locations. The locations will be selected based on land use pattern, traffic intersections and diversions along the existing alignment. Precision integrating sound level meter having statistical unit with digital display will be used for ambient noise level monitoring in the present study. The noise quality monitoring is planned and executed as per Protocol for Ambient Level Noise Monitoring. Noise monitoring for 24 hours is being carried out at each location during the study period. Noise monitoring locations and noise levels recorded i.e., Leq day, Leq night, Lmin and Lmax to be presented.

The Central Pollution Control Board has specified ambient noise levels for different land use for day and night times. Importance was given to the timing of exposure and areas designated as sensitive. The National ambient noise level standards are given below.

Table 10-6: The National ambient noise level standards

Area Code	Category	Limits in Decibels (dB(A))	
		Day Time	Nighttime
A	Industrial	75	70
B	Commercial	65	55
C	Residential	55	45
D	Silence Zones	50	40

The monitored samples are being analyzed with respect to concerned national standards for the respective categories.

10.6.7 Land Environment

As part of the land environment, soil quality is being studied in detail and the same will be presented after approval of Preliminary EIA report.

10.6.8 Soil Quality

The soil samples of different area along the project stretch will be collected at different locations for assessing the physic-chemical characteristics of the soil in the project area. The quality parameters will include pH, Electrical conductivity, sand, silt, clay, texture, moisture retention capacity, infiltration rate, bulk density, porosity, organic matter, Nitrogen, potassium, phosphorous, Pb, iron and organic carbon.

10.6.9 Land use Pattern

The proposed highway project traverses predominantly through agricultural land and barren land. The objectives of land use studies are:

- To determine the present land use pattern.
- To determine the temporal changes in land use pattern over a period.
- To analyses the impact on land use due to proposed site in the study area.

Anticipated Environmental Impacts and Mitigation Measures

Pre-Construction services from– (i) Silchar ISBT (Start point of Silchar Bypass) to junction of NH-37 & NH-6 at Dhaleshwari, (ii) End of proposed Badarpur bypass to Churaibari (Assam-Tripura border), (iii) Spur from NH-8 near Karimganj to Sutarkandi.in the state of Assam exhibit a symbiotic relationship between the environment and development with both positive and negative and reversible and irreversible impacts. The present chapter will be suggesting the analysis of the impacts in the proposed rehabilitation and up-gradation project and suggested mitigative measures. The Flow Chart showing the Itinerary of assessment, evaluation & interpretation of impact, prediction of impacts and suggesting suitable measures in Figure 10-2. The project specific impacts assessed will be described in draft EIA & EMP after approval of Preliminary EIA report.

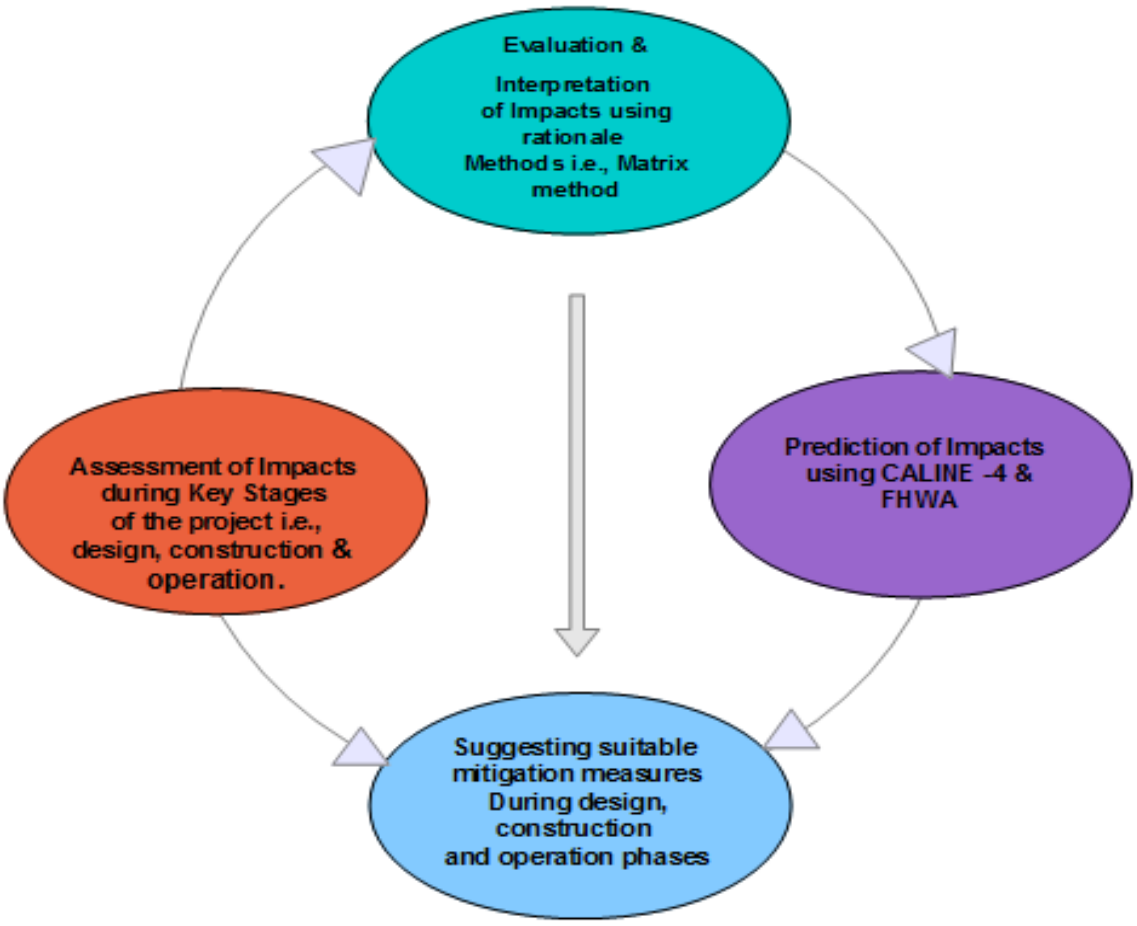

Figure 10-2 : Itinerary of Assessment of Impacts and Mitigation Measures

Assessment of Impacts in Key Stages of the Project

The proposed project can have impacts or cause impacts in three specific situations as follows:

- Impacts due to Project Design,
- Impacts during Construction, and
- Impacts during Operational stage.

Impacts due to Project Design

The engineering design of the road will be finalized by considering all environmental safeguards. The project envisages natural drainage network, roadways which will have marginal negative impacts of temporary and localized in nature. Land acquisition for road development is minimal of less than 10m. Rehabilitation and upgrading of the existing road is unavoidable and may lead to loss of livelihood for very few projects affected peoples.

Impacts during Construction Stage

The construction stage is one of the critical stages of the project which may pose maximum impact on the environment. The major impacts associated in this stage from site clearance to the final BT Stage of the main carriageway will be identified and the appropriate mitigation measures are being suggested.

10.6.10 Impacts during Operation Stage

The proposed project can harmonize with the surrounding environment and serve multiple users with the following positive impacts.

- To relieve traffic congestion on towns /cities along the proposed stretch.
- To provide effective linkage to their respective state.
- To Increase access to markets, jobs, education, and health services.

However, some of the negative impacts are also associated in this stage. The major impacts envisaged in this stage are increasing of traffic resulting an increase of air as well as noise pollution. To minimize the impacts an appropriate mitigative measures will be suggested.

Evaluation and Interpretation of the Impacts

Matrix method will be adopted for the evaluation of impacts. Based on the scoping of the areas and the work being proposed the following key issues were evaluated for this project.

- Preservation of aesthetic and landscape of the area to the possible extent.
- Effective restoration of Burrow areas and quarries.
- Evaluation of Environmental Quality
- Tree removal and tree plantation.
- Sanitation and waste disposal.
- Road safety.
- Protection of flora and fauna.
- Afforestation

The outcome of the results will be interpreted. The interpreted values will be helpful for the decision makers to take appropriate decision in right time.

Prediction of The Impacts

As discussed earlier, the major impacts associated with this project are air and noise. The air quality due to vehicular movement is predicted using the CALINEPro software and to predict the cumulative noise impacts, a Federal Highways Administration (FHWA) Noise Model will be adopted. The air and noise impacts are aimed to predict the future impacts for “Without and With Project Scenario” by using the traffic study report.

Suggesting suitable Mitigation Measures

The mitigation measures are highlighted for the following key issues in the project.

- Soil quality (Topsoil, soil erosion etc.)
- Solid waste or muck disposal
- Air quality
- Water quality (wetlands, water bodies, groundwater etc.)
- Noise quality
- Biological Environment (Flora, fauna, tree plantation and enumeration)
- Socio-economic quality of life
- Safety and health aspects during construction and operation phase.

Environmental Management Plan

The Environmental Management Plan (EMP) states the procedure in which the project proponent would carry out the implementation of the mitigation measures and ensure compliance with environmental regulations that are binding on the project. The EMP also specifies the organizational requirements and institutional strengthening necessary for sound environmental management of the project. The major components of the EMP are:

- EMP Implementing Agency
- Monitoring of the EMP implementation
- Training on Environmental management
- Budget for EMP implementation.

The project specific EMP with budgetary provisions will be given after approval of Preliminary EIA Report.

10.6.11 EMP Implementing Agency

The Project Proponent will establish an Environmental Management Cell (EMC) to supervise and implement the mitigation measures as documented in the EMP. This EMC must also be adequately empowered to discharge the responsibilities as outlined in the EMP. To ensure smooth implementation of EMP the project proponent will have to collaborate with various government agencies like Public Works Department, Revenue Department, State Pollution Control Board, State Forest Department, Police Department and other allied departments.

Monitoring of EMP Implementation

The EMP will primarily be implemented by the Project Proponent and Civil Contractor. However, for an effective implementation of EMP, the current project will be monitored two level monitoring. The first one is internally by top management of Contracting Company and the second one by the National Highways wing. The EMC constituted by Contracting Company shall be the prime agency for monitoring all the activities during construction and operation phases. National Highways wing under the R&B or supervision consultant appointed by R&B shall supervise all activities and accordingly advise the Contracting Company to improve on areas where any shortcomings are observed. The EMC shall provide all the monitoring results

to National Highways wing under the R&B. National Highways wing under the R&B shall keep a record of all information and shall suggest suitable measures to be adopted by Contracting Company if any aspect is found to be deviating from the stipulated values/ standards. Monitoring shall be carried out during construction and operation phase.

Budget for EMP Implementation

The design and construction of the project involves several items such as resettlement & rehabilitation, erosion prevention, rehabilitation of borrow areas, tree plantation, safety signage etc., which are included in the contract cost. Only those items that are not covered under the budget for construction will be shown in the EMP implementation budget.

The main components are as follows:

- Setting up of Environment Management Cell
- Tree Plantation
- Environmental monitoring during construction and operation phases
- Conducting awareness programmes
- Capacity building and training during construction and operation phases.

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11.SOCIAL IMPACT ASSESSMENT

11.1 INTRODUCTION

The government of India has envisaged to create a world-class infrastructure facility, to boost the economic development in the country, for which National Highways Authorities of India (herein after referred to as the "Authority" or "NHIDCL") plays a key role. As part of endeavor, NHIDCL has appointed M/s Aarvee Associates Architects Engineers & Consultants Pvt. Ltd. for the work of Consultancy Services for preparation of DPR and Pre-construction services from – (i) Silchar ISBT (Start point of Silchar Bypass) to junction of NH-37 & NH-6 at Dhaleshwari, (ii) End of proposed Badarpur bypass to Churaibari (Assam-Tripura border), (iii) Spur from NH-8 near Karimganj to Sutarkandi.

The main objective of development of proposed stretch is to improve the performance of national road transport network. By doing the Capacity Augmentation of the above Project Highway, the Level of Service will be improved, and number of accidents may be reduced as the provision of underpasses will be considered based on the prevailing and future traffic needs.

11.2 PROJECT ROAD DESCRIPTION

National Highway 37 (NH 37) is a two-lane national highway in India that connects the northeastern states of Assam and Manipur. It starts from Badarpur in Assam and terminates at Imphal in Manipur. The highway is 356 kilometers long and passes through some of the most scenic and remote parts of the region.

It is a vital artery for the socio-economic development of Assam and Manipur. It helps transport agricultural produce, other goods, and essential commodities between the two states. The highway also facilitates tourism, trade, and cultural exchange between the two northeastern states.

NH 37 is a challenging highway to drive on, especially in the rainy season. The highway is narrow and winding, and there are many landslides and potholes. However, the government is working on improving the condition of the highway.

Here are some of the key features of NH 37:

- Length: 356 kilometers
- Starting point: Badarpur, Assam
- Ending point: Imphal, Manipur
- States it passes through: Assam and Manipur
- Major cities and towns it connects: Badarpur, Silchar, Karimganj, Numaligarh, Jorhat, Tezpur, Golaghat, Dimapur, Kohima, and Imphal
- Important tourist destinations it passes through: Kaziranga National Park, Manas National Park, Pobitora Wildlife Sanctuary, Loktak Lake, Dzükou Valley, and Dzukou

Valley

NH 37 is a vital highway for the people of Assam and Manipur. It helps connect the two states to the rest of India and plays a key role in their economic development. The government is working on improving the condition of the highway to make it safer and more comfortable for drivers.

The Project stretch is mostly passing through the plain terrain and a mixed land use of urban/rural and agricultural can be seen throughout the project corridor. The proposed scheme has to be developed keeping in view the four-lane cross section along with additional facilities to be incorporated in such a manner that the improvements are accommodated to the maximum extent within the right-of-way.

Facilities in the form of service roads, slip roads for grade separators such as under/over passes and road over bridges will be considered at the reasonable intervals for local traffic including pedestrians.

Table 11-1: Proposed Project Highway Details

S No.	NH No.	Section	Section No.	District	State
1	NH-37 & NH-8	End of proposed Badarpur bypass to Churaibari (Assam-Tripura Border)	Section-II	Karimganj	Assam

With regard to district wise length of the road Karimganj district has a substantial 83.15 kilometers constituting 84.29 percent of the Project Stretch and a length of 12.75km is falling in Cachar District constituting 12.92 percent of the Project Stretch and a length of 2.75km falling in Hailakandi District with 2.79 percent.

Table 11-2: District wise Length of Project Highway

Sl. No.	State	Section	District	Length (Km.)	Percentage (%)
1	Assam	II	Karimganj	67.95	100

11.3 IMPORTANCE OF THE PROJECT ROAD

The main objective of development of proposed stretch is to improve the performance of national road transport network. By doing the Capacity Augmentation of the above Project Highway, the Level of Service will be improved, and number of accidents may be reduced as the provision of underpasses will be considered based on the prevailing and future traffic needs.

11.4 PROJECT IMPACTS

On account of development activities in and around the project stretch of NH-37 & NH-8, it is ascertained that Augmentation of existing 2-lane section is required. The Augmentation involves minuscule land acquisition from current owners/users. The construction of road project will have significant positive impacts, but they may simultaneously also bring negative impacts on nearby communities, if proper precaution is not taken during design and implementation stage of the project. Acquisition of land may cause social disruption and economic loss for project affected persons (PAPs) and their families. It is therefore important that disturbances and losses of PAPs due to project are minimized through proper planning. The Resettlement Action Plan needs a broad and comprehensive study and that will be incorporated in subsequent reports.

Social assessment study is generally carried out to identify critical locations and issues that need to be studied further in detailed in terms of impact assessment, mitigation measures and management plan. In socio-economic point of view, the identified areas directly served by the project road delineate the broad and immediate picture of influenced area. The salient features of SA road is presented in Table below

Table 11-3: Salient Features of the Project Highway

S. No	Particulars	Unit	Total
1	Total Length of Proposed Road (Design length)	Km.	67.95
2	Total no. of Revenue Villages in entire project area as per Draft 3A	No.	76
5	Total volume of land (Tentative) to be acquired for the proposed Project road	Ha.	383.74

11.5 OBJECTIVE OF THE STUDY

The objective of the survey is to generate an inventory of social impacts on the likely to be affected people by the project. The project impacts were identified through a series of exercises including social screening during early project preparation stage and informal discussion with villagers and road users. The screening on road sections focuses on:

- identification of social issues such as impact on livelihood due to land acquisition;
- current usage of land in proposed ROW;
- potential impact of the proposed project on productive resources, natural resources, common property resources and social infrastructures;
- social, economic, cultural and demographic characteristics of the potential project affected population;
- identification and special need analysis of vulnerable groups, ethnic minorities and SC/ STs among the population;

11.6 METHODOLOGY

Approach and methodology mainly consist of quantitative and qualitative tools and techniques. The following are the activities undertaken for the social screening or initial social assessment survey.

11.6.1 Collection and review of Project Literature

This phase intends to familiarize with the concerned and important stakeholders to identify and collect the available literature and to scope the activities. The activity is involved in two-pronged approach (a) discussions with Project Implementing authorities and other concerned, b) collection of available relevant project literature. The laws and regulations enacted by Government of India and state government of Assam pertaining to R & R issues. Consultations were held with concerned revenue/ government officials to establish the ownership of land. Literature review and informal discussions formed the basis for identification of key stakeholders.

11.6.2 Rapid reconnaissance survey to familiarize field activities

In addition to review of literature and informal consultations, rapid preliminary field visits were conducted as part of ground truthing exercise. The reconnaissance survey helped to gather firsthand information on the likely to be affected area, revenue villages, land details e.g. private, government and forest etc.

11.6.3 Identification of properties

For construction of new alignment, the social team conducted an identification exercises on different types of land within 60 meter of proposed ROW. Prior to initiation of physical identification of the properties, a detailed discussions were held with concerned officials to collect information on ownership of land. Since 3(A) activities are underway hence the type and classification of land and exact number of private land owners cannot be ascertained at this stage. The exact number of likely to be affected households and thereby magnitude of impact can be determined after the completion of census and socioeconomic survey. All the affected properties belonging to legitimate owners shall be incorporated in the subsequent reports.

11.6.4 Public Consultation Meeting

Meaningful, informed, and effective public consultations are inevitable for successful of any infrastructural project. Approaches to the public involvement can yield productive, long-term and trusting relationships between citizen and government. Consultative procedures are critical but very important aspects in entire social impact assessment process. Public consultations in social impact assessment facilitates to make a rapport with the villagers and simultaneously provide clear communication about the purpose of the consultation and its

relationship to the larger decision-making process. In this regard, the social assessment ensures the involvement of local communities through participatory and structured consultations that would endorse and integrate important resettlement issues in the project cycle. In this regard, we plan to disseminate the information to the villagers about the characteristic of the proposed alignment in terms of length, proposed right of way and upgradation features.

11.7 INITIAL SOCIAL IMPACT ASSESSMENT

An Initial Social Impact Assessment (ISIA) is carried out to gauze the magnitude of impact and people's overall perception about the proposed project. It helps to understand if the project impacts are likely to be minor or limited, which can easily be predicted and evaluated, and for which mitigation measures can also be prescribed easily. Generally, information on ISIA is obtained during field visit from the areas that may probably be impacted by the project road. The ISIA is also done to confirm whether this indeed requires a full-scale Social Impact Assessment (SIA) or not. A detailed SIA therefore needs to be carried out to make project design responsive to social development concerns. Usually, a comprehensive SIA is required for large projects, which entails a more detailed study, time, and resources.

Reconnaissance and initial social assessment survey were undertaken to take a detailed note of affected properties. However, full-fledged survey needs to be undertaken for preparation of the Resettlement Plan as per the policy and guidelines of Central Government and State Government. In this regard, surveys relating to social assessment of the impact will be conducted within 60 m of proposed Row.

The focus of this study is to understand the factors underlying the agricultural activity with reference to requirement of land from the villages for Greenfield alignment. The input consists of a combination of secondary data and preliminary surveys and consultation with a cross-section of people.

In order to assess the potential impacts within the project corridor, critical sections from social impact point of view have been identified. Such locations have been identified with the potential issues and thereby possible options for minimizing the impact need to be suggested.

The primary information was collected through consultations with villagers to comprehend the socio-economic characteristics, physical features and cultural set-up of the project area before undertaking detailed field investigations. Relevant land data were also collected from local Revenue/Taluka offices.

11.7.1 Extent of Land Acquisition

The Available RoW along the Project Highway is about of 20m. The Augmentation of project stretch involves minuscule land acquisition from current owners/users. As per our initial assessment, the proposed project road would require both private and government land of

approx. 383.74 hectares. A considerable length of 67.95 kilometer-long existing alignment passing through 76 revenue villages. The scope of land acquisition for the project road includes a) a minimum 45-60m RoW c) provisions on roadside amenities.

11.7.2 Revenue Villages in Project Area

The proposed road will pass through 105 villages covering 3 districts. Out of total 105 project affected villages, about 91 villages i.e. the highest in numbers come under Karimganj District followed by 11 villages in Cachar District, 3 villages in Hailakandi District. All these Districts fall in the territory of Assam state. The list of villages is given in Table below:

Table 11-4: List of villages along section-II

S.No.	Village name	Package	Taluk/ Circle	District
1	Kandigram Malua	Package-IV	Badarpur	Karimganj
2	Paterakandi			
3	Mahakal Pt I			
4	Kankalesh Pt I			
5	Mahakal Pt II			
6	Kankalesh Pt II (Sh 1 & 2)			
7				
8	Mosli Pt II			
9	Raj Pasha kitte Khag sheet-1 & 2			
10	Lamajuar Pt III			
11	Lamajuar Pt II			
12				
13	Nairgram			
14	Lamajuar Pt II kitte Ambari		Karimganj	
15	Nathupur Pt I			
16	Bakarshal Pt III			
17	Jinahabra			
18	Medal Pt II			
19	Medal Pt III			
20	Saidambar Pt I			
21	Saidambar Pt II			
22	Alampur			
23	Umarpur Pt I			

S.No.	Village name	Package	Taluk/ Circle	District
24	Nagkapan Chak			
25	Umarpur Pt II			
26	Umarpur Pt V			
27	Umarpur Pt III			
28	Umarpur Pt IV			
29	Berajal		Nilambazar	

11.7.3 Village Wise Impact and Land Requirement

The extent of land to be acquired by the project is an indicator of impact on the social environment. The type and extent of land acquisition is presented in the below table. It is analyzed that about 146.27 ha.of land is required for the Project Highway 45, 60m RoW. The total extent of land to be acquired under the project consists of two categories (as stated in 3A data wrt 45, 60m RoW).

Table 11-5: Village wise Project Impact & Requirement of Land in Hectare

S.No.	Package	Taluk/ Circle	Starting chainage	Ending chainage	Village name	Area to be Acquired
1	Package-IV	Badarpur	38.60	39.95	Kandigram Malua	8.1712
2			39.95	40.20	Paterakandi	4.2320
			40.52	41.00		
3			40.97	41.00	Kankalesh Part I	2.0762
4			41.00	41.25	Kankalesh Part II	8.5563
			42.11	43.50		
5			41.00	42.05	Mahakal Part I	5.9263
6			42.02	42.14	Mahakal Part II	0.5360
7			43.50	43.97	Mosli Part II	3.8516
8			43.97	45.00	Raj Pasha	6.1372
9			45.00	46.60	Lamajuar Part II	9.6236
10			46.60	48.55	Nairgram	11.7925
11		Karimganj	48.55	49.80	Lamajuar Part II	7.5157
12			49.80	50.85	Nathupur Part I	6.3306
13			50.85	52.92	Bakarshal Part III	13.0238

14			52.92	53.22	Jinahabra	1.8028
15			53.22	54.30	Medal Part II	6.6267
16			54.30	55.10	Medal Part III	4.5584
17			55.10	55.69	Saidambar Part I	3.5544
18			55.69	57.00	Saidambar Part II	7.9053
19			57.00	57.23	Alampur	1.3649
20			57.23	57.83	Umarpur Part I	3.5891
21			57.83	58.25	Nagkapan Chak	2.4532
22			58.25	58.97	Umarpur Part II	4.3309
23			58.25	59.04	Umarpur Part V	0.4017
24			59.33	60.78	Umarpur Part III	3.6350
25			59.03	60.75	Umarpur Part IV	6.6485
26		Nilambazar	60.75	62.70	Berajal	11.6303
Package-IV Total						**146.2743**

11.7.4 Impact on Trees:

The trees not only serve as natural sheds during summer but also enhance the beauty of the area. Existing Avenue observed along the Project Highway. With regard to development of the road, Minimum Number of trees will be felled to make space for the expansion.

11.7.5 Indigenous People and Vulnerable Groups:

Indigenous people are defined as those having a distinct social, cultural, economic, and political tradition and institutions compared with the mainstream or dominant society. According to Indian Constitution, indigenous people with similar cultural characteristics are recognized as Scheduled Tribes (ST). The number of likely to be affected ST population will be known after the completion of census and socio-economic survey. Proper provisions and adequate measures need to be taken to protect these vulnerable community.

11.7.6 Gender Issues:

The consideration of gender issues is crucial in the planning and implementation of resettlement and rehabilitation programs. Special needs and requirements of women must be considered and addressed in all program aspects—site selection, site and housing design, provision of civic infrastructure, access to service, provision of land and housing title, payment of compensation, and income restoration etc. As per the primary assessment, women's

participation and attendance in meeting is moderate in project area. However, majority of them do have decision making power at household level financial matters. Social and cultural factors may exclude women from participating actively in planning, implementing, and executing resettlement activities. Special efforts need to be made to ensure their inclusion.

11.7.7 Land Use Pattern in Project Area:

Variation of land using pattern was observed with respect to environmental factors such as soil characteristics, climate, topography, and vegetation etc. In project area, the land use is characterized by agricultural lands, barren, water bodies, forests, hills and plantation etc. The Agriculture land and water bodies' together accounts for 60-70 per cent of the total land to be acquired for the proposed project road. With regard to land use pattern, a major tract of land is used for cultivation purposes. The project area is a mix of both fertile wet and dry land.

11.7.8 Cropping Pattern:

The cropping pattern in Karimganj districts of Assam is characterized by a predominance of rice, followed by pulses, oilseeds, sugarcane, and vegetables. Other important crops include tea, pineapple, and fruits.

The cropping pattern in these districts is influenced by a number of factors, including climate, soil type, and topography. The region experiences a humid subtropical climate with high rainfall, which is favorable for rice cultivation. The soils are generally fertile and well-drained, making them suitable for a variety of crops.

The main cropping season in these districts is the kharif season (June-September), during which rice is the dominant crop. Other important kharif crops include pulses, oilseeds, and vegetables. The rabi season (October-March) is shorter and less productive than the kharif season. The main rabi crops are rice, pulses, and oilseeds.

11.7.9 Land Value in Project Village

The land price particularly under private transaction, varies from place to place. The market price of agricultural land ranges from Rs. 4 crores to 6 crore per hectare in Karimganj district.

11.7.10 Forest

Existing Alignment package-IV of the project corridor is not traverses through the forest location.

Sl. No	From Km.	To Km.	Length in Km	Package	Location
Nill					

11.8 LEGAL POLICIES AND RESETTLEMENT FRAMEWORKS

Principles and Policies needs to be adopted for the Project

The core involuntary resettlement and rehabilitation principles for this project are: (i) land acquisition, and other involuntary resettlement impacts will be avoided or minimized exploring all viable alternative project designs; (ii) where unavoidable, time-bound resettlement action plan (RAP) will be prepared and APs will be assisted in improving or at least regaining their pre-project standard of living;(iii) Consultation with APs on compensation, disclosure of resettlement information to APs, and participation of in planning and implementing sub-projects will be ensured; (iv) payment of compensation to APs for acquired assets at replacement rates; (v) payment of compensation and resettlement assistance prior to the construction contractor taking physical acquisition of the land and prior to the commencement of any construction activities.

Minimization of Social Impacts

According to the broad principle mentioned above, an appropriate decision by engineering, environmental and social impact assessment teams has to be taken to avoid land acquisition from fertile lands.

Rehabilitation and Relocation of PAPs

Restoring livelihood for project affected people is an important task in resettlement plan. The required support shall be extended to the affected households during relocation (if required) and a time bound, fair & just entitlements shall also be given to the people to compensate and regain their pre-project level status.

National Highways Act- 1956

Land acquisition for National Highways is done in accordance with the procedure laid in “The National Highways Act, 1956”. The act is applicable to the whole of India except the state of Jammu and Kashmir. The policy provides a broad guideline of procedure for land acquisition. The National Highways Act 1956 (NH Act) is commonly used for acquisition of land for public purpose of the road. It is used at the State level made to suit local requirements.

As a general practice Revenue Divisional Officer / Joint Collector in the District level is appointed as Competent Authority for Land Acquisition (CALA). Competent authority means any person or authority authorized by the Central Government, by notification in the Official Gazette, to perform the functions of the competent authority for such area as may be specified in the notification.

Intention & Declaration

When a National Highways require a land, an application is required to be made by it to the revenue authority;

3 (a) - Intention to Acquire Land: The Central Government upon publication of the Gazette nominates "Competent Authority for Land Acquisition" and expresses its intention to acquire land in respective revenue villages;

After the government has been fully satisfied about the purpose, the least area needed, and other relevant facts as provided under land acquisition rules, it will issue a notification under Section 3A of the act that the particular land is required for public purpose;

3 (A) - Power to Acquire Land: The central Government upon publication of this Gazette expresses its intention to acquire such land for construction, maintenance and management of National Highways. The same shall be intimated to the public through two local newspapers, one of which will be in vernacular language.

The application should be accompanied with a copy of the plan showing survey nos., purpose of acquisition and the reason for the particular site to be chosen and the provision made for the cost of the acquisition;

The Competent Authority will hold an inquiry under Section 3-B of the Act;

3 (B) - Power to entry for Survey: Upon getting the 3A notification published in the official Gazette, authorized persons are empowered to carryout survey, investigations and can cut trenches.

After notification the owner is prohibited from selling his property or disposing it off and prevented from carrying out any works of improvements for which no compensation will be paid if executed without prior permission from the collector.

Objection and Confirmation

Objections are invited from all persons interested in the land within 21 days from the date of notification under Section 3-A.

The objections will be valid on one or more of the following grounds:

- That the purpose for which the land is proposed for acquisition is not a public purpose.
- That the land is not or less suitable than another piece of land for the said purpose.
- That the area under acquisition is excessive.
- That the acquisition will destroy or impair historical or artistic monuments or will desecrate religious buildings, graveyards and the like.

3 (C) - Hearing of Objections: Any person interested in the land may within twenty-one days from the date of publication of the notification under sub-section (1) of section 3A, object to the use of the land for the purpose or purposes mentioned in that sub-section.

- The CALA after hearing the objections will submit his report to the Central government, who will finally declare the land for acquisition under Section 3-D of the Act.

3 (D)- Declaration for Acquisition: After hearing the objections the competent authority shall submit a report accordingly to the Central Government for declaring the extents of land proposed for acquisition. The Central Government shall declare, by notification in the Official Gazette, that the land should be acquired for the purpose or purposes mentioned in sub-section (1) of section 3A.

- Upon publication of the declaration in the official Gazette the land shall vest absolutely in the Central Government free from all encumbrances. A declaration made by the Central Government under sub-section (1) shall not be called in question in any court or by any other authority.
- After notification the collector proceeds with the claim. He is authorized to mark out the site, measure and plan of the same made vide Section 3-E.
- Power to take possession: For the lands vested in the Central Government under section 3D upon determining the compensation, the competent authority shall intimate by notice in writing direct the owner as well as any other person who may be in possession to surrender or deliver possession to the competent authority or any person duly authoritative within sixty days of the service of the notice.

Claim and Award

- The CALA will issue notices under Section 3-G to all persons interested in the acquisition to file their claim reports;
- The claim filed should contain the names of the claimants and co-shares, if any rents or profits for last three years and a valuation report of the land from an architect or an engineer;
- In determining the compensation, the market value of the land is determined at the date of notification. The rise and fall in the value during the period of transaction and notification is taken into consideration;

Compensation is also payable when:

- Part of the property is proposed for acquisition in such a manner that the remainder depreciates in value.
- When the land notified for acquisition has standing crops or trees.
- If the person interested has to change his place of residence or business, then the excess rent payable for the new premises is also considered for compensation.

Matters which are not taken into consideration for the purpose of land acquisition are:

- The degree of urgency which has led to the acquisition.
- Any disinclination of the person interested to part with the land.
- Any increase in the land value likely to accrue from the use to which it will be put when acquired.

- After necessary inquiries the collector declares his award showing true area of the land, total amount of compensation payable and apportionment of compensation if there are more than one owner or claimants.
- The collector has to make the award under section 11 within a period of two years from the date of notification.

The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013

The 1894 Land Acquisition Act was repealed, and a new comprehensive legislation was brought in Parliament and it came to effect on 1st January 2014. This Central Act ensures, in consultation with institutions of Local Self-Government and Gram Panchayats established under the Constitution, a humane, participative, informed and transparent process of land acquisition for industrialization, development of essential infrastructural facilities and urbanization with the least disturbance to the owners of the land and other affected families and provide just and fair compensation to the affected families whose land has been acquired or proposed to be acquired or are affected by such acquisition and make adequate provisions for such affected persons for their rehabilitation and resettlement and ensuring that the cumulative outcome of compulsory acquisition should be that the affected persons become partners in development leading to an improvement in their post-acquisition social and economic status and for matters connected therewith or incidental thereto.

The provisions of this Act Under Section 2(1) relating to land acquisition, compensation, rehabilitation and resettlement, shall apply, when the appropriate government acquires land for its own use, hold and control, including for Public Sector Undertakings and for public purpose. Under RFCTLARR- 2013 for land acquisition for various types of project, provisions of consent have been inbuilt to secure the interest of the stakeholders. As far as this project is concerned [when the appropriate government acquires land for infrastructural projects under Section-2 (1) (B) (Vii)] consent is not required.

Table 11-6: Consent Requirements for Project As per Types and Sites

Protect Type + Area	Consent	
	Landowners and Tenants	Gram Sabha/ Panchayat/ Autonomous District Council
Public + Non-Scheduled Area	Not required	Not required
Public + Scheduled Area	Not required	Required
PPP + Non-Scheduled Area	Required (70%)	Not required
PPP + Scheduled Area	Required (70%)	Required

Protect Type + Area	Consent	
	Landowners and Tenants	Gram Sabha/ Panchayat/ Autonomous District Council
Private + Non-Scheduled Area	Required (80%)	Not Required
Private + Scheduled Area	Required (80%)	Required

The RFCTLARR, 2013 provides a framework for facilitating land acquisition in India. RFCTLARR, 2013 enables the State Government to acquire private land for public purposes. With regard to land acquisition for the proposed alignment, NHIDCL has to adopt its own act (Schedule-IV, LARR Act). For provision of compensation and other applicable entitlements it is bound to abide by the guiding principles laid down under Schedule- I and II, RFCTLARR Act-2013. Table 1.7 presents the sections of RFCTLARR Act-2013.

Scheduled Caste and Scheduled Tribes Orders (Amendment) Act, 2002

The Act provides for the inclusion in the lists of Scheduled Tribes (ST), of certain tribes or tribal communities or parts of or groups within tribes or tribal communities, equivalent names or synonyms of such tribes or communities, removal of area restrictions and bifurcation and clubbing of entries; imposition of area restriction in respect of certain castes in the lists of Scheduled Castes (SC) and the exclusion of certain castes and tribes from the lists of SCs and STs

Various Provisions under the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013(RFCTLARR Act)

RFCTLARR Act-2013

1. LAND ACQUISITION
In case of land acquisition, the amount of compensation to be determined is that of the value of the land +100 percent Solatium+12 percent additional market value from the date of notification to taking over the possession or award whichever is higher. Market value of land as mentioned under section 26 of RFCTLARR Act-2013 needs to be multiplied by the radial factor (based on the distance of project from urban area as notified by the appropriate government- e.g multiplication of 2 in Rural area and Multiplication of 1 in Urban area) plus value of assets attached to land or building (mentioned in Section 29 of RFCTLARR Act-2013) Plus Solatium (solatium includes 100% market value multiplied by 2 plus value of assets in Rural area and multiplied by 1 plus value of assets in urban area)
2. PROVISION OF HOUSING UNITS IN CASE OF DISPLACEMENT
If a house is lost in rural areas, a constructed house shall be provided as per the Indira

Awas Yojana specifications. If a house is lost in urban areas, a constructed house shall be provided, which will be not less than 50 sq mts in plinth area.

The benefits listed above shall also be extended to any affected family which is without homestead land and which has been residing in the area continuously for a period of not less than three years preceding the date of notification of the affected area which has been involuntarily displaced from such area:

Provided that any such family in urban areas which opts not to take the house offered, shall get a one-time financial assistance for house construction, which shall not be less than one lakh fifty thousand rupees:

Provided further that if any affected family in rural areas so prefers, the equivalent cost of the house may be offered in lieu of the constructed house:

Provided also that no family affected by acquisition shall be given more than one house under the provisions of this Act.

Explanation- The houses in urban areas may, if necessary, be provided in multi-storied building complexes

3. CHOICE OF ANNUITY OR EMPLOYMENT

The appropriate Government shall ensure that the affected families are provided with the following options:

(a) where jobs are created through the project, mandatory employment at a rate not lower than the minimum wages provided for in any other law for the time being in force, to at least one member per affected family in the project or arrange for a job in such other project as may be required; or

(b) onetime payment of five lakhs rupees per affected family; or

(c) Annuity policies that shall pay not less than two thousand rupees per month per family for twenty years, with appropriate indexation to the Consumer Price Index for Agriculture Laborers.

4. SUBSISTENCE GRANTS

The appropriate Government shall ensure that the affected families are provided with the following options:

Given monthly subsistence allowance equivalent to three thousand rupees per month for a period of one year from the date of award. In addition to this amount, the scheduled castes and the scheduled Tribes displaced from Scheduled Areas shall receive an amount equivalent to fifty thousand rupees.

5. TRANSPORTATION COST

The appropriate Government shall ensure that the affected families are provided with the following options:
Each affected family which is displaced shall get a onetime financial assistance of fifty thousand rupees as transportation cost for shifting of the family, building materials, belongings and cattle.

6. CATTLE SHED/ PETTY SHOPS COST

Each affected family having cattle or having a petty shop shall get one-time financial assistance of such amount as the appropriate Government may, by notification, specify subject to a minimum of twenty-five thousand rupees for construction of cattle shed or petty shop as the case may be.

7. ONE TIME GRANTS TO ARTISAN, SMALL TRADERS AND OTHERS

Each affected family of an artisan, small trader or self-employed person or an affected family which owned non-agricultural land or commercial, industrial or institutional structure in the affected area, and which has been involuntarily displaced from the affected area due to land acquisition, shall get one-time financial assistance of such amount as the appropriate Government may, by notification, specify subject to a minimum of twenty-five thousand rupees.

8. ONE TIME RESETTLEMENT ALLOWANCE

Each affected family shall be given a one-time "Resettlement Allowance" of fifty thousand rupees only.

9. STAMP DUTY REGISTRATION

(1). The stamp duty and other fees payable for registration of the land or house allotted to the affected families shall be borne by the Requiring Body.
(2). The land for house allotted to the affected families shall be free from all encumbrances.
(3). The land or house allotted may be in the joint names of wife and husband of the affected family.

10. PROVISION OF INFRASTRUCTURAL AMENITIES

1. Roads within the resettled villages and an all-weather road link to the nearest pucca road, passages and easement rights for all the resettled families be adequately arranged.
2. Proper drainage as well as sanitation plans executed before physical resettlement.
3. One or more assured sources of safe drinking water for each family as per the norms prescribed by the Government of India.

4. Provision of Drinking water for cattle.
5. Grazing land as per proportion acceptable in the State.
6. A reasonable number of Fair price Shops
7. Panchayat Ghars, as appropriate.
8. Village level Post Offices, as appropriate, which facilities for opening saving accounts.
9. Appropriate seed-cum-fertilizer storage facility if needed.
10. Efforts must be made to provide basic irrigation facilities to the agricultural land allocated to the resettled families if not from the irrigation project, then by developing a cooperative or under some Government scheme or special assistance.
11. All new villages established for resettlement of the displaced persons shall be provided with suitable transport facilities which must include public transport facilities through local bus services with the nearby growth centres/ urban localities.
12.Burial or cremation ground, depending on the caste communities at the site and their practices.
13. Facilities for sanitation, including individual toilet points.
14. Individual single electric connections (or connection through non-conventional sources of energy like solar energy), for each household and for public lighting.
15.Anganwadi's providing child and mother supplemental nutritional services.
16. School as per the provisions of the right of children to Free and Compulsory Education Act, 2009 (35 of 2009);
17. Sub-health centre within two kilo metres range.
18. Primary Health Centre as prescribed by the Government of India.
19. Playground for children.
20. One community centre for every hundred families.
21. Places of worship and chowpal/tree platform for every fifty families for community assembly, of numbers and dimensions consonant with the affected area.
22. Separate land must be earmarked for traditional tribal institutions.
23. The forest dweller families must be provided, where possible, with their traditional rights on non-timber forest produce and common property resources, if available close to teh new place of settlement and, in case any such family can continue their access or entry to such forest or common property in the area close to the place of eviction, they must continue to enjoy their earlier rights to the aforesaid sources of livelihood.
24. Appropriate security arrangements must be provided for the settlement, if needed.
25. Veterinary service centre as per norms.

11.SPECIAL PROVISIONS FOR SCHEDULED CASTE AND SCHEDULED TRIBES

(1) In case of a project involving land acquisition on behalf of a Requiring Body which

involves involuntary displacement of the Scheduled castes or the Scheduled Tribes families, a Development plan shall be prepared, in such form as may be prescribed, laying down the details of procedure for settling land rights due but not settled and restoring titles of tribals on alienated land by undertaking a special drive together with land acquisition.

(2) The Development Plan shall also contain a programme for development of alternate fuel, fodder and non-timber forest produce resources on non-forest lands within a period of five years sufficient to meet the requirements of tribal communities as well as the Scheduled castes.

(3) The concerned Gram Sabha or the Panchayats at the appropriate level in the Scheduled Areas under the Fifth Schedule to the Constitution or , as the case may be, Councils in the Sixth Scheduled Areas shall be consulted in all cases of land acquisition in such areas, including acquisition in case of urgency, before issue of a notification under this Act, or any other Central Act or a State Act for the time being in force as per the Provisions of the Panchayats (Extension to the Scheduled Areas) Act, 1996 (40 of 1996) and other relevant laws.

(4) In case of land being acquired from members of the Scheduled Castes or the Scheduled Tribes, at least one-third of the compensation amount due shall be paid to the affected families at the outset as first instalment and the rest shall precede the taking over of the possession of the land.

(5) The Scheduled Tribes affected families shall be resettled preferably in the same Scheduled Area in a compact block, so that they can retain their ethnic, linguistic and cultural identity.

(6) The resettlement areas predominately inhabited by the Scheduled castes and the Scheduled Tribes shall get land, to such extent as may be decided by the appropriate Government, free of cost for community and social gatherings.

(7) In case of a project involving land acquisition on behalf of a Requiring body, the affected families belonging to the Scheduled Castes and the Scheduled Tribes resettled out of the district of acquisition will get twenty-five percent. Higher monetary benefits under Rehabilitation and Resettlement Scheme.

(8) Any alienation of tribal lands or lands belonging to members of the Scheduled Castes in disregard of the laws and regulations for the time being in force shall be treated as null and avoid; and in the case of acquisition of such lands, the rehabilitation and resettlement benefits shall be available to the original tribal land owners or land owners belonging to the Scheduled Castes.

(9) The affected Scheduled Tribes, other traditional forest dwellers and the Scheduled

castes families having fishing rights in a river or pond or dam in the affected area shall be given fishing rights in the reservoir area of the irrigation or hydel projects.
(10) Where the affected Scheduled Castes and Scheduled Tribes are relocated outside of the district then they shall be paid an additional twenty-five percent. Rehabilitation and Resettlement benefits to which they are entitled in monetary terms along with a one-time entitlement of fifty thousand rupees.

ENTITLEMENT MATRIX

The broad entitlement matrix comprising the R & R compensation and assistance is presented in below table. The landowner (titleholder) will receive compensation for land and assets, as decided by the competent authority. The titleholders are also entitled to receive R & R assistance/ allowances and exempted from stamp duty. They should be given advanced notice to harvest non-perennial crops, or compensation for lost standing crops. They will have the right to salvage material from existing structures.

The RFCTLARR Act-2013, represents a significant milestone in the development of a systematic approach to address resettlement issues in India and closes significantly the gap between Indian national policies and operational policy of the World Bank/ADB. All the affected persons irrespective of ownership status are eligible for respective allowances. The Act gives directives for the acquisition of land in the public interest and even provides assistance to landless, agricultural labors, tenants, sharecropper, dependents and those who reside preceding three years prior to land acquisition for their loss of livelihood/income under R & R provisions

Table 11-7: Entitlement Matrix

Entitlement Matrix					
Sl. No.	Category of Impact	Eligibility for Entitlement	RFCTLARR Act- 2013 Provisions		Remarks
			Entitlement	Provisions	
1	2	3	4	5	6
1.	Loss of Land	Land Owner	Compensation for land shall be considered at Market value of land. This will be determined by the District Collector as per Sections 26 to 29 of TRFC&TLARR (LARR) Act-2013). Amount equivalent to current stamp duty and registration charges on compensation amount for replacement of	• Compensation at market value of the land • Multiplier factor upto 2 for rural area • Value of the assets attached to land • Building/Trees/Wells/Crop etc. as valued by relevant govt. authority; • Solatium: 100% of total compensation • Additional 12% per annum on market value of land from the date of the publication of the notification of the SIA to till the date of the award or the date of taking possession of the land.	The method of calculation of market rate – the minimum land value, if any, specified in the Indian Stamp Act, 1899 for the registration of sale deeds in the area, where the land is situated; or – the average of the sale price for similar type of land situated in the immediate areas adjoining the land being acquired, ascertained from fifty per cent of the sale deeds registered during the preceding three years, where higher price has been paid;

Entitlement Matrix

Sl. No.	Category of Impact	Eligibility for Entitlement	RFCTLARR Act- 2013 Provisions		Remarks
			Entitlement	Provisions	
1	2	3	4	5	6
			lost assets.		or – Consented amount of compensation as agreed upon under sub-section(2) of Section 2 in case of acquisition of lands for private companies or for public private partnership projects, whichever is higher – All the entitlements for loss of land will be provided for each survey number based on ownership records to the legitimate owner or their heirs as applicable.
			Land Value factor	Scale 1 to 2 based on the distance of project from urban area, as may be notified by appropriate government. Illustrative scale (0-10 km=1), (10-20=1.20), (20-30 km=1.40),	– The proposed alignment passes through rural areas in KAndigram, Nilambazar, Cheragi, Patharakandi in

Entitlement Matrix					
Sl. No.	Category of Impact	Eligibility for Entitlement	RFCTLARR Act- 2013 Provisions		Remarks
			Entitlement	Provisions	
1	2	3	4	5	6
				(30-40 km=1.80), and (40-50 km=2).	Assam state Thus, as per First Schedule of LARRA 2013 the radial factor of 1.25 - 2 shall be applicable for calculating the market value of the land. The multiplication factor is prerogative of state government and it certainly depends on distance from the urban location.
		Affected Family/Person	Land for land	Not applicable	Not applicable
2.	Loss of other Immovable Assets	Titleholder	Value of Assets attached to land or building	To be considered: ➢ Standing crops, Trees, Livelihood loss.	➢ As per LARRA 2013 under First Schedule Sl. No.2 (ref. Section 29).
3.	Loss of Land, Structure and other immovable assets (1+2)	Titleholder	Solatium	100% on total compensation (including value of assets)	Under Section 30(1) of the LARRA Act 2013. The compensation is calculated for land and structures as applicable

Entitlement Matrix

Sl. No.	Category of Impact	Eligibility for Entitlement	RFCTLARR Act- 2013 Provisions		Remarks
			Entitlement	Provisions	
1	2	3	4	5	6
					and the total compensation of all lost properties taken into account before considering the solatium. As per Section 30(1) of the Act Solatium of 100% on the compensation be considered.
4.	Loss of Land and other assets	Titleholder	Additional 12% on market value of land.	In addition to the market value of land, additional 12% per annum to be paid on such market value commencing on and from the date of publication of notification, till award or date of taking possession of land whichever is earlier.	➢ Provision made Under section 30 (3) of the LARR Act 2013.
5a.	Loss of Structure	Titleholder	Provision of Housing unit or value of the lost structure	➢ If a house is lost in urban areas, a constructed house shall be provided, which will be not less than 50 sq. mts. in plinth area. ➢ Provided also that no family affected by acquisition shall be given more than one	➢ As per section 30 (3) of the LARR Act- 2013.

Entitlement Matrix

Sl. No.	Category of Impact	Eligibility for Entitlement	RFCTLARR Act- 2013 Provisions		Remarks
			Entitlement	Provisions	
1	2	3	4	5	6
				house under the provisions of this Act. ➢ Provided that any such family in urban areas which opts not to take the house offered, shall get a one-time financial assistance for house construction, which shall not be less than one lakh fifty thousand rupees. (Rs. 1,50,000.00) ➢ Provided further that if any affected family in rural areas so prefers, the equivalent cost of the house may be offered in lieu of the constructed house; ➢ Provided also that no family affected by acquisition shall be given more than one house under the provisions of this Act. Explanation: The houses in urban areas may, if necessary, be provided in	

Entitlement Matrix

Sl. No.	Category of Impact	Eligibility for Entitlement	RFCTLARR Act- 2013 Provisions		Remarks
			Entitlement	Provisions	
1	2	3	4	5	6
				multi-story building complexes.	
5b.	Loss of Structure	Non-titleholder	Provision of Housing unit or value of the lost structure	The benefits listed above shall also be extended to any affected family which is without homestead land and which has been residing in the area continuously for a period of not less than three years preceding the date of notification of the affected area and which has been involuntarily displaced from such area: ➢ Provided that any such family in urban areas which opts not to take the house offered, shall get a one-time financial assistance for house construction, which shall not be less than one lakh fifty thousand rupees. (Rs. 1,50,000.00) ➢ Provided further that if any affected family in rural areas so prefers,	➢ Even Non-titleholder is eligible as mentioned in II Schedule of this LARR Act-2013 but it solely depend on the prerogative of the Executing Authority.

Entitlement Matrix

Sl. No.	Category of Impact	Eligibility for Entitlement	RFCTLARR Act- 2013 Provisions		Remarks
			Entitlement	Provisions	
1	2	3	4	5	6
				the equivalent cost of the house may be offered in lieu of the constructed house; ➢ Provided also that no family affected by acquisition shall be given more than one house under the provisions of this Act. Explanation: The houses in urban areas may, if necessary, be provided in multi-story building complexes.	
5c.	Loss of Livelihood	Affected Family/Person	Annuity or Employment **(a)** Job OR **(b)** 5 lakh one-time payment OR **(c)** Rs. 2000.00 per month for 20 years (with	Where jobs are created through the project affected families will get after providing suitable training and skill development in the required field, make provision for employment at a rate not lower than the minimum wages provided for in any other law for the time being in force, to at least one member per	➢ As per Second Schedule of LARRA Act.

Entitlement Matrix

Sl. No.	Category of Impact	Eligibility for Entitlement	RFCTLARR Act- 2013 Provisions		Remarks
			Entitlement	Provisions	
1	2	3	4	5	6
			increment) (the option of availing a, b, or c shall be that of the affected family)	affected family in the project or arrange for a job in such other project as may be required; or (b) onetime payment of five lakhs rupees (Rs.5,00,000) per affected family; or (c) Annuity policies that shall pay not less than two thousand rupees per month per family for twenty years, with appropriate indexation to the Consumer Price Index for Agricultural Labourers. (Refer: http://labourbureau.nic.in).	
6b.	Loss of Livelihood	Affected Family/Person	Subsistence grant for displaced families for a period of one year (even if the families displaced due to land acquisition)	➢ Each affected family which is displaced from the land acquired shall be given a monthly subsistence allowance equivalent to three thousand rupees per month for a period of one year from the date of	➢ As per Second Schedule of LARRA Act.

Entitlement Matrix

Sl. No.	Category of Impact	Eligibility for Entitlement	RFCTLARR Act- 2013 Provisions		Remarks
			Entitlement	Provisions	
1	2	3	4	5	6
				award. (Rs. 3000.00 per month for one year = 36,000.)	
				➢ In addition to this amount, the Scheduled Castes and the Scheduled Tribes displaced from Scheduled Areas shall receive an amount equivalent to fifty thousand rupees. (Rs. 50000.00).	➢ Provision made in Second Schedule of LARR Act- 2013
7.	Structure	Affected Family/Person	Transportation cost for displaced families.	One time financial assistance of Rs. 50000.00 for shifting family, building material, belongings and cattle.	➢ Provision made in Second Schedule of LARR Act- 2013.
8.	Structure	Affected Family/Person	Commercial Establishments including Owners and Tenants	Each affected family having cattle or having a petty shop shall get one time financial assistance of such amount as the appropriate government may, by notification, specify subject to a minimum of Rs. 25000.00 for construction of	➢ Provision made in Second Schedule of LARR Act- 2013.

Entitlement Matrix

Sl. No.	Category of Impact	Eligibility for Entitlement	RFCTLARR Act- 2013 Provisions		Remarks
			Entitlement	Provisions	
1	2	3	4	5	6
				cattle shed or petty shop as the case may be.	
9.	Livelihood	Affected Family/Person	One time grant to artisan, small traders and certain others	Each affected family of an artisan, small trader or self-employed person or an affected family which owned non-agricultural land or commercial, industrial or institutional structure in the affected area, and which has been involuntarily displaced from the affected area due to land acquisition, shall get one-time financial assistance of such amount as the appropriate Government may, by notification, specify subject to a minimum of Rs. 25000.00.	➢ Provision made in Second Schedule of LARR Act- 2013.
10.	Land/Structure/Livelihood	Affected Family/Person	One time resettlement allowance.	Each affected family shall be given a one-time "Resettlement Allowance" of Rs. 50000.00.	➢ As per LARRA 2013 under Second Schedule of the Act.
11.	Land/Structure	Titleholder	Stamp duty and registration fee.	(1) The stamp duty and other fees payable for registration of the land or house allotted to the affected families shall	➢ Provision made in Second Schedule of LARR Act- 2013

Entitlement Matrix					
Sl. No.	Category of Impact	Eligibility for Entitlement	RFCTLARR Act- 2013 Provisions		Remarks
			Entitlement	Provisions	
1	2	3	4	5	6
				be borne by the Requiring Body. (2) The land for house allotted to the affected families shall be free from all encumbrances. (3) The land or house allotted may be in the joint names of wife and husband of the affected family.	
12.	Land/Structure/Livelihood	Affected Family /Person	Any other unforeseen impact	Any unforeseen impact would be addressed and mitigated as necessary by the Implementing Agency.	

Note: The Ministry of Road Transport and Highways issued a number of orders/ clarifications regarding the applicability of provisions of the RFCTLARR Act to the NH Act, 1956. The same will be applicable.

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13. FINANCIAL ANALYSIS

13.1 BACKGROUND

The main objective of financial analysis is to assess the likely returns to the investors under realistic conditions. For this purpose, the prevailing market rates and return on debt and equity issues in local capital markets are the important factors. In the present studies, the financial viability of the project is assessed on the basis of project's financial internal rate of return on investments and Rate of Return on Equity, which is estimated on the basis of cash flow analysis.

13.2 APPROACH TO FINANCIAL EVALUAUTION

The main objective of financial analysis is to examine the viability of implementing the project on BOT/HAM basis. The analysis attempts to ascertain the extent to which the investment can be recovered through toll revenue and the gap, if any, be funded through Grant / Subsidy. This covers aspects like financing through debt and equity, loan repayment, debt servicing, taxation, depreciation, etc. The viability of the project is evaluated on the basis of Project FIRR (Financial Internal Rate of Return) on total investment. The FIRR is estimated on the basis of cash flow analysis, where both costs and revenue have been indexed to take account of inflation. Financial analysis has been carried out for the entire project road with debt equity ratio of 70:30. The basic indicators for assessing the Financial Viability of the project are as follows.

NPV (Net Present Value): The NPV for the project should be positive when a discount rate representing the opportunity cost along with a risk premium is applied in the financial analysis.

FIRR (Financial Internal Rate of Return): The FIRR should have a value above the discount rate (opportunity cost).

13.3 MODEL CONCESSION AGREEMENT

Financial analysis was carried out based on following Assumptions:

Time Assumptions:

1. Concession Period has been fixed to the year in which the projected traffic would cross the design capacity of the Project Road.
2. Concession Period included the time required for construction also.

Economic Assumptions:

Annual Inflation rate of 5% has been considered for determining the Project Cost, Routine Maintenance and Periodic Maintenance.

Project Cost Assumptions*:

1. Contingency cost has been taken as 1% of the civil construction cost.
2. IC&Pre-Operative Expenses cost has been taken as 1% of Estimated Project Cost.
3. Financing Cost has been taken as:

Civil Cost	% on Debt amount
Up to 500 crores	2%
Between 500 crores to 1000 crores	1.5%
More than 1000 crores	1%

4. Interest rate for calculation of Interest during Construction has been taken as 12.5% (Base rate 10%+2.5% as per MoRTH Circular dated 16/06/14)
5. The Construction cost for the up gradation of the Project Road does not include the Environmental, Social, Land Acquisition, Utility relocation and Tree cutting cost for the purpose of Financial Analysis.

Financing Assumptions:

1. The Debt has been considered as 70% of the Net Project Cost.
2. Equity has been considered as 30% of the Net Project Cost.
3. Maximum Government/Client Contribution (Grant) is 40% of TPC.
4. Toll rates have been rounded to nearly 5 rupees.

Expenditure Assumptions:

1. Cost of Routine Maintenance and Periodic Maintenance has been taken from NHAI circular (NHAI/11033/CGM(Fin.)/2011 dated 29/04/11)
2. The interest rate on Debt has been considered as 12.50% per annum.

Other Assumptions:

1. Loan Repayment Period- 10 Years.
2. Tax Exemption/Tax Holiday- 10 Years of Concession Period to get maximum advantage of tax exemption. The MAT rate has been made applicable in those years.
3. Income Tax rate- 33.063% & MAT- 20.389%

13.4 TOLL POLICY

The new toll policy – 2008 has been used for calculation of toll revenues. The Ministry of Road Transport and Highways (MORTH) has come up with couple of amendments to National Highway Fee Rules, 2008.

13.4.1 Traffic considerations

The share of through traffic, traffic using daily/monthly passes and local passes have been assessed by roadside interview and number plate surveys.

Three categories of traffic can avail discounted rates at the toll plaza.

a) Owners residing within 20 kms distance from the plaza, using the vehicle for non-commercial purposes can take a monthly pass.

b) Vehicles making return trips on the same day within 24 hours can take a daily pass.

c) Vehicles making a maximum of 50 or more one-way trips/month can take a monthly pass.

d) Local commercial vehicles with the same district registration number and without National permit can avail 50% discount for regular tickets and passes.

Amendments to National Highways Fee Rules, 2008

Following are the changes in subsequent amendments:

Particulars	As per Original Notification	Amendment
December 2010 Amendment		
Additional Toll Rates for Bypasses	Bypasses with cost more than 50 crores were eligible for cost-based toll rates	Bypasses with cost more than10 crores are eligible for additional toll rates. However, the additional toll rates are not based on the cost of bypass but are 50% more than per kilometer toll rates given in 2008 notification.
WPI to be considered for toll escalation	Week ending January1st of current year (Calendar)	For the month of December of previous year (Calendar)
Eligibility of Two Lane	The rate of fee for use of a section of National highway,	The rate of fee for use of a section of National highway, having two lanes and on which the average investment for

Particulars	As per Original Notification	Amendment
Roads for Tolling	having two lanes and on which the average investment for up gradation has exceeded. one crore per Km., shall be sixty per cent of the rate of fee.	up gradation has exceeded two crore and fifty lakhs per Km., shall be sixty per cent of the rate of fee.
January 2011 Amendment		
Toll Rates for 3-axle Trucks	3-axle Trucks were to be charged under MAVs. MAV was defined as heavy construction machinery or earth moving equipment or mechanical vehicle including a multi axle vehicle with three to six axles or vehicle with a gross vehicle weight	A separate toll category has been created for 3-axle trucks with substantially less toll rates. The per kilometer toll rate for 3-axle Truck is 2.4 whereas for 2-axle Truck it is 2.2. (The toll rate for 3-axle Truck was 3.45 per kilometer) Similarly, New toll rates are given for 3-axle Trucks for Bridges/Tunnels. 3-axle Truck is defined as a mechanical vehicle having 3-axles (including the axle of the trailer, if any) and with gross vehicle weight, of less than 25,000 kilograms.

Particulars	As per Original Notification	Amendment
	exceeding twenty thousand kilograms but less than sixty thousand kilograms.	MAV is now defined as heavy construction machinery or earth moving equipment or mechanical vehicle including a multi axle vehicle with four to six axles or vehicle with a gross vehicle weight exceeding twenty-five thousand kilograms but less than sixty thousand kilograms.
Local Concessions for Commercial Vehicles	We're not available.	Are now provided, as given below: A person, who owns a commercial vehicle (excluding vehicle plying under National Permit), registered with address on the Registration Certificate of a Particular district uses such vehicle for commuting on a section of the National Highway, permanent bridge, tunnel or bypass, as the rule may be, which is located within that district, shall be levied user fee on all toll plazas which are located within that district, at the rate of fifty percent of prescribed rate of fee. Provided that no such concession will be given, if the service road or alternative road is available for use by such commercial vehicles.

Particulars	As per Original Notification	Amendment
October 2011 Amendment		
Toll rates for the existing toll road users	-	The section of the national highway or the bridge has been taken for further lane up-gradation, the increase in the toll
December 2013 Amendment		
Annual Revision during Construction from Four lane to Six lane		For the section of highways which has been taken up for up gradation of Four lane to Six lane, increasing in rate shall be limited to Seventy Five Percent of the Toll rates, from the date of commencement of work to toll the completion of the project according to the agreement entered into with the concessionaire without any annual revision. Provided also that no user fee shall be levied for the delayed period between the date of completion as per the agreement and the date of actual completion.
Structure cost	AS per Rule 4 of sub rule (4)	The rate of fee of stand-alone structure shall be calculated by converting the cost of structure into equivalent length of highway/Express way by dividing by an equalization factor equal to average cost per Km of highway/Expressway on 1st April of that year.

Particulars	As per Original Notification	Amendment
Stand-alone structure		The rate of fee of stand-alone structure forming part of a linear highway/expressway, shall be calculated by converting the length of the structure into an equivalent length of highway/expressways by multiplying by a factor of ten. The structure of Length 60me or less, on a linear highway/Expressway will be considered as part of the normal length of highways for calculation of Fee.

The Toll Rates for the project have been determined on the basis of user fees as prescribed by NHAI for collection of fees by any person for the use of National highways (effective 1st April 2007).

The rates shall be increased annually by 3 percent without compounding thereof with effect from April 1, 2008 and such incremented rates shall be deemed to be the base rate for the purpose of these rules. The applicable base rates shall be revised annually with effect from April 1 each year to reflect the increase in WPI for the month of December of the immediately preceding year and the month of December of the year subsequent to January 1st of the year in which such revision is undertaken; but restricted to 40% of such increase in WPI.

The fee and amounts shall be rounded off to a multiple of 'five rupee' in accordance with the Indian Standards IS: 2-1960 “Rules for rounding of numerical values” issued by Bureau of Indian Standards as amended from time to time. Accordingly rates applicable for 4 or more lanes of National Highway and for the permanent structures like bridge or flyover at the toll plaza for the base year 2007-08 have been calculated and presented below.

Table 13-1: Toll Capping Rates for National Highway

S. No	Type of Vehicle	Base rate of fee per Km
1	Car, Jeep, Van or Light Motor Vehicle or tractor with trolley carrying non-agricultural produce	0.65
2	Light Commercial Vehicle, Light Goods Vehicle or minibus	1.05
3	Bus or 2 Axle Truck	2.2
4	3 Axle Truck	2.4
5	Heavy Construction Machinery or Earth Moving Equipment or M axle vehicle with four to six axles	3.45
6	Oversized Vehicles	4.2

13.4.2 Discounts to users

13.4.2.1 Discount to frequent user:

Any user may opt for the payment of fee for multiple journeys within the specified period in accordance with the rates mentioned below, as per the toll notification.

Discounts to frequent users

Type of Pass	Amount Payable	Maximum number of one-way journeys allowed	Validity period for crossing the fee plaza
Round (or) Return Pass	One and half times of fee for one-way journey.	Two	Twenty-four hours from the time of the payment
Monthly Pass	Two-third of amount of the fee payable for fifty or more-one-way trips.	Fifty	One month from the date of payment

Discount to local user:

Local traffic* shall be entitled to ply on the project highway and cross the toll plaza on production of a monthly pass to be issued by the concessionaire on payment of a monthly fee of 150/- per month.

*Local user means a person who owns a mechanical vehicle registered for non-commercial purposes and uses it as such for commuting on a section of national highway, permanent bridge, bypass or tunnel, may obtain a pass, on payment of fee at the base rate for the year 2007-08 of 150/-per calendar month. Provided that such pass shall be issued only if such driver, owner or person in charge of such mechanical vehicle resides with in a distance of 20 km from the toll plaza specified by such person and the use of such section of national highway, bypass or tunnel, as case may be, does not extend beyond the toll plaza next to the specified toll plaza.

A person, who owns a commercial vehicle (excluding vehicle plying under National Permit), registered with address on the Registration Certificate of a Particular district uses such vehicle for commuting on a section of the National Highway, permanent bridge, tunnel or bypass, as the rule may be, which is located within that district, shall be levied user fee on all toll plazas which are located within that district, at the rate of fifty percent of prescribed rate of fee.

Location of Toll Plaza

The fee levied and collected for use of a National highway shall be due and payable at the toll plazas. In the present scenario, an open tolling policy is adopted along the project corridor. The fee levied and collected for use of a National highway shall be due and payable at the toll plaza. Our project stretch is divided into 3 packages. As per client, each package will go into bidding separately. So financial analysis has to be performed for each package.

As the stretch is only of 67.95kms, toll plaza cannot be placed in all packages. So, for purpose of analysis, a dummy toll plaza is considered in each package

Financial Analysis

Table 13-2: Location of Toll Plaza's

S. No	Section	Design Chainage	Toll Plaza
1	From Km. 38.600 to Km. 62.800 of NH-8 in the state of Assam	Km. 61.200	Berajal

Toll Revenue

Toll revenue is the product of the forecast traffic expected to use the road and the appropriate toll fee for the vehicle category. Toll indexing has been carried out as per the new toll policy and rounded off to nearest five-rupee multiples. As per the new toll policy the toll revenue calculations for through traffic, local traffic and vehicles making frequent trips are given below:

Nonlocal category	
Revenue from single trips (Through traffic)	No. of vehicles making single trips X Toll Rate X 365 days
Revenue from daily pass traffic (Return trips)	No. of vehicles taking Daily passes X Toll rate X 150% X 365 days
Revenue from monthly traffic (Monthly pass trips)	No. of vehicles taking monthly passes X 2/3 X 50 X Toll rate X 12 months
Local category	
Revenue from local noncommercial traffic	No. of vehicles taking local pass X 150 X 12 months
Revenue from commercial through traffic	No. of vehicles making single trips X Toll Rate X 365 days X 0.5
Revenue from commercial daily pass traffic (Return trips)	No. of vehicles taking Daily passes X Toll rate X 150% X 365 days X 0.5
Revenue from commercial monthly traffic (Monthly pass trips)	No. of vehicles taking monthly passes X 2/3 X 50 X Toll rate X 12 months X 0.5

The summary of computed Toll Rates is presented below for quick reference and details are provided in volume-I Annexures.

Table 13-3: Toll Rates per Kilometer

Year		Car /Mini LCV	Minibus/ LCV	Bus/ 2 Axle Truck	3 Axle Truck	Multi-axle	Over Sized Vehicles
2023	2024	1.44	2.23	4.89	5.33	7.67	9.33
2024	2025	1.52	2.45	5.14	5.60	8.06	9.81
2025	2026	1.60	2.58	5.40	5.89	8.47	10.31
2026	2027	1.68	2.71	5.68	6.19	8.90	10.84
2027	2028	1.76	2.85	5.97	6.51	9.36	11.39
2028	2029	1.85	3.00	6.28	6.85	9.84	11.98
2029	2030	1.95	3.15	6.60	7.20	10.35	12.60
2030	2031	2.05	3.31	6.95	7.58	10.89	13.26
2031	2032	2.16	3.49	7.31	7.97	11.46	13.95
2032	2033	2.27	3.67	7.69	8.39	12.06	14.69
2033	2034	2.39	3.86	8.10	8.83	12.70	15.46
2034	2035	2.52	4.07	8.53	9.30	13.37	16.28
2035	2036	2.65	4.29	8.98	9.80	14.08	17.14
2036	2037	2.79	4.51	9.46	10.32	14.83	18.06
2037	2038	2.94	4.76	9.97	10.87	15.63	19.03
2038	2039	3.10	5.01	10.50	11.46	16.47	20.05
2039	2040	3.27	5.28	11.07	12.08	17.36	21.13
2040	2041	3.45	5.57	11.67	12.73	18.30	22.28
2041	2042	3.64	5.87	12.30	13.42	19.30	23.49
2042	2043	3.83	6.19	12.98	14.16	20.35	24.77
2043	2044	4.04	6.53	13.69	14.93	21.46	26.13
2044	2045	4.27	6.89	14.44	15.75	22.64	27.57
2045	2046	4.50	7.27	15.24	16.62	23.89	29.09

Year		Car /Mini LCV	Minibus/ LCV	Bus/ 2 Axle Truck	3 Axle Truck	Multi-axle	Over Sized Vehicles
2046	2047	4.75	7.67	16.08	17.54	25.21	30.70
2047	2048	5.01	8.10	16.97	18.51	26.61	32.40
2048	2049	5.29	8.55	17.92	19.54	28.09	34.20
2049	2050	5.59	9.03	18.92	20.63	29.66	36.11
2050	2051	5.90	9.53	19.97	21.79	31.32	38.13
2051	2052	6.23	10.07	21.09	23.01	33.08	40.27
2052	2053	6.58	10.63	22.28	24.31	34.94	42.53
2053	2054	6.95	11.23	23.54	25.67	36.91	44.93
2054	2055	7.35	11.87	24.86	27.12	38.99	47.47
2055	2056	7.76	12.54	26.27	28.66	41.20	50.16
2056	2057	8.20	13.25	27.76	30.29	43.53	53.00
2057	2058	8.67	14.00	29.34	32.01	46.01	56.01

13.5 Financial Calculations

13.5.1 Tax Calculation Model

According to the scheme under section 80-IA, 100% of the profit is deductible for the continuous period of ten years out of the concession period. However the benefit deduction is available only for ten consecutive assessment years falling within the concession period. The tax rate adopted for this study is 33.063% (30% tax + 7% surcharge + 3% education cess) following the deduction of depreciation and amortization. Minimum Alternate Tax (MAT) of 20.389% (18.5% tax + 7% surcharge + 3% education cess) has been taken into account for the total concession period.

13.5.2 Proposed Source of Finance

In general, the developer shall crystallize the sources of finance by optimizing his equity returns keeping in view the project cash flows, terms, and conditions of various financing options available. Further the market standing, and financial strength of the Developer would largely determine the terms and conditions of finance offered to the Developer by various lending agencies. For the purpose of the study, following sources of finance have been taken:
Equity: To be provided by the Developer
Subsidy / Grant for viability of funding, to be provided by the client.

Debt: To be arranged by the Developer / Concessionaire.

13.5.3 Methodology

The procedure and steps undertaken to assess the financial viability of the captioned Project are outlined in this section. The first stage in evaluation of the financial viability is the identification of the revenue and expenditure streams. The revenue for the captioned Project will be generated primarily from toll income. Revenues from hoardings are not considered in the income stream.

13.5.4 Expenses

Expenses can broadly be classified based on the phases in which they are incurred, viz. construction period expenses and operation & maintenance period expenses.

Construction Period Expenses

- Preliminary and pre-operative expenses
- Contingency allowance
- Interest during construction period

13.5.4.1 Operation and Maintenance Period Expenses

- Toll collection expenses
- Maintenance expenses, which include routine and periodic maintenance.
- Interest expenses incurred for servicing term loans.

Client would extend toll collection rights to the developer. The developer then would have the option of either collecting the toll himself or further subcontracting the same to a toll collection agency. In the present study, it is assumed that the developer would undertake operation and maintenance himself. The details of the toll collection expenses are given below for the year 2023 for 4 lane road:

13.5.5 Civil Cost of the Project and Interest during construction (IDC)

The cost of Civil works of the project including the improvement of existing carriageway and cost of toll plaza and details are given below:

Table 13-4: Cost Summary

Project corridor	Length in km	Cost/ Km (Cr.)	Civil Cost excluding GST (Cr.)	Civil Cost including GST (Cr.)
From Km. 38.600 to Km. 62.800	24.200	23.75	574.72	678.17

The interest during construction, which is on the cost of funding incurred on the project, has been calculated on the basis of an interest rate of 12.50% per annum as per the present trends.

The total landed cost for the project at the end of the construction period has been estimated by adding the (capitalizing) interest during construction (IDC).

Table 13-5: Summary of Concessionaire cost in Crores

Concessionaire Cost	Construction Grant		
	0%	20%	40%
Total Civil Construction cost in 2023 year in Crores	718.40	718.40	718.40
Contingencies/QC @ 1.0% of Civil Cost in Crores	7.18	7.18	7.18
Total EPC Cost in Crores	725.58	725.58	725.58
IC & Pre-operative expenses @1.5% of EPC in Crores	10.88	10.88	10.88
Financing Cost @ 1.5% on Debt. in Crores	9.72	7.57	5.54
Escalation @ 5% Per Anum in Crores	81.93	81.93	81.93
Interest During Construction in Crores	97.15	75.74	55.40
TOTAL PROJECT COST in Crores	925	902	879

14.1.1 Operation and Maintenance Cost

Routine maintenance costs comprise of maintenance of the pavement, collection of litter, traffic management, repairs due to accident and all ancillary works including beautification.

The periodic maintenance costs include cost of overlay, repair/renovation of road furniture, drains, buildings etc. The periodic maintenance includes periodic renewals at every 7 years.

Routine maintenance/ Periodic maintenance costs have been taken from NHAI circular (NHAI/11033/CGM(Fin.)/2011 dated 29/04/11). The details of the maintenance costs and administration charges are given below.

Routine maintenance every year for 4 Lane divided (Flexible Pavement) is 6.60 Lakhs/km. Periodic Maintenance at every 7th year is taken as 66.00 Lakhs/Km.

13.5.6 Resource Mobilization Scheme

In general, the duration of construction for 6 Lane divided projects ranges between 2.5-3.0 years. Since the proposed Project is planning to be implemented on a DBOT format, the developer has an incentive in early completion of the project in order to expedite toll collection. Based on the implementation period, the project cost has been phased as under:

- First Year (6 months) - 20%

- Second year (12 months) - 40%
- Third year (12 months) - 40%

13.5.7 Minimum Return Criteria

The minimum return criteria for the B.O.T project is considered as follows: -

Return on Equity (EFIRR): Considering a safe investment in bank in the form of a term deposit, an interest rate of 10% is generally a return with safety. However, when investing in the road sector, a perspective investor would normally need to cover the business risks(e.g. the decreasing revenue, increasing cost, construction time overrun, etc.) and therefore would require a return higher than a return on the safe investment as mentioned above. Based on usual trends, it is estimated that an additional return of 5% would be adequate to cover these risks. Hence, a minimum return on equity of 15% could be considered satisfying the requirement of prospective concessionaire.

The return on project investment (PFIRR): In the light of the facts as stated above Project FIRR of 12% is considered to be a satisfactory criterion.

The minimum average DSCR is taken as 1.5 to 2.5.

Considerations for Calculating the Project FIRR

Considerations for Calculating the Project FIRR

* Investment = Net Project Cost
= Total Project Cost– Equity Support (Grant during Construction)
* Operating Income = Toll Revenue
O&M Support
* Operating Expenses =Toll Plaza Maintenance
(O&M Expenses) Annual Maintenance of Road
Periodic Maintenance of Road
Concession Fee
Tax on Net Profit as per Income Tax Act

Considerations for Calculating the Equity FIRR

Investment = Equity Contribution on Net Project Cost (30% of the Net Project Cost by the Concessionaire)

i. Operating Income = Toll Revenue
ii. O&M Support (Grant During Operation)
iii. Operating Expenses =Toll Plaza Maintenance
iv. Annual Maintenance of Road

Periodic Maintenance of Road
Concession Fee
Tax on Net Profit as per Income Tax Act

Interest on Debt/Loan (Diminishing Interest)
Debt/Loan Repayment
Debt Service Coverage Ratio (DSCR)

DSCR = Net Operating Income after Tax / (Interest on Loan + Repayment of Loan)
Net Operating Income = Total Revenue – O&M Expenses -Tax.
Net Operating Income Period equal to Loan Repayment Period.

13.5.8 Financial Analysis Considerations

The main objective of undertaking this study is to assess whether the project is financially viable or not. It is important to note that the proposal should be an attractive proposition for private sector participation under Build, Operate and Transfer (BOT) system. The basic methodology followed for estimating the financial viability of the project is to calculate the FIRR (Financial Internal Rate of Return) on the investment for the project.

Following assumptions are taken into consideration for the financial analysis: -

i. Debt – Equity ratio: - 70:30
ii. Subsidy/Grant – 40% (maximum)
iii. Concession period (Including construction period) – 20 years.
iv. Escalation – 5%
v. Interest on Debt – 12.5%
vi. Project Phasing: First year–20%, Second year–40% and Third year -40%

13.5.9 Financial Viability based on BOT-Toll Basis

Based on the project structure traffic study and toll rate analysis, financial feasibility analysis has been carried out as per the methodology outlined in earlier sections. The objective of the financial analysis is to ascertain the existence of sustainable project returns, which shall successfully meet the expectations of its financial investors. The analysis reveals various FIRR values corresponding to each year of toll operation. FIRR for the Returns on Investment and Returns on Equity for the concession period of 20 years has been examined and tabulated below and details are provided in Appendix.

Table 13-6: Financial Analysis Results (BOT)

Tolling Lengths (km)			Grant (%)	Concession Period	Civil Cost in Cr. in the year 2023	Project FIRR (%)
From	To	Length				
38.600	62.800	24.200	0	20 Yrs.	574.72	-ve
			20			-ve
			40			-ve

13.5.10 Financial Viability based on Hybrid Annuity Mode (HAM)

Based on the project structure traffic study and toll rate analysis, financial feasibility the Project has been proposed to execute on Hybrid Annuity Mode.

13.5.10.1 Bid Project Cost

The Parties expressly agree that the cost of construction of the Project, as on the Bid Date, which is due and payable by the Authority to the Concessionaire, shall be deemed to be the " Bid Project Cost". The Parties further agree that the Bid Project Cost for payment to the Concessionaire shall be inclusive of the cost of construction, interest during construction, working capital, physical contingencies and all other costs, expenses and charges for and in respect of construction of the Project, save and except any additional costs arising on account of variation in Price Index,

Change of Scope, Change in Law, Force Majeure, which costs shall be due and payable to the Concessionaire in accordance with the provisions of the Agreement

13.5.10.2 Adjusted Bid Project Cost

- The Bid Project Cost specified above shall be revised from time to time in accordance with the variation in Price Index occurring after the Reference Index Date immediately preceding the Bid Date.
- The Bid Project Cost adjusted for variation between the Price Index occurring between the Reference Index Date preceding the Bid Date and the Reference Index Date immediately preceding the Appointed Date shall be deemed to be the Bid Project Cost at commencement of construction.
- For every month occurring after the Appointed Date, the Authority shall compute the variation in Price Index occurring between the Reference Index Date preceding the Bid Date and the Reference Index Date preceding the date of Invoice, and shall express the latter as a multiple of the former (the "Price Index Multiple"). All Invoices to be submitted by the Concessionaire to the Authority for and in respect of the Construction Period shall be the product of the relevant proportion of the Bid Project Cost and the Price Index Multiple applicable on the date of Invoice.

13.5.10.3 Payment of Bid Project Cost

- [40% (forty per cent)] of the Bid Project Cost, adjusted for the Price Index Multiple, shall be due and payable to the Concessionaire in 5 (five) equal installments of [8% (eight per cent)].
- The remaining Bid Project Cost, adjusted for the Price Index Multiple, shall be due and payable in [30 (thirty)] biannual installments commencing from the 180th (one hundred and eightieth) day of COD.

13.5.10.4 Payment during Construction Period

Upon receiving a report from the Independent Engineer certifying the achievement of the below mentioned Payment Milestones, the Authority shall disburse, within 15 (fifteen) days of the receipt of each such report, an installment equal to 8% (eight per cent) of the Bid Project Cost, adjusted for the Price Index Multiple as applicable on the Reference Index Date preceding the date of that report.

The Payment Milestone for release of payment during Construction Period shall be as under:

a) I (first) Payment Milestone – On achievement of 20% Physical Progress
b) II (second) Payment Milestone – On achievement of 40% Physical Progress
c) III (third) Payment Milestone – On achievement of 60% Physical Progress
d) IV (fourth) Payment Milestone – On achievement of 75% Physical Progress
e) V (fifth) Payment Milestone – On achievement of 90% Physical Progress

Provided that in case of Change of Scope, the Physical Progress shall be recalculated to account for the changed scope.

13.5.10.5 Annuity Payments during Operation Period

The (the "Completion Cost" shall be the summation of A, B, C, D, E, and F below:

A. 20% of the Bid Project Cost adjusted for the Price Index Multiple as applicable on the Reference Index Date preceding the date of report confirming 20% Physical Progress.
B. Another 20% of the Bid Project Cost adjusted for the Price Index Multiple as applicable on the Reference Index Date preceding the date of report confirming 40% Physical Progress.
C. Another 20% of the Bid Project Cost adjusted for the Price Index Multiple as applicable on the Reference Index Date preceding the date of report confirming 60% Physical Progress.
D. Another 15% of the Bid Project Cost adjusted for the Price Index Multiple as applicable on the Reference Index Date preceding the date of report confirming 75% Physical Progress.
E. Another 15% of the Bid Project Cost adjusted for the Price Index Multiple as applicable on the Reference Index Date preceding the date of report confirming 90% Physical Progress.
F. Another 10% of the Bid Project Cost adjusted for the Price Index Multiple as applicable on the Reference Index Date preceding the COD.

The Parties acknowledge and agree that the Authority has paid a portion of the Completion Cost as payments during Construction Period. The balance Completion Cost remaining shall be due and payable during the Operation Period.

The Completion Cost remaining to be paid in pursuance of the provisions of above shall be due and payable in biannual installments over a period of [15 (fifteen)] years commencing from COD, (the "Annuity Payments"). The 1st (first) installment of Annuity Payments shall be due and payable within 15 (fifteen) days of the 180th (one hundred and eightieth) day of COD and the remaining installments shall be due and payable within 15 (fifteen) days of completion of each of the successive six months ("the Annuity Payment Date").

Each of the Annuity Payments due and payable during the years following the COD shall be as under:

Annuity Following the COD	Percentage of completion cost remaining to be paid on COD
1st Annuity	2.10%
2nd Annuity	2.17%
3rd Annuity	2.24%
4th Annuity	2.31%
5th Annuity	2.38%
6th Annuity	2.45%
7th Annuity	2.52%
8th Annuity	2.60%
9th Annuity	2.68%
10th Annuity	2.76%
11th Annuity	2.84%
12th Annuity	2.93%
13th Annuity	3.02%
14th Annuity	3.11%
15th Annuity	3.20%
16th Annuity	3.30%
17th Annuity	3.40%
18th Annuity	3.50%
19th Annuity	3.61%
20th Annuity	3.72%

Annuity Following the COD	Percentage of completion cost remaining to be paid on COD
21st Annuity	3.83%
22nd Annuity	3.94%
23rd Annuity	4.06%
24th Annuity	4.18%
25th Annuity	4.25%
26th Annuity	4.25%
27th Annuity	4.44%
28th Annuity	4.71%
29th Annuity	4.75%
30th Annuity	4.75%

Each of the biannual installments payable here under shall be paid along with interest.
Interest shall be due and payable on the reducing balance of Completion Cost at an interest rate equal to the applicable Bank Rate [plus 3% (three per cent)]. Such interest shall be due and payable biannually along with each installment.

13.6 O&M PAYMENTS

All O&M Expenses shall be borne by the Concessionaire and in lieu thereof; a lump sum financial support in the form of biannual payments shall be due and payable by the Authority, which shall be computed on the amount quoted by the selected bidder under its O&M Bid. The Parties further acknowledge and agree that any O&M Expenses in excess of the O&M Payments shall be borne solely by the Concessionaire, save and except as expressly provided.
The O&M Payments due and payable to the Concessionaire shall be paid in 2 (two) equal biannual installments and disbursed by the Authority together with the corresponding installments of Annuity Payments.
Each installment of O&M Payment shall be the product of the amount determined in accordance with the Price Index Multiple on the Reference Index Date preceding the due date of payment thereof.

13.7 FINANCIAL VIABILITY

FIRR for the Returns on Investment and Returns on Equity for the concession period of 15 years has been examined and tabulated below and details are provided in Appendix.

Table 13-7: Financial Analysis Results (HAM)

Tolling Lengths (km)			Construction Support (%)	Concession Period in	Civil Cost in Cr. Year 2023	Bid Parameters (Cr.)	
From	To	Length		Yrs.		TPC	O&M
38.600	62.800	24.200	40	15	574.72	925	10.41

13.8 CONCLUSIONS

A minimum return on equity of around 15% could be considered satisfying the requirement of prospective concessionaire. The project is not yielding return on equity even with the 40% grant and 20 years concession period. In view of this, the option with BOT (Toll) is not viable for taking up the project on BOT -Toll basis.

In view of the above it is recommended to taken up the project on one of the following options:

- HAM with a concession period of 15 years with 40% construction support and the bid parameters are TPC of Rs.925 Cr. & O&M of Rs.10.41 Cr.

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13.1 Economic Analysis

13.1.1 Methodology

The economic evaluation has been carried out within the broad framework of social cost benefit. The objective is to determine the appropriate improvement Scheme out of several proposals that leads to minimizing total transport costs and maximizing benefits to the road users. The indicators for economic viability analysis are Economic Internal Rate of Return (EIRR), Net Present Value (NPV) and NPV/Cost Ratio.

The costs considered comprise of road agency costs and costs to road users as follows:

Road Agency Costs	Road User Costs
• Construction Cost • Maintenance Cost	• Vehicle Operating Cost • Travel Time Cost • Congestion Cost • Accident Cost

The benefits accruing to society from the proposed improvement are as follows

Road User Benefits	Social Benefits
• Vehicle Operating Cost Savings • Value of Travel Time Savings • Value of Savings in Accident Costs • Savings in Maintenance Costs	• Improvements in administration, Law and order • Improvements in health and education • Improvements in agriculture, Industry, trade and mining • Improvements in environmental standards • Appreciation in value of Land adjacent to roads

At the present state of knowledge in the country, it is possible to monetarily quantify only the direct road user benefits. This report, therefore, restricts itself to only the direct road user benefits.

Road users experience different costs in the “With Project” and “Without Project” scenarios. The benefits to road users are constituted by the savings in costs. Increasing traffic volumes as a result of the project implies more vehicle kilometres and hence more

vehicle operating costs and, possibly showing more saving in with project conditions viz. benefits as a result of the project.

Based on traffic, Road network and Socio-economic characteristics of the project road, two different improvement options(with project) have been considered. The Economic analysis is carried out for the following improvement options

· "Without project/ Do minimum" - Routine maintenance of the existing road

· "With Project"- 4 lane road with paved shoulder as per the warrants of traffic volumes.

The total transport costs for both the Options have been worked out on yearly basis for the entire analysis period of 15/20 Years. All costs and benefits considered in the study have been valued in monetary terms and expressed in economic prices for avoiding distortion in the input prices of labour, materials, equipment and foreign exchange due to market imperfections. The ratio of Economic and Financial costs is taken as 0.85.

Economic analysis is carried out with help of HDM-4 (version 1.3) developed by the World Bank. The HDM-4 Road User Effects (RUE) sub-model uses mechanistic principles for modeling of fuel and tyre consumption. The mechanistic forces comprise of the aerodynamic, gradient, rolling and inverted resistance. It calculates vehicle speeds and operating costs taking into account road roughness, geometry, together with the characteristics of representative vehicles and the traffic flow.

The new HDM-4 also makes use of the CRRI deterioration models for Indian asphalt mixes such as semi dense carpet and premix carpet and gives accurate predictions of roughness for various road maintenance related components.

This model provides for calibration of crucial input parameters to suit the local conditions and analysis of a number of alternatives and sections at relatively greater speed than is possible with HDM III. The Road user cost streams generated by HDM-4 are extracted and Economic Internal Rate of Return (EIRR), Net Present Value (NPV) and sensitivity analysis have been carried out.

13.1.2 Measures of project Analysis

In order to quantify the economic viability of a project or projects three measures can be used. All of these use a discounting approach. These are:

* Net Present Value (NPV)
* Benefit Cost Ratio (BCR)
* Internal Rate of Return (IRR)

(1) Net Present Value (NPV)

$$\sum_{i=1}^{n} \frac{B_i}{(1+r)^i} - \sum_{i=1}^{n} \frac{C_i}{(1+r)^i}$$

NPV = Discounted Benefit – Discounted Cost

Where B_I = Benefit in the i^{th} year

C_I = Cost of the i^{th} year

(2) Benefit Cost Ratio (BCR)

$$\sum_{i=1}^{n} \frac{B_i}{(1+r)^i} \div \sum_{i=1}^{n} \frac{C_i}{(1+r)^i} \quad BCR = \frac{\text{Present Value of benefits}}{\text{Present value of costs}}$$

(3) Internal Rate of Return (IRR)

$$\text{or}, \sum_{i=1}^{n} \frac{B_i - C_i}{(1+r)^i} = 0$$

The IRR is that discount rate which makes NPV = 0

IRR represents average earning power of the money used in the project over the project life.

13.1.3 Decision Criteria

The formal decision criterion is to accept all projects with a BCR of one or greater than one, NPV greater than Zero or IRR greater than opportunity cost of capital, since primary tangible returns are greater than primary tangible costs. If funds are limited, the magnitude of IRR or BCR can be used in ranking the order of priority of undertaking projects whose ratios are more than one. This assumes, of course, that the indirect tangible and intangible benefits and costs are of minor importance or are approximately the same for the various projects under consideration. Sometimes, however, the indirect tangible and intangible benefits may dictate over direct tangible benefits and so the projects with even less than one BCR may be selected for the overall intangible benefits of the society. In practice, there is really no single yardstick to measure the economic and financial viability of the project.

13.1.4 Price Elasticity of Demand and Traffic Forecasting

An important benefit of a capacity expansion project is the reduction in travel times for highway users. Travel time is a major component in overall price or cost to the user, which includes time as well as out-of-pocket costs. As with most goods and services, a lower price can be expected to lead to more quantity demanded – in this case, some additional travel.

Price elasticity of demand is an economic concept used to summarize how much more or less of something people will consume if its price changes. From the standpoint of estimating future traffic levels, elasticity represents how a change in the cost of driving, due to a reduction in travel time or implementation of a toll, may affect the volume of travel that will take place. These changes in volume result from some drivers' decisions to make more or fewer trips than they otherwise would have made.

Elasticity is stated in percentage change terms, e.g., an "*X*" percent reduction in travel time leads to a "*Y*" percent increase in travel Km or trips. An elasticity of zero implies that travel is unresponsive to a time change, no matter how large, while an infinite elasticity implies that even a one-second decrease in travel time will cause all capacity to be completely absorbed.

While price elasticity is a generally accepted tool in economics, there are differing opinions about how to apply it in a transportation context. The transportation economics literature reveals a wide range of measured elasticity values, reflecting different study methods, data, time periods, and locations. No studies, however, suggest that travel demand elasticity is either zero or infinite. When measured on a given facility, observed elasticity includes the effects of both diverted trips, which represent existing traffic that has simply shifted from other routes or time periods, and new travel taken as a consequence of the lower user cost. Additional research is needed to narrow the range of elasticity values that are applicable to a given set of circumstances – whether facility, corridor, or region – and to develop methods for better incorporating demand elasticity into traffic forecasting.

13.1.5 Road User Costs (RUC) Components

RUC consists of following three components:

- Vehicle operating costs (VOC), that is, the physical costs of operating a vehicle such as fuel, spare parts, depreciation, crew costs, etc;
- Travel time costs (TTC), that is, the value of time spent in travelling that could be used in other activities;
- Accident costs (ACC), that is, the physical costs of an accident and the value of injuries and fatalities.

The financial price is the retail market price to the consumer of the product. The economic price reflects the true value (that is, the real worth) as well as the scarcity premium of the resource to the economy. In the economic jargon, this is termed as a "shadow" or "accounting" price of the resource in the economy. The shadow price of unskilled labour, for instance, may well be lower than the wage to reflect its abundant supply, while that of a skilled professional may be higher than the salary given to him, if his opportunity cost is considered.

The economic price of a factor or a product also excludes all tax elements as they reflect mostly a transfer of resources from one sector of the economy to another. On the other hand, subsidy elements, if any, are included with the economic price.

Furthermore, market distortion or imperfection and government regulations or interventions are also taken into consideration while shadow-pricing a factor or a product. In case of imported inputs, economic costs were based on the border prices plus port handling, transportation, assembling and retail cost (profit margin) duly shadow priced. Local inputs of labour and materials were shadow priced using the Standard Conversion Factor of 0.85.

13.1.6 Inputs to the HDM-4 Model

13.1.6.1 Project Road Inputs

Project corridor length details mentioned in below table

Table 13-1: Project Length Details

Sections	Existing Chainage (Km)			Design Chainage (Km)			
	From	To	Length	From	To	Length	Remarks
HS-1	38.600	62.400	23.800	38.600	62.800	24.200	4-laning of existing 2-lane stretch

13.1.6.2 General Inputs

Analysis period - 20 & 30 years
Discount rate - 12 %
Construction Period - 3.0 Years
Construction Beginning Year - 2023
Opening year to Traffic - 2026
Standard Conversion factor - 0.85
Salvage value - 10 %

13.1.6.3 Pavement Characteristics

Road and pavement characteristics obtained from the Road Inventory Survey have been used as Model input. These include road length, carriageway width, width of paved shoulders, roughness of the existing road (IRI), structural number and cracking area.

The details of model inputs for road and pavement characteristics are presented below.

Table 13-2: Details of existing Pavement Conditions

S. No.	Item	Kurnool to Devanahalli
01	Visual Riding Quality	Good
02	Surface Type	Bitumen
03	Cracking (%)	5.00
04	Average Pot holes (No/Km)	4.00
05	Average Ravelled Area (%)	8.00
06	Average Rut depth (mm)	3.00
07	Average Roughness	2.5
08	Shoulder Condition	Good
09	Road Length	23.800 Km
10	Carriageway Width	15-20m
11	Shoulder Width	1.5 to 2 m

13.1.6.4 Traffic Composition and Growth Rates

The classified Traffic Volume Count Survey for both the directions have been carried out. The estimated ADT has been converted in to AADT, by applying the seasonal factor as applicable to the area. The summary of AADT is below and the details are presented in Traffic Report.

Table 13-3: AADT details

Survey Location No.	1
Name of Location	Near Nilambazar
Two-Wheeler	2168
Three-Wheeler (Passenger)	1932
Car	2406
Car (Y)	116
Tata Magic	17
RTC Bus	80
Private Bus	91
Minibus	50
School/ College Bus	3
2 Axle	212
3 Axle	100
Multi Axle	524

Survey Location No.		1
Name of Location		Near Nilambazar
HEM		3
LCV		389
Mini LCV		529
Tractor		2
Tractor with Trailer		2
Three-Wheeler (Goods)		48
Bicycle		147
Cycle Rickshaw		15
Animal Drawn		1
Government Exempted		18
		8
		5
Others		0
Vehicles	Motorized	8703
	Non-Motorized	163
	Total Traffic	8866
	Tollable Traffic	4519
PCUs	Motorized	10676
	Non-Motorized	112
	Total Traffic	10788
	Tollable Traffic	7552

The traffic growth rates have been worked out on the basis of present GDP and NSDP for the state of Assam. The growth rates for the 30 horizon years are tabulated below for the motorized traffic and for the non-motorized traffic a growth rate of 2% has been considered. Based on the NHIDCL guidelines, the growth rates adopted to 5% along the project corridor for all modes of traffic.

Table 13-4: Traffic Growth Rates

Projected Growth Rates of Assam							
S. No	Period	2W	Car	Truck	Bus	Tractor	Tractor with trailoer
1	2023 - 2027	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
2	2028 – 2032	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
3	2033 – 2037	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%

Projected Growth Rates of Assam							
S. No	Period	2W	Car	Truck	Bus	Tractor	Tractor with trailoer
4	2038 - 2042	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
5	Beyond 2043	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%

13.1.6.5 Road Side Friction

Roadside friction has to be computed for each project road package considering the following:

- The road width
- Total traffic Volume and its Composition (Slow, Two & Three wheelers Traffic)
- Settlement pattern along the roadside
- Percentage of Built-up Area
- Number and location of Dabhas and Fuel Stations

The number of settlements along the roadside and especially the extensive ribbon development that takes place is a major factor influencing road performance. The maximum friction factor for the existing condition is taken as 0.7 and the minimum 0.6 amongst different sub projects. Following the improvements of package the roadside friction factor for the two/four lane has to be taken as 0.95.

Roadside friction factors have been incorporated into VOC as well as vehicle speeds for the given volumes and composition of traffic. Survey speed observations by the traffic planner have validated the speed assumption for the HDM-4 inputs. It is considered that the creation of free flow conditions will be a more important yardstick with which to measure the success of any project improvement rather than increase in vehicle speeds.

13.1.6.6 Base vehicle characteristics and Utilization data

The data as given in the table below have been obtained from manufacturer's literature and RUCS report and details are furnished in Appendix.

13.1.7 Capital cost of the Project

The capital costs (financial) of the project road have been converted into economic cost by using a standard conversion factor of 0.85, as suggested by the World Bank for highway projects in India. The conversion factor of 0.85 has been applied to all cost items except land acquisition cost and R&R cost. The economic cost excludes the cost of toll plazas and the proportionate design & supervision cost for the same. A salvage value of 15% of capital cost has been considered in the terminal year for flexible pavements. The project costs in financial and economic terms for different schemes are presented below:

Table 13-5: Capital Cost of the Project Road

Package	Financial Cost	Economic Cost
IV	574.72 Cr.	488.51 Cr.

13.1.8 Routine and Periodic Maintenance

Routine maintenance, Periodic maintenance costs have been considered as per the MORT&H guidelines 1997 prices. Routine maintenance, Periodic maintenance costs of 1997

prices have been escalated to 2018 prices with an inflation rate of 5%. The details of the maintenance costs and administration charges are given below:

Table 13-6: Routine and Periodic Maintenance

S. No.	Description	Amount (Rs. Lakhs/Km)
01	Routine maintenance in every year cost per km for the six lane	9.9
02	Periodic maintenance in every 7th year cost per km for the six lane.	99
03	Routine maintenance in every year cost per km for the four lanes with Paved Shoulders	6.6
04	Periodic maintenance in every 5th year cost per km the four lanes with Paved Shoulders	66

13.1.9 Project Benefits

The direct benefits of road improvement considered in the study include vehicle operating cost (VOC) savings for vehicular traffic using the project road and time savings for passengers and goods (carried) in transit. The benefit streams have been computed annually over the 20 year benefit period for all homogeneous sections.

13.1.9.1 VOC Savings:

The unit Vehicle Operating Cost (VOC) by vehicle type and VOC savings section-wise has been computed by the HDM model. The VOC computation takes into account capacity augmentation, pavement characteristics, roughness progression vis-à-vis intervening surface treatment and strengthening policies, traffic characteristics, geometric conditions and vehicle characteristics.

13.1.9.2 Time Savings:

The HDM Model has generated average speeds in km/hr by vehicle type, in the existing (without project) and the improved (with project) road conditions. The time savings for passengers and goods (in transit) vehicles have been derived separately. For computing time saving for passengers of cars and buses, a weighted average occupancy was used viz. Car – 4 persons and Bus – 40 persons. The average payloads considered for goods vehicles are: LCV – 6 tonnes, 2 Axle Truck-16.2 tonnes, 3 Axle Truck – 30 tonnes and MAV – 35 tonnes.

The value of time (VOT) for passengers and goods considered in this analysis has been based on earlier studies carried out in recent years. For the average car passenger, VOT has been taken as Rs. 68 per hour, and for the average bus passenger it was Rs. 47 per hour. The value placed on time is rather on the conservative side. For goods in transit, time value has been worked out using the inventory cost method, with a 15% interest rate considered as the opportunity cost of capital. The VOT for goods (Cargo) vehicle worked out to Rs. 3.43 per hour for LCV, Rs. 10.54 per hour for 2-axle trucks and Rs. 19.73 per hour for multi-axle vehicles.

13.1.9.3 Accident Cost Savings:

A distinction made between main cause of accident and the contributory factors of accident. It is usually difficult to identify the main cause of accidents, whereas several factors which could have contributed to accidents can be identified.

13.1.9.4 Contributory factors of Accidents:

Human Factors: Manner of executions (Deficiency in actions & behavior)
Perceptual errors
Impairment
Lack of Skill

Road Factors: Adverse Road Design
Adverse Environment
Inadequate Furniture or Markings
Obstacles

Vehicle Factors: Tires
Brakes
Other defects due to poor maintenance
Unsuitable Designs

It is possible to predict the reduction in accidents on account of road improvements. The accidents costs collected from IRC-SP-30 (the values are in the year 1990 and escalated with 5% to get the values in the year 2018 are given below.

Accident Costs (Rs.)	1990	2018
Fatal	210000	746692
Serious injury	32000	113781
Minor injury	1130	3911
Damages to car	4700	16712
Damages to 2-wheeler	1100	3911
Damages to bus	15800	56179
Damages to truck	18100	64358

13.1.10 Economic Analysis

The annual cost and benefit streams are used to derive the net cash flow for the project. The EIRR and NPV @ 12% discount rate are determined using the discounted cash flow technique for all the Sections. The results for the improvement scheme are presented below and details are provided in Appendix.

Table 13-7: EIRR & NPV

Package	EIRR (%)			NPV (Cr.)		
	15 Year	20 Year	30 Years	15 Year	20 Year	30 Years
IV	**10.0**	10.6	12.3	**-ve**	-Ve	127.41

13.1.11 Sensitivity Analysis

Sensitivity analysis has been carried out for the below mentioned four variations in costs and benefits. The sensitivity scenarios take into account possible construction cost overrun, traffic volume, revenue shortfalls, interest rate volatility, non-compliance or default by contractors, and political risks.

Case-I Base Cost and Base Benefits
Case-II Base Cost plus 15 % and Base Benefits
Case-III Base Cost and Base Benefits minus 15%
Case-IV Base cost plus 15% and Base Benefits minus 15%

Summary for the Sensitivity analysis for the three sections are given below:

Table 13-8: Sensitivity Analysis (20 years)

Case	EIRR		
	15yrs	20yrs	30yrs
Case-I	10.0	10.6	12.3
Case-II	8.1	8.8	10.7
Case-III	6.1	6.8	9.1
Case-IV	7.8	8.5	10.5

13.1.12 Conclusion

From the results of the Economic Analysis, it can be seen that the improvement scheme, the EIRR is getting higher than minimum threshold value of 12% for 30 years only.

So, it can be concluded that the project of four lane with paved shoulder option is economically viable and recommended for implementation.

HDM - 4
HIGHWAY DEVELOPMENT & MANAGEMENT

Economic Analysis Summary

Study Name: **Assam DPR - P-IV**
Run Date: **12-12-2023**
Currency: **Indian Rupee (millions)**
Discount: **12.00%**
Analysis Mode: **Analysis-by-Project**

Alternative: Upgradation vs Alternative: Existing Alternative
Sensitivity Scenario: Base Sensitivity Scenario

	Increase in Road Agency Costs			Savings in M VOC	Savings in M Travel Tim Costs	Savings ir NMT Trave & Operating Costs	Reductio in Acciden Costs	Net Social / Exogenous Benefits	Net Economic Benefits (NPV
	Capital	Recurrent	Special						
Undiscounted	6,241.16	21.66	0.00	9,384.03	7,206.40	0.00	46.15	0.00	10,373.77
Discounted	6,064.67	23.43	0.00	3,051.66	2,400.92	0.00	22.23	0.00	-613.30

Economic Internal Rate of Return (EIRR) = 10.6% (No. of solutions = 1)

Alternative: Upgradation vs Alternative: Existing Alternative
Sensitivity Scenario: Case II: 15% incre in base cost & base benifits

	Increase in Road Agency Costs			Savings in M VOC	Savings in M Travel Tim Costs	Savings ir NMT Trave & Operating Costs	Reductio in Acciden Costs	Net Social / Exogenous Benefits	Net Economic Benefits (NPV
	Capital	Recurrent	Special						
Undiscounted	7,177.33	24.91	0.00	9,384.03	7,206.40	0.00	46.15	0.00	9,434.35
Discounted	6,974.37	26.95	0.00	3,051.66	2,400.92	0.00	22.23	0.00	-1,526.51

Economic Internal Rate of Return (EIRR) = 8.8% (No. of solutions = 1)

Alternative: Upgradation vs Alternative: Existing Alternative
Sensitivity Scenario: Case III: 15% incres in base cost & 15% redu in base benifts

	Increase in Road Agency Costs			Savings in M VOC	Savings in M Travel Tim Costs	Savings ir NMT Trave & Operating Costs	Reductio in Acciden Costs	Net Social / Exogenous Benefits	Net Economic Benefits (NPV
	Capital	Recurrent	Special						
Undiscounted	7,177.33	24.91	0.00	7,976.43	6,125.44	0.00	39.23	0.00	6,938.86
Discounted	6,974.37	26.95	0.00	2,593.91	2,040.78	0.00	18.89	0.00	-2,347.73

Economic Internal Rate of Return (EIRR) = 6.8% (No. of solutions = 1)

Alternative: Upgradation vs Alternative: Existing Alternative
Sensitivity Scenario: Case IV: Base cost & 15% reduction in base benifits

	Increase in Road Agency Costs			Savings in M VOC	Savings in M Travel Tim Costs	Savings ir NMT Trave & Operating Costs	Reductio in Acciden Costs	Net Social / Exogenous Benefits	Net Economic Benefits (NPV
	Capital	Recurrent	Special						
Undiscounted	6,241.16	21.66	0.00	7,976.43	6,125.44	0.00	39.23	0.00	7,878.28
Discounted	6,064.67	23.43	0.00	2,593.91	2,040.78	0.00	18.89	0.00	-1,434.52

Economic Internal Rate of Return (EIRR) = 8.5% (No. of solutions = 1)

HDM - 4
HIGHWAY DEVELOPMENT & MANAGEMENT

Economic Analysis Summary

Study Name: **Assam DPR - P-IV**
Run Date: **12-12-2023**
Currency: **Indian Rupee (millions)**
Discount: **12.00%**
Analysis Mode: **Analysis-by-Project**

Alternative: Upgradation vs Alternative: Existing Alternative
Sensitivity Scenario: Base Sensitivity Scenario

	Increase in Road Agency Costs			Savings in M VOC	Savings in M Travel Tim Costs	Savings ir NMT Trave & Operating Costs	Reductior in Accident Costs	Net Social / Exogenous Benefits	Net Economic Benefits (NPV)
	Capital	Recurrent	Special						
Undiscounted	6,241.16	148.87	0.00	17,239.57	13,290.68	0.00	-111.42	0.00	24,028.80
Discounted	6,119.26	36.09	0.00	3,517.15	2,752.12	0.00	13.50	0.00	127.42

Economic Internal Rate of Return (EIRR) = 12.3% (No. of solutions = 1)

Alternative: Upgradation vs Alternative: Existing Alternative
Sensitivity Scenario: Case II: 15% incre in base cost & base benifits

	Increase in Road Agency Costs			Savings in M VOC	Savings in M Travel Tim Costs	Savings ir NMT Trave & Operating Costs	Reductior in Accident Costs	Net Social / Exogenous Benefits	Net Economic Benefits (NPV)
	Capital	Recurrent	Special						
Undiscounted	7,177.33	171.20	0.00	17,239.57	13,290.68	0.00	-111.42	0.00	23,070.31
Discounted	7,037.15	41.50	0.00	3,517.15	2,752.12	0.00	13.50	0.00	-795.89

Economic Internal Rate of Return (EIRR) = 10.7% (No. of solutions = 1)

Alternative: Upgradation vs Alternative: Existing Alternative
Sensitivity Scenario: Case III: 15% incres in base cost & 15% redu in base benifts

	Increase in Road Agency Costs			Savings in M VOC	Savings in M Travel Time Costs	Savings in NMT Travel & Operating Costs	Reduction in Accident Costs	Net Social / Exogenous Benefits	Net Economic Benefits (NPV)
	Capital	Recurrent	Special						
Undiscounted	7,177.33	171.20	0.00	14,653.63	11,297.08	0.00	-94.71	0.00	18,507.48
Discounted	7,037.15	41.50	0.00	2,989.58	2,339.30	0.00	11.47	0.00	-1,738.30

Economic Internal Rate of Return (EIRR) = 9.1% (No. of solutions = 1)

Alternative: Upgradation vs Alternative: Existing Alternative
Sensitivity Scenario: Case IV: Base cost & 15% reduction in base benifits

	Increase in Road Agency Costs			Savings in M VOC	Savings in M Travel Time Costs	Savings in NMT Travel & Operating Costs	Reduction in Accident Costs	Net Social / Exogenous Benefits	Net Economic Benefits (NPV)
	Capital	Recurrent	Special						
Undiscounted	6,241.16	148.87	0.00	14,653.63	11,297.08	0.00	-94.71	0.00	19,465.98
Discounted	6,119.26	36.09	0.00	2,989.58	2,339.30	0.00	11.47	0.00	-815.00

Economic Internal Rate of Return (EIRR) = 10.5% (No. of solutions = 1)

HDM-4
HIGHWAY DEVELOPMENT & MANAGEMENT

Economic Analysis Summary

Study Name: **Assam DPR - P-IV**
Run Date: **12-12-2023**
Currency: **Indian Rupee (millions)**
Discount: **12.00%**
Analysis Mode: **Analysis-by-Project**

Alternative: Upgradation vs Alternative: Existing Alternative
Sensitivity Scenario: Base Sensitivity Scenario

	Increase in Road Agency Costs			Savings in M VOC	Savings in M Travel Tim Costs	Savings ir NMT Trave & Operating Costs	Reductior in Accident Costs	Net Social / Exogenous Benefits	Net Economic Benefits (NPV)
	Capital	Recurrent	Special						
Undiscounted	6,241.16	82.72	0.00	8,286.71	6,536.39	0.00	52.91	0.00	8,552.13
Discounted	6,032.07	30.34	0.00	2,909.52	2,314.41	0.00	23.07	0.00	-815.40

Economic Internal Rate of Return (EIRR) = 10.0% (No. of solutions = 1)

Alternative: Upgradation vs Alternative: Existing Alternative
Sensitivity Scenario: Case II: 15% incre in base cost & base benifits

	Increase in Road Agency Costs			Savings in M VOC	Savings in M Travel Tim Costs	Savings ir NMT Trave & Operating Costs	Reductior in Accident Costs	Net Social / Exogenous Benefits	Net Economic Benefits (NPV)
	Capital	Recurrent	Special						
Undiscounted	7,177.33	95.13	0.00	8,286.71	6,536.39	0.00	52.91	0.00	7,603.55
Discounted	6,936.88	34.89	0.00	2,909.52	2,314.41	0.00	23.07	0.00	-1,724.76

Economic Internal Rate of Return (EIRR) = 8.1% (No. of solutions = 1)

Alternative: Upgradation vs Alternative: Existing Alternative
Sensitivity Scenario: Case III: 15% incres in base cost & 15% redu in base benifts

	Increase in Road Agency Costs			Savings in M VOC	Savings in M Travel Tim Costs	Savings ir NMT Trave & Operating Costs	Reductior in Accident Costs	Net Social / Exogenous Benefits	Net Economic Benefits (NPV
	Capital	Recurrent	Special						
Undiscounted	7,177.33	95.13	0.00	7,043.70	5,555.93	0.00	44.97	0.00	5,372.15
Discounted	6,936.88	34.89	0.00	2,473.09	1,967.25	0.00	19.61	0.00	-2,511.81

Economic Internal Rate of Return (EIRR) = 6.1% (No. of solutions = 1)

Alternative: Upgradation vs Alternative: Existing Alternative
Sensitivity Scenario: Case IV: Base cost & 15% reduction in base benifits

	Increase in Road Agency Costs			Savings in M VOC	Savings in M Travel Tim Costs	Savings ir NMT Trave & Operating Costs	Reductior in Accident Costs	Net Social / Exogenous Benefits	Net Economic Benefits (NPV
	Capital	Recurrent	Special						
Undiscounted	6,241.16	82.72	0.00	7,043.70	5,555.93	0.00	44.97	0.00	6,320.73
Discounted	6,032.07	30.34	0.00	2,473.09	1,967.25	0.00	19.61	0.00	-1,602.45

Economic Internal Rate of Return (EIRR) = 7.8% (No. of solutions = 1)

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14 CONCLUSIONS AND RECOMMENDATIONS

Some of the important aspects which require the attention of the authority have been presented below for consideration, along with the recommendations of the consultants.

14.1 RIGHT OF WAY

The Right of way required for the project corridor is 45m to 60m.

14.2 EXISTING TRAFFIC

Based on the Traffic Surveys conducted along the project corridor in the state of Assam (in the year 2023), Existing Traffic along the project corridor is as follows:

Table 14-1: Existing Traffic along the Package-IV of Project Corridor

Survey Location No.	1
Name of Location	Near Nilambazar
Two-Wheeler	2045
Three-Wheeler (Passenger)	1823
Car	2270
Car (Y)	109
Tata Magic	16
RTC Bus	75
Private Bus	86
Minibus	47
School/ College Bus	3
2 Axle	200
3 Axle	94
Multi Axle	494
HEM	3
LCV	367
Mini LCV	499
Tractor	2
Tractor with Trailer	2

Survey Location No.		1
Name of Location		Near Nilambazar
Three-Wheeler (Goods)		45
Bicycle		147
Cycle Rickshaw		15
Animal Drawn		1
Government Exempted		17
		8
		5
Others		0
Vehicles	Motorized	8210
	Non-Motorized	163
	Total Traffic	8373
	Tollable Traffic	4263
PCUs	Motorized	10077
	Non-Motorized	112
	Total Traffic	10189
	Tollable Traffic	7128

14.3 PAVEMENT TYPE

Flexible Pavement is recommended for main carriageway along Section-II of Project Highway. It is recommended to construct following pavement option i.e., (BC+DBM+AIL+CTB+CTSB)

Table 14-2: Pavement Composition

a) Flexible Pavement Composition for Main Carriageway:

Section	Eff. CBR (%)	MSA for 20 yrs design life	Bitumen Grade	Crust Composition (mm)					
				BC	DBM	AIL	CTB	CTSB	Total
Section-II	8	70	VG-40	40	65	100	100	200	**505**

Note: As per circular by MoRTH, "RW/NH – 35072/05/2018 – S&R(P&B) "dated August 24, 2018, only VG-40 Grade of Bitumen shall be used for the National Highways.

b) Flexible Pavement Composition for Service Roads:

S No	Project Stretch	Eff CBR (%)	MSA	Binder	Crust Composition (mm)				
					BC	DBM	WMM	GSB	Total
1	For Service Roads	8	20	VG-40	40	80	250	200	**570**

c) Rigid Pavement Composition

S.No	Item	Rigid Pavement Crust Composition Details
1	PQC of M40 grade (mm)	300
2	DLC of M10 grade (mm)	150
3	GSB (mm)	150
4	Dia. of Dowel bar (mm)	38
5	Length of Dowel bar (mm)	500
6	Spacing of Dowel bar (mm)	300
7	Dia. of Plain tie bar (mm)	12
8	Length of Plain tie bar (mm)	580
9	Spacing of Plain bar (mm)	370
10	Dia. of Deformed bar (mm)	12
11	Length of Deformed bar (mm)	640
12	Spacing of Deformed bar (mm)	595

14.4 EXISTING/PROPOSED STRUCTURES

The list of existing/proposed list of structures are mentioned below:

Table 14-3: Summary of Proposed/Existing Structures

S. No	Type of Structure	Existing No's	Proposed No's	Total
1	Box Culvert	0	43 on MCW, 12 on CR	55
2	Box Structure	0	7	7
3	LVUP	0	4	4
4	VUP	0	5	5
5	MIB	4	9	13
6	MJB	1	1	2
7	ROB	1	1	2
8	Pipe Culverts	0	22 on CR	22
9	Slab Culverts	0	0	0
Total		**6**	**104**	**110**

*- Existing here represents the number of existing structures in our proposed alignment that needs to be widened or reconstructed

14.5 MODE OF EXECUTION

The proposed mode of execution for the project corridor is Hybrid Annuity Mode (HAM)