NATIONAL HIGHWAYS & INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

(Ministry of Road Transport & Highways, Govt. of India)

Feasibility Study and Detailed Project Report for Development of existing road to 2-lane with Paved Shoulder/4 laning from Imphal to Kohima of NH-39 (New NH-2) in the State of Manipur & Nagaland (126 Km) for execution on EPC Mode

DRAFT DETAILED PROJECT REPORT

(Package 4 & 5 - Senapati to Imphal)

Volume I – Main Report

January 2020

Stanley Consultants, Inc.
Unit No. 206, Rectangle-1,
District Center, Saket, New Delhi – 17

In JV with

CARITAS Infra Consulting Pvt. Ltd.
B-45, Dayalbag, Faridabad Haryana

DRAFT DETAILED PROJECT REPORT -Package 4 & 5: Senapati to Imphal

Volume-I	Main Report	✓
Volume-II	Design Report	
Volume-III	Material Report	
Volume-IV	Environmental Impact Assessment and Management Plan	
Volume-V	Technical Specification	
Volume-VI	Rate Analysis	
Volume-VII	Cost Estimate	
Volume-VIII	Bill of Quantities	
Volume-IX	Drawing Volume	
Volume -X	Civil Work Contract Agreement	

Contents

CHAPTER-0 EXECUTIVE SUMMARY

0.1 PROJECT BACKGROUND

National Highways & Infrastructure Development Corporation Ltd. (NHIDCL) has been mandated by Central Government to take up the developments, maintenance and management of National Highways in North East region and some states which share International borders of the country. Government has decided to improve some sections of National Highway network that pass and serve the NE region to two lanes with paved shoulder /4-laning with provision of capacity argumentation for execution on EPC mode.

The project under study is National Highway-39 (New NH-2) in the States of Nagaland & Manipur from Km185+540 of NH 39 (Lerie colony Jn., Kohima) to Imphal (Km311+082) via Phesama, Jakhama, Viswema, Khuzama, Mao, Tadubi, Maram, Senapati, Kalapahar, Pheidinga and Koirengei, Potsangbam Khoiru. The executing agency has commissioned the services to M/s Stanley Consultants Inc. in JV with Caritas Infra Consulting Pvt. Ltd, Faridabad for carrying out Consultancy Services for preparing Detailed Project Report (DPR) and establishes financial viability on executing the Project on EPC mode through ADB / budgeting resources.

This Volume of the Draft Detailed Project Report deals with the Civil Construction for the Package 4 & 5 only which falls in the state of Manipur. The remaining three construction packages are being submitted separately.

0.2 CONSULTANCY APPOINTMENT

The Agreement for carrying out the Consultancy Service has been signed on 22rd October 2015 and effective date of commencement of services is 2nd December 2015. Communication in this regard was sent to NHIDCL vide Consultant's letter No. SCI/NHIDCL/Imphal Kohima/2015/522 dated 3rd December 2015.

0.3 OBJECTIVES

The main objective of the Consultancy Services is to prepare the DPR, for upgradation of existing road to 2-lane with Paved Shoulders/4-laning of NH-39 from Kohima to Imphal section in the state of Nagaland and Manipur ensuring:

- ✓ Enhanced Safety
- ✓ Minimum adverse impact on Environmental
- ✓ Minimum Land Acquisition.

Project preparation activities have been split into following stages in accordance with Terms of Reference (TOR):

Stage 1	:	Inception Report (IR)
Stage 2	:	Feasibility Study Report (FSR)
Stage 3	:	Preliminary Project Report (PPR)
Stage 4	:	Detail Project Report (DPR)

During presentation held on 2nd February 2018 at NHIDCL, HQ; five civil construction packages were decided for the project road from Kohima to Imphal section of NH-39. The Minutes of Meeting (MoM)

of this presentation were issued vide letter reference NHIDCL/Manipur Nagaland/NH-39/DPR-Imphal – Kohima/2015/Vol-II/645 dated 27th February 2018. The details of construction packages are presented in Table Ex-0.1.

Table Ex-0.1: Details of Construction Packages

Package Nos.	Design Chainage		Length (km)
	From	To	
1	Lerie Colony, Kohima (Km185+540)	Nagaland Border (Km210+700)	25.16
2	Nagaland Border (Km210+700)	Maram Centre (Km237+900)	27.20
3	Maram Centre (Km237+900)	End of Senapati Bypass (Km262+370)	24.47
4	End of Senapati Bypass (Km262+370)	Saparmeina (Km286+750)	24.38
5	Saparmeina (Km286+750)	Imphal (Km309+315)	22.56

This report covers the primary surveys and their analysis carried out for entire project highway from Kohima to Imphal by the Consultants upto "Stage 4: Detailed Project Report". However, at present the project proposal and cost estimates have been carried out for Package 4 and 5 i.e. from Senapati to Imphal section of NH-39 only. There are minor deviations in package lengths due to geometric improvement as discussed during presentation held on 2nd February 2018 and finalized packages details are presented in Table Ex-0.2.

Table Ex-0.2: Details of Civil Contract Package 4 and Package 5

Pkg. No.	Existing Chainage		Design Chainage		Length (km)
	From	To	From	To	
Package 4	264+313	288+815	262+175	287+000	24.82
Package 5	288+815	311+082	287+000	308+460	21.46

0.4 PROJECT DESCRIPTION

0.4.1 Project Road

The Project road starts from Lerie colony Jn., Kohima in Nagaland State at Km185+540 of NH-39 and terminates at Imphal in Manipur State where existing road is already 4-lane divided carriageway i.e. Km311+082 of NH-39. The existing carriageway configurations along the project road are described in Table Ex-0.3.

Table Ex-0.3: Details of Carriageway Configuration

S No.	Existing Chainage (Km)		Length (km)	Carriageway width	Terrain
	From	To			
1	185+540	259+600	74.1	6m-7.7m	Hilly
2	259+600	260+000	0.4	20m	Hilly

S No.	Existing Chainage (Km)		Length (km)	Carriageway width	Terrain
	From	To			
2	260+000	266+000	6.0	7.5m	Hilly
4	266+000	304+000	38.0	6.2-7.5	Plain/Rolling
5	304+000	311+100	7.1	2-lanes+ Paved Shoulder	Plain/Rolling
Total length			**125.5**		

The project road along its route from Kohima to Imphal traverses through five districts i.e. Kohima district in the state of Nagaland and Senapati, Kongpokpi, Imphal West & Imphal East districts of Manipur.

The Project Road links the India with Myanmar and the road NH-39 serves as a part of Great Asian Highway.

0.4.2 Terrain

The Terrain classification as per IRC: SP: 48-1998. ***"Hill Road Manual"*** has been adopted for the Project Road. Accordingly, the Project road from Kohima (km 185+540 of NH-39) to Senapati is considered as Hilly Terrain. Thereafter, the Plain/Rolling Terrain beyond Senapati town and continues upto km 311+082 of NH-39 with some patches of hilly Terrain in between.

0.4.3 Habitation/Settlements

There are around 47 villages along the project road with left /right or both sides settlement/habitation. The major settlements along the project road are Lerio colony Kohima, Viswema, Mao, Tadubi, Lairou, Senapati, Kongpokpi, Kalapahar, Sekmai, & Motbung.

The Senapati (km255+800 to km261+400) and Kongpokpi (km275+200 to km276+200) villages have dense habitated settlements on both side of the project road. Hence, Bypasses have been proposed for these towns.

Elsewhere, the settlements are noticed either for short length or a bit scattered, hence, project proposal appears feasible along the existing road without much social disturbance. Adequate safety measures for road users will be considered at these locations.

0.5 ENGINEERING SURVEYS & INVESTIGATIONS

The Consultant has carried out Engineering Surveys/Investigations that include Topographic Surveys, Road Inventory and Pavement Condition Surveys, study of Sinking and Sliding Zones of Project Highway, Alignment Studies, Initial Environment Screening and Assessment, Social Screening Assessment; Pavement related aspects, Material Surveys, Condition Surveys of existing Bridge/culverts and other structures. The field studies were performed as per the stipulations of the TOR which are quite elaborate and self-explanatory.

0.5.1 Pavement Condition

The project road from Kohima (Km185+540) to Imphal (Km311+082) generally has two lane carriageways with '*Fair*'to 'Poor' pavement condition. But some sections generally have cracking and rutting more than 20mm. Therefore, as per IRC 81, pavement compositions of these sections are considered as failed requiring 'reconstruction'.

The carriageways under the section from Km217+800 to Km231+600 and Km286+800 to Km291+400 have 'Very Poor' road condition. The rest of the project road may be classified as 'Poor' to 'Very Poor' except small section near Imphal which has 'Good' condition since recently laid by State PWD. The summary of pavement condition is summarized in Table Ex-0.4.

Table Ex-0.4: Summary of Pavement Condition

Ex. Chainage (Km)		Length (m)	Lane Configurations	Pavement Condition	Shoulder width & Condition
From	To				
185+540	194+800	9.26	2-lanes	F	0.5m generally and 1m at some locations with F/P condition
194+800	213+600	18.8	2-lanes	F/P/VP	
213+600	232+000	18.4	2-lanes	P/VP	
232+000	259+600	27.6	2-lanes	F/VP	
259+600	279+000	19.4	2-lanes	F/P	1m generally with F/P/VP condition
279+000	304+200	25.2	2-lanes	G/P/VP	
304+200	311+100	6.9	2-lanes + PS	G	1m-PS & 1.5m- ES
Note: 1)Based on Pavement Condition Survey- April 2016 2)G- Good, F- Fair, P- Poor , VP- Very Poor, PS- Paved Shoulder and ES Earthen Shoulder					

0.5.2 Bridges and Structure

The existing structures from Kohima to Imphal section of NH-39 are given in the Table Ex-0.5.

Table Ex-0.5: Summary of Existing Structures

Sl. No.	No. of Existing Structures	
	Minor Bridges	Major Bridges
1	25	1

0.5.3 Cross drainage Structures

There are total 781 culverts that exist along the project road. The summary of existing cross drainage structures are presented in Table Ex-0.6.

Table Ex-0.6: Summary of Existing Culverts

Arch		Slab		Slab+Steel		Slab+Pipe		Pipe		BOX		Chocked
Span	Nos.	Span	Nos.	Span	Nos.	Span	Nos.	dia	Nos.	Span	Nos.	Nos.
1.1 - 4.5m	**3**	0.6 - 6.0m	**544**	4.5 - 5.0m	**2**	1.0- 2.5m	**3**	0.9 - 1.2m	**212**	1.0 - 2.0m	**8**	**9**

0.5.4 Trial Pit Investigation- Pavement Composition

Trial pits were excavated at the pavement/shoulder interface to determine pavement composition details (pavement course, material type and thickness) and soil characteristics including soil classification of subgrade material. The data would be used to estimate the overlay thickness of the existing pavement if appropriate to the design. The details of trial pits observed are summarised in Table Ex-0.7.

Table Ex-0.7: Existing Pavement Composition

S No.	Existing Chainage (Km)		Length (km)	Lane Configurations	Terrain	Bituminous thickness (mm)	Base & Subbase thickness (mm)
	From	To					
1	185+540	219+600	34.06	2-lanes	Hilly	60-200	130-810
2	219+600	259+600	40.0	2-lanes	Hilly	50-150	175-685
3	259+600	260+000	0.4	20m	Hilly	70	460
4	260+000	275+700	15.7	2-lanes	Hilly/Plain/Rolling	60-130	200-525
5	275+700	304+000	28.3	2-lanes	Hilly/Plain/Rolling	30-160	220-650
6	304+000	311+000	7.0	2-lanes+ Paved Shoulder	Hilly/Plain/Rolling	40-130	250-750

0.6 TRAFFIC STUDIES AND ANALYSIS

In view of the Reconnaissance Survey of the project carried out by the Consultants, existing traffic flow pattern especially intensity of commercial traffic and condition of the project road, the following four homogeneous sections were identified in view of conducting primary surveys as given in Table Ex-0.8.

Table Ex-0.8: Traffic Homogeneous Sections for Project Road NH-39

Sl. No.	From	To	Start (km)	End (km)	Length (km)
1	Kohima	Tadubi (NH-102A Jn)	185+540	219+600	34.1
2	Tadubi (NH-102A Jn)	Senapati	219+600	259+250	39.6
3	Senapati	Kangpokpi (SH Jn)	259+250	275+700	16.5
4	Kangpokpi (SH Jn)	Imphal (Koirengei)	275+700	311+082	35.3

The selected location of traffic surveys are shown in a line diagram as given in Fig Ex-0.1 showing the type of surveys and the number of locations.

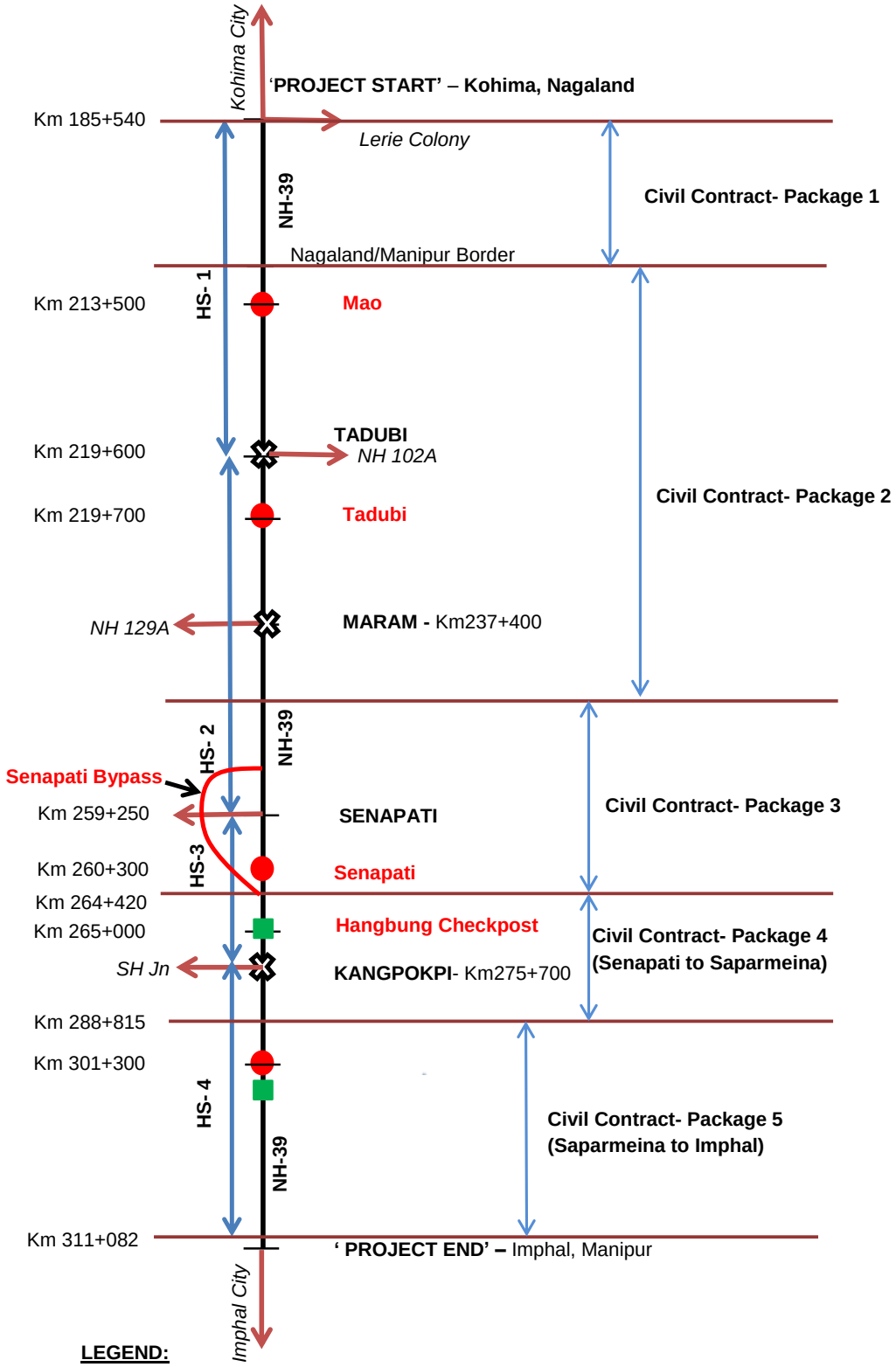


Fig Ex-0.1: Details of Traffic Survey Locations

0.6.1 Average Daily Traffic (ADT)

The Average Daily Traffic (for 7 days and 24 hours) was computed for project corridor sections where the mid-block traffic volume count survey was done. The Daily traffic volumes were averaged to achieve Average Daily Traffic (ADT). The section wise ADT in vehicles and equivalent PCUs are given in Table Ex 0.9.

Table Ex-0.9: Average Daily Traffic (ADT)

Sl. No.	Section Name		Survey Location	Location Name	ADT in	
	From	To			Vehicles	PCUs
1	Kohima	Tadubi	Km 213+500	Mao	2164	3578
2	Tadubi	Senapati	Km 219+700	Tadubi	1992	3605
3	Senapati	Kangpokpi	Km260+300	Senapati	5517	8085
4	Kangpokpi	Imphal	Km301+300	Sekmai	9595	12710

0.6.2 Annual Average Daily Traffic (AADT):

Traffic fluctuates by the hour by the day and by the month. Hence, it is essential to establish Seasonal Correction Factor (SCF) for the project corridor to finalize Annual Average Daily Traffic (AADT). The seasonal variation factor is estimated using the past fuel sales data collected from the existing Petrol pumps along the project stretch, the Petrol (MS) and Diesel (HSD) sales data in litres has been collected in the past years and analysed. Table Ex-0.10 presents AADT on the project corridor.

Table Ex-0.10: AADT on Project Corridor

Sl. No.	Section Name		Survey Location	Location Name	AADT in	
	From	To			Vehicles	PCUs
1	Kohima	Tadubi	Km213+500	Mao	1898	3169
2	Tadubi	Senapati	Km 219+700	Tadubi	1747	3198
3	Senapati	Kangpokpi	Km260+300	Senapati	4833	7165
4	Kangpokpi	Imphal	Km301+300	Sekmai	8239	11233

0.6.3 Axle-Load Surveys

The Axle load survey carried out was analysed and adopted Vehicle Damage Factor (VDF) for project corridor are presented in Table Ex-0.11

Table Ex-0.11: Adopted Vehicle Damage Factors (VDF) for Observed Commercial Vehicles

S. No.	Road Section	Length (km)	Trucks				Bus
			LCV	2-Axle	Tandem	MAV	
1	Kohima to Senapati	74.3	1.17	3.66	3.61	4.68	0.84
2	Senapati to Imphal	51.0	1.45	3.26	3.43	4.14	0.88

0.6.4 Projected Traffic Growth Rates

The traffic growth rates projected for each type of vehicle for each 5 year interval, over the next 30 years are given in Table Ex-0.12.

Table Ex-0.12: Vehicle-wise Proposed Traffic Growth Rates

Period	2 Wheelers	3 Wheelers	Cars/ Jeeps	Buses	Trucks			
					2 Axle	3 Axle	M Axle	LCV and Mini LCV
Up to 2020	10.7	4.0	10.1	8.9	5.5	7.0	7.0	5.5
2021 – 2025	8.9	3.8	8.9	7.7	5.1	6.5	6.5	5.1
2026 – 2030	7.1	3.5	7.7	6.6	4.9	5.9	5.9	4.9
2031 – 2035	5.4	3.0	7.1	5.4	4.5	5.4	5.4	4.5
2036 - 2040	5.4	3.0	7.1	5.4	4.5	5.4	5.4	4.5
Beyond 2041	5.4	3.0	7.1	5.4	4.5	5.4	5.4	4.5

0.6.5 Capacity and Level of Service

The AADT Section wise traffic has been projected considering the proposed growth rates and the year are mentioned when project road sections warrants upgradation to 4-lane carriageway facilities in Table Ex-0.13. The Design Service Volume for 2-Lane with paved shoulder at Level of Service 'B' and 'C' are taken as 18000/25000 PCUs/day for plain terrain and 13000/18570 PCUs/day for rolling terrain. For hilly terrain, the corresponding figures are 9000PCUs/day and 12860PCUs/day respectively.

Table Ex-0.13: Year for Upgradation to 4-lane carriageway facility

Sl. No.	From	To	Length (km)	Year of Achieving 2-lane Capacity		Recommendation
				LOS B	LOS C	
1	Kohima	Tadubi	33.9	2030	2036	Two Lane with Paved Shoulder
2	Tadubi	Senapati	39.6	2030	2036	
3	Senapati	Kongpokpi	16.5	2024	2029	Four lane Divided Carriageway
4	Kongpokpi	Imphal	35.3	2018	2023	

Hence, the project road from Kohima to Senapati is recommended for upgradation to Two lanes with Paved Shoulder.

The Senapati to Kongpokpi section warrants 4- laning in the year 2024 for LOC B and Kongpokpi to Imphal Section warrants 4- laning in year 2018. Hence, Senapati to Imphal section has been proposed to upgrade as Four lane divided carriageway configuration.

0.7 CROSS-SECTIONAL ELEMENTS

The Proposed Design Standards and Cross-sectional widths for the project road are presented in Table Ex-0.14.

Table Ex-0.14: Design Standards for Cross Sectional Elements

Normal Sections	**Plain/Rolling**	**Mountainous/Steep**
Standard Lane width	3.5m	
2-lane Carriageway		
Carriageway width	7.0 m	7.0 m
Paved Shoulder	2x1.5 m	2x1.5 m
Earthen Shoulder	2x2.0m	1.0 m (Valley Side)
4-lane Carriageway		

Normal Sections	**Plain/Rolling**	**Mountainous/Steep**
Carriageway width	2x7.0 m	2x7.0 m
Median+ kerb Shyness	4m+2*0.5m	1.5m+2*0.5m
Paved Shoulder	2x1.5 m	2x1.5 m
Earthen Shoulder	2x2.0m	0.5m(Hill side), 1.0 m (Valley Side)
Camber/Cross Slope		
Paved Carriageway /Shoulder	2.5 %	2.5 %
Earthen Shoulder	3.0 %	3.0 %
At Bridge Locations	***Ex Br+ New 2-lane***	***New 4-lane***
Paved Carriageway including Kerb Shyness	9.0 m	2x9m
Foot Path	1 x 1.0 = 1.0 m	2x1.0=2.0m
Crash Barrier	2 x 0.5m	4x0.5m

The other pertinent geometric details and design parameters have been provided in Table 0.15.

Table Ex- 0.15: Geometric/ Design Parameters

Design Speed	Plain/Rolling Terrain • Ruling – 100kmph • Minimum – 80kmph Mountainous Terrain • Ruling – 50kmph • Minimum – 40kmph Steep Terrain • Ruling – 40kmph • Minimum – 30kmph
Min Radius of Horizontal Curves (m)	360m for 100kmph 230m for 80kmph 80m for 50kmph 50m for 40kmph 30m for 30kmph
Transition Curve not required	1800m for 100kmph 1200m for 80kmph 500m for 50kmph 400m for 40kmph
Vertical Gradient	Plain/Rolling Terrain • Ruling gradient - 3.3% (1 in 30) • Limiting gradient - 5.0% (1 in 20) Mountainous Terrain • Ruling gradient - 5.0% (1 in 20) • Limiting gradient - 6.0% (1 in 16.6)

Existing bridges with available carriageway width of 7m and in good condition are retained with its present width.

0.8 PROPOSED IMPROVEMENTS

The project road from Km185+540 to Km260 passes through hilly/rolling terrain is a 2-Lane road but has shown heavy distress in the form cracking and rutting in the wheel path. The spectrum of characteristic deflection as observed during Benkelman Beam Deflection (BBD) test carried out in accordance with IRC-81-1997 also demonstrated a value of over 1.5mm. Besides, there exists several sinking and sliding zones enroute, more towards Senapati.

Further, the road stretch from Km260 to Km 303 is 2-lane road which passes through rolling/plain terrain with hilly stretches in patches and has heavy pot holes and depression including exhibiting signs of settlement along substantial lengths. The road beyond km 303 upto end point at km 311 is 2-lane with paved shoulder which is recently laid by Manipur PWD and is quite good.

In view of above circumstance, it is considered prudent to upgrade the existing road for package 4 & 5 to 4-Lane divided carriageway involving reconstruction/ new construction on modified alignment in entire length after easing out vertical gradient to 6% and down. The huge economic benefit on account of reduction in Vehicle Operating Cost (VOC) together with 'time saving' and enhancing the 'safety' of road users besides several benefits shall offset the cost of new construction in a short period from now thus protecting the environment from pollution taking place at present due to fumes produced from extra fuel consumption. Also, a good new 4-lane road shall allow the region to open out for undertaking whole range of new economic activities thus contributing to development of the states and enhancing better connectivity with the North-East region and Myanmar onwards.

With the proposed improvement of this road (NH-39) being part of Great Asian Highway will entail increase in international trade with the neighbouring Countries. Further, the area shall get boosts besides reduction of turnaround time for the vehicle fleet. The proposed improved road will also encourage multi–axle vehicles to ply on this road resulting reduction in transportation cost and pollution besides the overloading menace taking place at present.

0.8.1 Recommended Pavement Composition

The proposed Pavement compositions for Homogeneous section wise are presented in Table Ex-0.16.

Table Ex-0.16: Pavement Composition Details for New Flexible Pavements

Road Section		Ex. Length (km)	15 yr. Design Traffic (MSA)	Design CBR %	Pavement Composition (IRC:37-2012)			
From	To				BC	DBM	WMM	GSB
Kohima	Tadubi	33.9	20	6%	40	90	250	260
Tadubi	Senapati	39.6	20	6%	40	90	250	260
Senapati	Kongpokpi	16.5	30	8%	40	100	250	200
Kongpokpi	Imphal	35.3	30	8%	40	100	250	200

The proposed Pavement compositions for Service road are presented in Table Ex-0.17

Table EX-0.17: Proposed Pavement Crust Composition for Service road (mm)

Description	Pavement Crust Composition (mm)			
	BC	DBM	WMM	GSB
Service Road	40	60	250	200

0.8.2 Structural Proposal

The structural Proposal for package 4 and 5 i.e. from Senapati to Imphal section are summarised in Table Ex-0.18

Table Ex-0.18: Bridges/other Structures Proposal

Bridge & other stru cture Proposal	Minor Bridge (each side)	Major Bridge (each side)	4-lane LVUP	4 Lane-Tunnel (Cut & Cover)
Package 4: Senapati to Saparmeina				
Retained	4	-	1	-
Proposed New Bridges	16	-	-	-
Package 5: Saparmeina to Imphal				
Retained	3	-	-	-
Proposed New Bridges	7	2	-	1

0.10 LAND ACQUISITION

The package 4 & 5 of project road passes through the Manipur state involving three districts namely Kongpokpi, Imphal West and Imphal East total length of the project road is 46.28km. A total of 138.583 hectare land will be required. A detailed breakup of land requirement, road stretch wise is presented in ***Table Ex-0.19***.

Table Ex-0.19: Land Acquisition Details along Project Corridor

Package No.	Design Chainage (km)		Length (km)	Project Proposal	Land Required (hectare)
	From	To			
4	262+290	287+000	24.825	4L Divided Carriageway	96.863
5	287+000	308+460	21.460		41.720
Total Design length (km)			***46.285***	**Total Land Required (hect.)**	***138.583***

0.9 ENVIRONMENTAL IMPACT ASSESSMENT OF THE PROJECT

The Initial screening and Preliminary Environmental Assessment reveals that the project implementation will result in appreciable social and economic benefits to the people in the project affected area in terms of easy access to the schools, hospitals, government offices, markets etc., increase in land value; reduced travel time & cost and traffic congestion. The proposed road would act as the prime artery for the economic flow to this region.

The proposed project for improvement is mainly passing through agricultural land predominantly with sandy soil. One major river exists along the project corridor.

The project road will be bided in five packages each length less than 100km hence, Environmental clearance from MoEF is not required for this project. The forest clearness for tree cutting is required.

Project specific environmental management plan have been prepared for ensuring the implementation of the proposed measures during construction phase of the project, implementation and supervision responsibilities, sufficient allocation of funds, timeframes for anticipated activities etc. has been dealt

with in this document, which will eventually form a part of the Contract documents between the NHIDCL and the Contractor. The cost of environmental management for Packages 4&5 is ***8.40 Crores***.

0.11 SOCIAL ASSESSMENT AND SOCIAL PROFILE OF PAPS ALONG THE PROJECT CORRIDOR

The preliminary survey carried out indicates in brief about the social features of the project road. The details about the social & environmental issues would be further examined during the Draft Detailed Project Report (DPR) stage. The project road does not pass through sensitive locations, densely congested built-up areas except Senapati and Kongpokpi and high volume of PAPs and therefore, project road does not require elaborate mitigation measures. However, at some isolated locations, few PAPs do exist for which necessary mitigation measures have been considered.

In addition to this the applicable legal position and acts as per the policies of the Government of India and Government of Manipur will be reviewed and appropriate clauses utilized for preparation of the entitlement framework and matrix prescribing the compensation and assistances as necessary. This will be provided as part of the Resettlement Plan (RP).

The sex ratio is 931 females per 1000 males in Nagaland and 985 females per 1000 males in Manipur in year 2011. The literacy rate is above 79.55% in Nagaland and 76.94 in Manipur. The affected PAPs has revealed that a majority of households are likely to be affected belong to General Category followed by Scheduled Tribes.
The Budget for additional land and R&R of affected structrues for Package 4 & 5 have been assessed as ***137.59 Cr.***

0.12 IDENTIFICATION OF MATERIAL SOURCES

The materials commonly used in highway construction comprise of the following broad items:

- Borrow materials like soil and gravel
- Quarry materials like hard stone metal (aggregate) and sand
- Manufactured material like Cement, Steel and Bitumen
- Other construction materials like flyash, water, additives etc.

Borrow Area Soil

Extensive survey was conducted to locate the potential borrow area soils required for construction of embankment and subgrade near the project road. The borrow areas have been identified which ensure CBR in the range of 8.5%-10% between Senapati and Imphal section of the project road.

Quarry Materials

The stone quarries at Bongmol village (Km290.5) were identified as the potential source of coarse aggregate required for road construction. The location, lead, owner and tentative area of mining have been identified. Potential source of sand, quarrying has also been identified. Details of such materials along with involved lead is presented in Table Ex-0.20

Table Ex-0.20: Construction Material and their Leads

Construction Material	Quarry Location	Location on Project Road (Km)	Approach Lead (km)
Ballast / Stone	Bongmol village	Km290+500 of NH-39	2
Sand	Sekmai	Km300+000 of NH-39	2

The availability of manufactured construction materials is as below:

- Steel from Local Market of Guwahati
- Cement from M/s Adhunik Cements, East Jayantia Hills
- Bitumen VG-40 – Barauni/ Haldia
- Bitumen/Emulsion/PMB- Haldia

0.13 PRELIMINARY COST ESTIMATES

0.13.1 Unit Rates

Inputs for Unit rates of major items of works have been considered from available latest Manipur Schedule of Rates for National Highway, 2018 of Public Works Department, Manipur and specific rate analysis for package 4 and 5 have been worked out based on Standard Data Book for Rate Analysis, MOST.

0.13.2 Project Cost

The cost of upgrading existing road to 4-Lane divided carriageway with paved shoulder from Senapati to Imphal has been worked out and presented in Table Ex-0.21

Table Ex-0.21: Project Cost

Package No.	Design Chainage (Km)		Design Length (km)	Project Proposal	Civil Cost (Cr/km)
	From	To			
4	262+175	287+000	24.825	4-Lane divided Carriageway	**16.54**
5	287+000	308+460	21.460	4-Lane divided Carriageway	**15.26**

CHAPTER-1 INTRODUCTION

1.1. GENERAL

The National Highways & Infrastructure Development Corporation Ltd. (NHIDCL), Ministry of Road Transport & Highway (MoRT&H) has decided to upgrade the existing NH-39 (also rechristened as NH 2) road section from Imphal to Kohima in the states of Manipur & Nagaland (126km) for considering execution on EPC Mode.

The project road from Imphal to Kohima is a 125 km long section of NH-39 which connects with Myanmar. The existing road is two lanes wide with deficient geometry and extremely poor road conditions with pavement failures at many locations.

In pursuance of the above, National Highways & Infrastructure Development Corporation Ltd. (NHIDCL), has engaged M/s *Stanley Consultants Inc.* in Joint Venture with *CARITAS Infra Consulting Pvt. Ltd.* for the work of carrying out Feasibility Study and Preparation of Detailed Project Report for upgradation of existing road to 2-Lane or 4- laning the entire 126 km length. The effective date of start of Consultancy Services was 2nd December 2015.

1.2. THE PROJECT

The National Highway number 39 (NH-39) starts from Numaligarh in Assam in the North-East part of the Country, travels through the State of Nagaland and enters the state of Manipur through Mao Gate and terminates at Indo Myanmar Border. It traverses a distance of 436km with 48% of its length falling in Manipur. The road NH 39 is a lifeline of Manipur and it travels through one of the most breathtaking beautiful landscape of the North-East part of the Country.

The Project Highway starts from Lerie colony Jn. at km 185+540 of NH 39 and ends at km 311+082 of NH 39 passing through Phesama, Jakhama, Viswema, Khuzama, Mao, Tadubi, Maram, Senapati, Kalapahar, Pheidinga and Koirengei, Potsangbam Khoiru.

1.3. OBJECTIVE AND SCOPE OF WORK

The main objective of the proposed consultancy assignment is to prepare the Detailed Project Report (DPR) for Construction of two/four lane road (NH-39) between Imphal and Kohima (Ref. TOR 2.1). In order to finalize the proposal of DPR, the Consultant would undertake survey and investigation to collect field data and based on the analysis of data will form the Feasibility Report followed by DPR.

The objectives of this consultancy service is to undertake Feasibility Study and prepare a detailed Feasibility Report cum DPR of the Project Highway for the purpose of firming up the requirements in respect of development and construction of the Project Highway and Project Facilities and enabling the prospective bidders to assess the requirements in a clear and predictable manner with a view to ensure:

- Provide the rejuvenated Project Highway with improved engineering inputs.
- Enhanced safety and level of service for the road user
- Minimal adverse impact on environment
- Minimal additional acquisition of land

The Detailed Project Report would inter-alia include carrying out topographical survey, soil testing, traffic survey, material survey, analysis of field data and design of geometrics, finalization of alignment conforming to IRC standards, land plan, pavement design with options for flexible or rigid pavements, Geotechnical Investigation at the site of major/minor structures, GADs for bridges and cross drainage structures followed by their preliminary design, road safety devices, project facilities, quantities of various items, drawings, probable cost estimates and documents required for tendering the project on EPC basis for International/Local Competitive Bidding, preparation of land acquisition proposal as per NH Act and/or State Act. The Key Plan of project corridor is shown in ***Figure 1.1***.

The broad Scope of Consultancy Services comprises:

a) Topographic Surveys, Utilities/ Services identification
b) Traffic surveys and demand assessment
c) Engineering surveys and investigations
d) Design of roads, bridges, structures, etc.
e) Preparation of Land Acquisition Plan, Forest Diversion Plan and Utility Relocation Plans
f) Environment Impact Assessment Report and Environment Mitigation Plan.
g) Preparation of BOQ and Cost Estimates.
h) Preparation of Bid Document and Draft Contract Agreement.

1.4. STATUS OF THE STUDY

1.4.1. Mobilization of Key Professionals

Preparatory works for different requisite engineering surveys and Mobilization of team have started after signing of Contract Agreement. Consultant's key professionals identified and deployed for the project are:

S. No.	Name	Position
1	Vishwanath Jagid	Team Leader cum Senior Highway Engineer
2	Virendra Pal Singh	Bridge Engineer
3	Prashant Joshi	Highway cum Pavement Engineer
4	Umesh Sharma	Material cum Geotechnical Expert
5	Arun Kumar Bag	Senior Survey Engineer
6	Anil Panda	Environment Specialist
7	Sanjib Mondal	Sr. Quantity Surveyor cum Documentation Exp

1.4.2. Reconnaissance and Site Visit

The Team Leader cum Senior Highway Engineer and Mr. Prashant Joshi, Highway cum Pavement Engineer and Mr. Arindam Bhattacharya, Caritas carried out the reconnaissance survey of project road in July 2016 and undertaken meeting with NHIDCL, Imphal officials and other stake holders.

Mr Vishwanath Jagid and Mr Arun Kumar Bag visited the project site in the month of October 2016 and had held detailed discussions on the progress of project with NHIDCL, Imphal officials.

The team of Geotechnical experts visited the project road to examine the problem of road sinking and land slide phenomenon along the corridor in particular the vulnerable locations identified in this respect in this month of November 2017.

Mr Vishwanath Jagid and Mr Arun Kumar Bag visited the project site in the month of November 2017 and had held a detailed discussion on Draft Feasibility Report Submission with subsequent joint site visit of project road with NHIDCL, Imphal officials.

Mr Vishwanath Jagid and Mr Arun Kumar Bag had joint site visit with Shri Ajay Ahluwalia, ED, NHIDCL and Shri Sunil Kumar, GM, NHIDCL on 28-29 June 2018 and had a detailed discussion on Sinking and Sliding options and Senapati bypass alignment.

Mr Vishwanath Jagid and Mr Arun Kumar Bag had site visit to verify the project proposal on 14-17 May 2019 and had joint site visit from Kohima to Mao section of project corridor with officials of BO- Dimapur and had detailed with GM, NHIDCL, BO-Dimapur on 17th May 2019.

1.5. EARLIER SUBMISSION

The Inception Report with Quality Assurance Plan was submitted in the months of January 2016. On the basis of the same, Survey and Investigations and other activities, related to preparation of the Feasibility Report have been carried out.

Further, the four sets of Draft Feasibility Reports in hard copy (2 sets at BO, NHIDCL, Imphal +1 Set at NHIDCL HQ + 1 Set at ED (P), NHIDCL, Guwahati) were submitted vide our letter no 5923 dated 25th November 2017.

The observation/comments of Branch office, NHIDCL, Imphal were received vide their letter NHIDCL/BO-Imphal/Imphal Kohima/2017-18/1468 & 1469 dated 7th December 2017. The detailed presentation on Draft Feasibility Report was made at NHIDCL, HQ on 12th June 2017.

The six sets of Final Feasibility Reports for Package 4: Senapati to Saparmeina in hard copy (4 sets at BO, NHIDCL, Imphal +1 Set at NHIDCL HQ + 1 Set at ED (P), NHIDCL, Guwahati) were submitted vide our letter no 5992 dated 6th August 2018:

The six sets of Final Feasibility Reports for Package 5: Saparmeina to Imphal in hard copy (4 sets at BO, NHIDCL, Imphal +1 Set at NHIDCL HQ + 1 Set at ED (P), NHIDCL, Guwahati) were submitted vide our letter no 5999 dated 31st August 2018.

The six sets of Final Feasibility Reports for Package 1,2&3: Kohima to Senapati including Senapati Bypass in hard copy (3 sets at BO- Imphal + 1 Set at BO-Dimapur+1 Set at NHIDCL HQ + 1 Set at ED (P), NHIDCL, Guwahati) were submitted vide our letter no 6027 dated 17th January 2019.

- Volume I- Main Report
- Volume II- Drawings-P&P, TCS and GAD of Bridges
- Volume IIIA- Rate Analysis
- Volume IIIB- Bill of Quantities
- Volume IIIC- Cost Estimate
- Volume V- Utility Services Plan
- Volume VI- Land Acquisition Plan
- Volume IX- Draft Civil Work Contract Agreement & Schedules (EPC)

The four sets of Preliminary Project Reports for Package 4&5: Imphal to Senapati and Package 1,2&3: Kohima to Senapati including Senapati Bypass in hard copy (2 sets at BO- Imphal + 1 Set at ED(P)/BO-Dimapur+1 Set at NHIDCL HQ, NHIDCL, Guwahati) were submitted vide our letter no 6074 dated 30th September 2019 and letter no. 6087 dated 29th November 2019 respectively with following volumes:

Volume I- Preliminary Design Report
Volume II- Design Report
Volume III- Drawings
Volume IIIa- Land Acquisition Plan
Volume IV- Environment Impact Assessment and Environment Management Plan
Volume V- Appendix to Preliminary Design Report

1.6. PRESENT SUBMISSION

The present submission pertains to submission of the **Draft Detailed Project *Report for Package 4 & 5.*** The comments/observations received from NHIDCL have been addressed while preparing the present Deatiled Project Report. It is being submitted in following volumes:

Volume I- Main Report
Volume II- Design Report
Volume III- Material Report
Volume IV- Environment & Social Impact Assessment and Management Plan
Volume V- Technical Specification
Volume VI- Rate Analysis
Volume VII- Cost Estimate
Volume VIII- Bill of Quantities
Volume IX- Drawing Volume
Volume X- Civil Work Contract Agreement

This ***'Volume I – Main Report'*** for Package 4 & 5 i.e. from Senapati to Imphal is being submitted with the following chapters:

Chapter No.	**Description**
Chapter No. 0	Executive Summary
Chapter No. 1	Introduction
Chapter No. 2	Project Appreciation
Chapter No. 3	Detailed Methodology
Chapter No. 4	Engineering Surveys & Investigations
Chapter No. 5	Traffic Survey and Analysis
Chapter No. 6	Improvement Proposal
Chapter No. 7	Environment & Social Impact Assessment
Chapter No. 8	Preliminary Cost Estimate
Chapter No. 9	Economic and Financial Analysis

Figure 1.1: Key Plan

CHAPTER-2 PROJECT APPRECIATION

2.1. GENERAL

Manipur and Nagaland are two out of eight states in north eastern part of the Country, with the city of Imphal and Kohima as their respective Capitals.

Manipur is sometimes called alternative names such as Kangleipak or Sanaleibak. The state covers an area of 22,327 square kilometres (8,621 sq. mi). Its people include the Meetei, Kuki, Naga, and Pangal tribes/communities, who speak Sino-Tibetan languages. Manipur has been at the crossroads of Asian economic and cultural exchange for more than 2,500 years. It has long connectivity of the Indian subcontinent to Southeast Asia, enabling migration of people, cultures and religions. It has also witnessed many wars, including fighting during World War II. Manipur became part of the Republic of India in October 1949. It was made a Union Territory in 1956 and a fully-fledged State in 1972. The common language in school is Hindi.

Nagaland has an area of 16,579 square kilometres (6,401 sq. mi) with a population of 1,980,602 per the 2011 Census of India, making it one of the smallest states of India. The state is inhabited by 16 major tribes - Ao, Angami, Chang, Konyak, Lotha, Sumi, Chakhesang, Khiamniungan, Dimasa Kachari, Phom, Rengma, Sangtam, Yimchunger, Thadou, Kuki, Zeme-Liangmai (Zeliang) and Pochury as well as a number of sub-tribes. Each tribe is unique in character with its own distinct customs, language and dress. Two threads common to all, are language and religion - English is in predominant in use. Nagaland is one of three States in India where the population is mostly Christian. Nagaland became the 16th State of India on 1st December 1963.

2.2. AREA AND POPULATION

The project road passes through the two north-eastern states of the country namely Nagaland and Manipur. The area and population of Nagaland and Manipur alongside India have been presented in **Table 2.1**.

Table 2.1: Area and Population

State/Country	Area (Sq. km)	Population in lakhs	Density
India	3,287,240	12108.5	382 Per Sq.Km
Manipur	22,327	25.7	115 Per Sq.Km
Nagaland	16,579	19.8	119 Per Sq.Km

(As per Census data 2011)

2.3. DEMOGRAPHICS

The project road passes through Kohima district of Nagaland and Senapati and Imphal West districts of Manipur. The project road lengthwise distributions in different districts are:

S. No.	State	Districts	Existing Chainage (Km)		Length	
			From	To	km	%
1	Nagaland	Kohima	185+540	212+334	26.794	21%
2	Manipur	Senapati	212+334	263+000	50.666	40%
3	Manipur	Kangpokpi	263+000	296+077	33.077	26%
4	Manipur	Imphal West	296+077	308+951	12.874	10%
5	Manipur	Imphal East	308+951	311+082	2.131	2%

A small description of these districts is presented below.

Kohima

Kohima district is a hilly district of India's North Eastern State of Nagaland, sharing its borders with Assam State and Dimapur District in the West, Phek District in the East, Manipur State and Peren District in the South and Wokha District in the North.

One of the oldest among the eleven districts of the state, Kohima is the first seat of modern administration as the Headquarters of Naga Hills District (then under Assam) with the appointment of G.H. Damant as Political Officer in 1879. When Nagaland became a fully fledged state on 1st December, 1963, Kohima was christened as the capital of the state. Since then, parts of Kohima district have been carved out thrice - the first in 1973 when Phek District was created, then in 1998 Dimapur was carved out and declared as a separate district and it was in 2004 for the third time that Kohima district once again gave birth to one of the youngest districts in the state called Peren District.

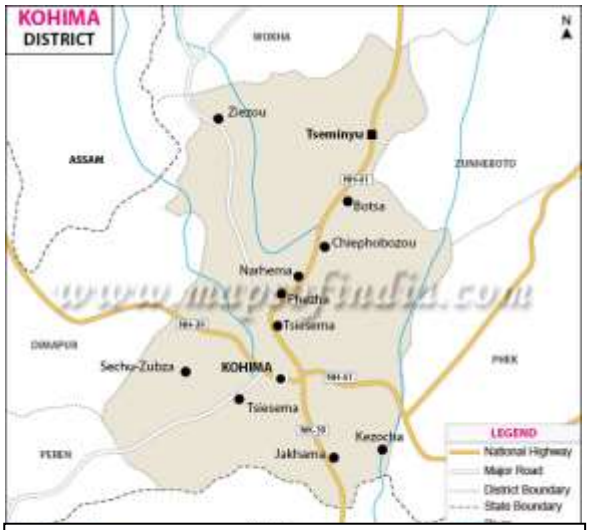


Figure 2.1: Map of Kohima District

The name Kohima is so called because the Britishers could not pronounce its original name "KEWHIRA" which is the name of the village where Kohima town is located. Kohima village, also called 'Bara Basti' which is the second largest village in Asia forms the North-Eastern part of Kohima Urban area today.

As of 2011 Census, Kohima district has a population of 270,063. Males constitute 140,118 of the population and females 129,945. Kohima has an average literacy rate of 85.58%, higher than the national average of 74.04%, male literacy is 89.28% and female literacy is 81.56%. In Kohima, 36,157 of the population are under 6 years of age.

The main indigenous inhabitants of Kohima District are the Angami Nagas and the Rengma Nagas. But Kohima being the capital city, it is a cosmopolitan city with a pot pouri of all the tribes of Nagaland as well as mainland India residing here.

Kohima features a more moderate version of a humid subtropical climate. Kohima has a pleasant and moderate climate - not too cold in winters and pleasant summers. December and January are the coldest months when frost occurs and in the higher altitudes, snowfall occurs occasionally. During peak summer months from July-August, temperature ranges an average of 80-90 Fahrenheit. Heavy rainfall occurs during summer.

Kohima is located at 25°40'N 94°07'E 25.67°N 94.12°E. It has an average elevation of 1261 metres (4137 feet).Kohima town is located on the top of a high ridge and the town serpentines all along the top of the surrounding mountain ranges as is typical of most Naga settlements.

Senapati

Senapati is a district in the State of Manipur. It is bounded by Imphal, Ukhrul and Tamenglong districts. It also shares a state boundary with Nagaland. Its climate is quite humid with a generous amount of rainfall all through the year. Senapati is one of the ancient centers of art and culture of the local tribes like Nagas and Meitis.

Figure 2.2: District Senapati

There are several places to visit at Senapati like Mao and Markhel. Mao, located high up in the hills, is one of the oldest hill stations in this area. This hill station also borders Nagaland and is located halfway between the state capital of Imphal and Dimapur. It is quite easily accessible as the National Highway No. 39 also passes through this location. Mao is located at a height of almost 5760 feet. The Mao Inspection Bungalow, built in 1897 by the Royal Military Engineers, bear testimony to the heritage of this location. Also, the Mao Naga dance, local type of dance of this region, is also quite popular.

Markhel is venerated by the local tribes as the common origin of the Meiti and the Naga tribes. There is an ancient Pear tree, which has a place in the legends of these tribes and is supposed to bear testimony to the dispersal of these tribes. There is also a rolling valley called the Dzukou valley in which rare species of flowers blossom in the summer months. Mount Isu, the highest peak of this region, also draws huge number of tourists.

Imphal West

Imphal is the capital of Manipur, which has been divided into two districts, West Imphal and the East Imphal. West Imphal lies in the valley region and is a tiny plain that is surrounded by plains of other districts. West Imphal has its own natural beauty and is full of culture and rich heritage.

West Imphal lies between 24.30 degree north and 25.00 degree north latitudes and between 93.45 degree east and 94.15 degree east longitudes. The city is surrounded by other districts on all sides, with the Imphal east and the Thoubal districts to the east, Senapati districts to the North, Thoubal and Bishnupur to the south, Bishnupur and Thoubal districts to the west. The land of West Imphal is fertile and made up of alluvial soil. The main rivers that can be seen draining the west Imphal are Imphal River, Nambul River and its tributaries.

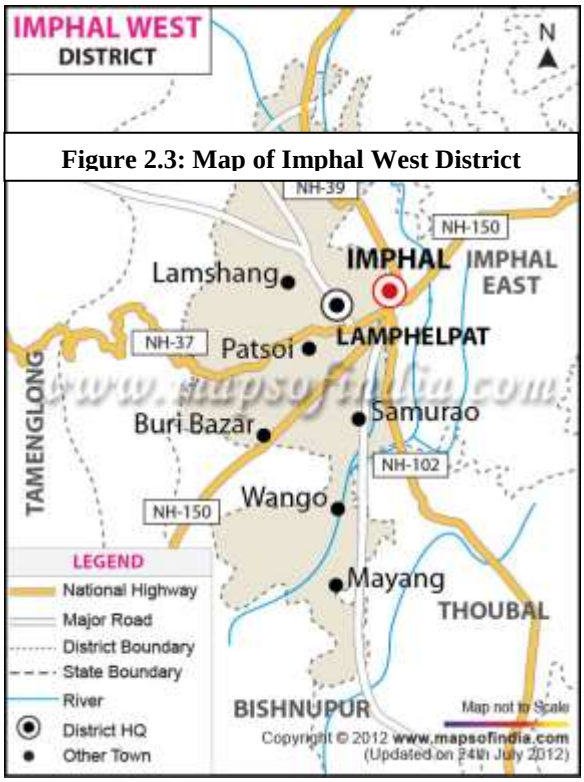


Figure 2.3: Map of Imphal West District

As far as progress is concerned, we can see much progress in the west Imphal as there are many industries set up here like the handloom and handicrafts, traditional cottages, small scale industries like the bed sheet, pillow cover, mosquito net, chadar, scarf, shawl etc. There are other industries like the cane industry, jewelry, bamboo industry etc. Some of the large scale industries are the spinning mill at Loitang Khunou and at Takyel that is a bicycle factory and the electronic factory that assembles TV sets.

Original Manipur constitutes around the major population and there are also migrants but in small numbers. Meiteilon is the language of West Imphal. The people here observe various festivals and cultures and wear traditional clothes during feasts. West Imphal has many kinds of cultural institutions like the Manipur Jagoi Marup, Jawaharlal Nehru dance academy etc. The people here eat rice, vegetables, fruits, meat, fish etc.

West Imphal is great attraction for tourists. It has various places of interest like the Shree Shree Govindjee Temple, adjoining the Palace of the Maharajas. It is a beautiful temple that has shrines of Krishna, Balaram and Jagannath on two sides of the main deity. Women's market is another unique market, where you can see two sections of market, one with fresh vegetables and fruits and the other with handlooms and household goods and is run exclusively by women. War cemeteries is another attraction, were you can see the cemeteries of the Indian and British soldiers who fought and died in World War II.

2.4. CLIMATE

The climate of Manipur is largely influenced by the topography of this hilly region. Lying 790 meters above sea level, Manipur is wedged among hills on all sides. This north eastern corner of India enjoys a generally amiable climate, though the winters can be a chilly. The maximum temperature in the summer months is 32 °C (90 °F). In winter the temperature often falls below 0 °C (32 °F), bringing frost. Snow sometimes falls in hilly regions due to the Western Disturbance. The coldest month is January, and the warmest July.

The state is drenched in rains from May until mid-October. It receives an average annual rainfall of 1,467.5 millimetres (57.78 in). Rain distribution varies from 933 millimetres (36.7 in) in Imphal to 2,593 millimetres (102.1 in) in Tamenglong. The precipitation ranges from light drizzle to heavy downpour. The normal rainfall of Manipur enriches the soil and helps in agriculture and irrigation. The South Westerly Monsoon picks up moisture from the Bay of Bengal and heads toward Manipur, hits the eastern Himalaya ranges and produces a massive amount of rain. The climate is salubrious with approximate average annual rainfall varying from 933 millimetres (36.7 in) at Imphal to 2,593 millimetres (102.1 in) at Tamenglong. The temperature ranges from sub 0 to 36 °C (32 to 97 °F).

Nagaland has a largely monsoon climate with high humidity levels. Annual rainfall averages around 70–100 inches (1,800–2,500 mm), concentrated in the months of May to September. Temperatures range from 70 °F (21 °C) to 104 °F (40 °C). In winter, temperatures do not generally drop below 39 °F (4 °C), but frost is common at high elevations. The state enjoys a salubrious climate. Summer is the shortest season in the state that lasts for only a few months. The temperature during the summer season remains between 16 °C (61 °F) to 31 °C (88 °F). Winter makes an early arrival and bitter cold and dry weather strikes certain regions of the state. The maximum average temperature recorded in the winter season is 24 °C (75 °F). Strong north-west winds blow across the state during the months of February and March.

2.5. LAND USE

The land along the project road is a combination of built-up area and forest land. Agricultural and barren lands are also seen especially in Manipur state.

Table 2.2: Land use pattern of NE Region

State	Total Geogr-aphical Area (000'ha)	Cultiv-able Land (000'ha)	% of Geograp hical Area	Total Crop Area (000'ha)	Area Sown More Than Once (000'ha)	Net Sown Area (000'ha)	% of Cultiv-able Area Used	Gross Irrigated Area (000'ha)	% of Gross Cropped Area
Arunachal Pradesh	8374.3	293	3.5	244	59	185	63.14	36	14.75
Assam	7843.8	3387	43.18	3938	1158	2780	82.08	572	14.53
Manipur	**2232.7**	**164**	**7.35**	**182**	**42**	**140**	**85.37**	**75**	**41.21**
Meghalaya	2242.9	1074	47.88	247	41	206	19.18	45	18.22
Mizoram	2108.1	445	21.11	109	0	109	24.49	9	8.26
Nagaland	1657.9	626	37.76	228	17	211	33.71	72	31.58

State	Total Geogr-aphical Area	Cultiv-able Land (000'ha)	% of Geograp hical Area	Total Crop Area (000'ha)	Area Sown More Than Once (000'ha)	Net Sown Area (000'ha)	% of Cultiv-able Area	Gross Irrigated Area (000'ha)	% of Gross Cropped Area
Tripura	1048.6	310	29.56	426	149	277	89.35	60	14.08
All NE	25508.3	6299	24.69	5374	1466	3908	62.04	869	16.17
All India	328726.	194680	59.22	186561	44346	142215	73.05	71510	38.33

2.6. GEOLOGY AND SOIL TYPES

Geologically, Manipur and Nagaland states belong to the young folded mountains of the Himalayan system. The rocks in the state vary from upper cretaceous to the present Alluvium. The oldest rocks found in Manipur are mainly confined in the eastern part of the State close to Indo-Myanmar border and the rocks are grouped as cretaceous rocks consisting chromite, serpentine etc. availability of Asbestos, Chromite, Copper ore, Coal, Big iron, Lignite, Lime stone, Nickel ore and petroleum is reported in some parts of the state. The common rocks found are sandstone, shale, silt, stone, clay stones and slates. The rock system is weak and unstable prone to frequent seismic influence. The states are also seismically active and characterized by frequent landslides. The proposed project road falls under the Seismic Zone V, which is a susceptible to major earthquake as per the seismic zone map of India (IS 1893 - Part I: 2002).

The characteristics of soil of the project area vary from place to place due to topographical variations. The soil in general is loamy sand to silty clay loam with a depth of 30 cm to 100 cm and in some cases even more than 120 cm. It has less water holding capacity and is dry in nature. Chemically acidic soil abound resulting from the washing down of the salts in rainwater and also on account of leaching effect. The pH value varies from 7.3 to 7.92. The soils are characterized by low to high organic matter (2.5-4 percent, in some places even more than 5 percent) with low action exchange capacity and high lime requirement. Notwithstanding the relatively high organic matter content, the nitrogen content in the soil is low. The geological map of Manipur is shown below:

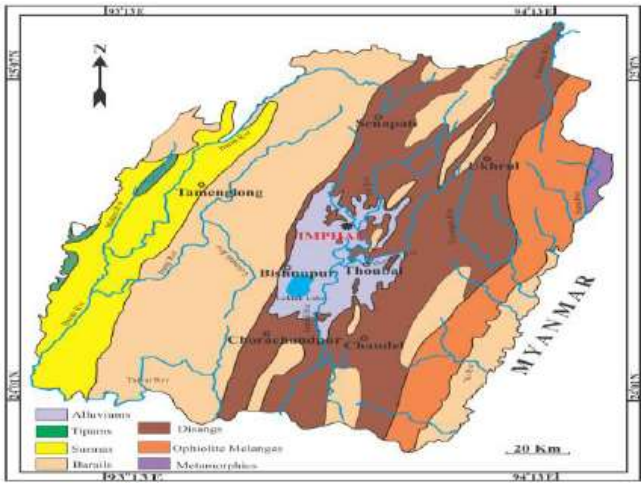


Figure 2.4: Geological map of Manipur

2.7. ROAD RECONNAISSANCE SURVEY

The consultant mobilized professionals for carrying out base line study, review of secondary data, past studies and reconnaissance survey of project road upon award of project. The Team Leader and other key professionals made field visits of project road and had meetings with NHIDCL, officers at Imphal and at NHIDCL Headquarter, Delhi and other stake holders. Other teams mobilized for various kinds of detailed survey and investigation as per TOR.

The project corridor is a part of proposed Great Asian Highway-2, presently designated as National Highway-2 in India (earlier NH-39) which connects Numaligarh - Golaghat - Dimapur - Kohima - Imphal – Moreh, the Mayanmar Border. The entire road length is around 1214 km.

2.7.1. 'START' and 'END' Point

As per Contract, the Project corridor is named as Imphal to Kohima; however, it is evident from the chainage of NH-39 at site, the road chainage increases from Kohima towards Imphal.

Hence, the 'START' point of project road is at Km185+540 of NH-39 i.e. Lerie colony Jn. Kohima. The 'END' point on Imphal side is at Km311+082 of NH-39, where it merges with the existing road which is already a 4-lane divided carriageway near Koirengei village.

Figure 2.5: Lerie Colony Junction, Kohima - Starting Point of Corridor

Figure 2.6: Imphal (Koirengei)- End Point of Corridor

The project corridor passes through many towns/villages namely Lerie Colony, Kohima, Phesama, Kigwema, Jakhama, Viswema, Khuzama, Mao, Tadubi, Khridziiphi, Makhan Centre, Maram, Maram Kabinam, Lairouching, Puni Pfosemai, Karong, New Karong, Senapati, Taphou Kuki, Hengbung, Thangal, Tumuyon Khullen, Kangpokpi, Mao Daili, Tumnoupokpi, Kalapahar, Keithelmanbi, Bongmoul, Lhangjol, Phoibih, Saparmeina, Tokpa Khul, Pangmoul, Motbung, Kuraopokpi, Kanglatongbi, Awang Sekmai, Tendongyan, Pheidinga, Awang Leikai, Khonghampat, Mantri Leikai, before reaching the termination point at Koirengei Imphal at Km 311+082 where the project road is already 4-lane road towards the city of Imphal starts.

The project road from Lerie colony Jn., Kohima to km304 of NH-39 near Imphal generally has two lanes carriageway and balance section from km304 to km311 has two lanes carriageway with paved shoulders. The project corridor from Kohima to Senapati passes through Hilly terrain. After Senapati town, the project road enters in plain/rolling terrain.

The existing length of project road from Kohima to Imphal is 125.5 km. The terrain/ carriageway characteristics of project road are summarised in ***Table 2.3***:

Table 2.3: Lane and Terrain Configuration

S No.	Existing Chainage (Km)		Length (km)	Carriageway width	Terrain
	From	To			
1	185+540	259+600	74.1	6m-7.7m	Hilly
2	259+600	260+000	0.4	20m	Hilly
2	260+000	266+000	6.0	7.5m	Hilly
4	266+000	304+000	38.0	6.2-7.5m	Plain/Rolling
5	304+000	311+082	7.0	2-lanes+ Paved Shoulder	Plain/Rolling
Total length			**125.5**		

2.7.2. Traffic Volume and Traffic Homogeneous Sections

The project highway is the life line of Manipur State and one of major connecting road to Nagaland.

It is noticed that Imphal to Senapati section of the project road has more traffic volume compared to Senapati to Kohima section.

The Senapati and Kongpokpi are major settlement along the project corridor. Based on the traffic pattern the homogeneous sections of project corridor are presented in Table 2.4:

Table 2.4: Homogeneous Sections of Project Corridor

Sl. No.	From	To	Start (km)	End (km)	Length (km)
1	Kohima	Tadubi (NH-102A Jn)	185+540	219+600	34.06
2	Tadubi (NH-102A Jn)	Senapati	219+600	259+250	39.6
3	Senapati	Kangpokpi (SH Jn)	259+250	275+700	16.5
4	Kangpokpi (SH Jn)	Imphal (Koirengei)	275+700	311+000	35.3

2.7.3. Existing Alignment

The alignment from Kohima to Senapati section is a typically hill road, with horizontal alignment meandering along substantial portion with sharp reverse curves and steep gradient at some locations following the natural terrain. The horizontal and vertical alignments are very poor, especially in the reach which is predominantly hilly.

The Senapati to Imphal section generally passes through Plain/Rolling terrain with number of geometric deficient locations.

The existing alignment has a large scope of improvement of both horizontal and vertical alignment which would bring in the relief to the traffic and enhance the safety of the road users substantially.

2.7.4. Existing Configuration of Carriageway and Pavement condition

The existing NH 39 section of project road is a combination of 2-lane and intermediate lane carriageway configuration having 6.0m to 7.7m width, with 1m/1.5m wide earthen shoulders on either side of the carriageway. The condition of the pavement in Nagaland portion of Project Highway varies from 'Fair' to 'Poor'.

In Manipur portion of the Project highway, the carriageway width in Senapati town is about 20m for 400m length with 'Fair' pavement condition. The rest of the section may be classified as 'Fair', 'Poor' to 'Very Poor' road condition. The existing carriageway width in terms of its lane configurations and their pavement conditions are summarised below:

S. No.	Ex. Chainage (Km)		Length (km)	Carriageway width	Pavement Condition
	From	To			
1	185+540	205+800	20.26	2-lane	Good to Fair in Major Portion
2	205+800	208+000	2.20	2-lane	Major Pothole, Cracking and Patching. In some Portion, WBM Exposed.
3	208+000	210+600	2.60	2-lane	Good to Fair in Major Portion
4	210+600	212+600	2.00	2-lane	Major Pothole, Cracking and Patching. In some Portion, WBM Exposed.
5	212+600	217+800	5.20	2-lane	Good to Fair in Major Portion
6	217+800	231+000	13.20	2-lane	Major Pothole, Cracking and Patching. In some Portion, WBM Exposed.
7	231+000	235+600	4.60	2-lane	Good to Fair in Major Portion
8	235+600	238+200	2.60	2-lane	Major Pothole, Cracking and Patching. In some Portion, WBM Exposed.
9	238+200	286+800	48.60	2-lane	Good to Fair in Major Portion
10	286+800	291+400	4.60	2-lane	Major Pothole, Cracking and Patching. In some Portion, WBM Exposed.
11	291+400	297+000	5.60	2-lane	Good to Fair in Major Portion
12	297+000	303+000	6.00	2-lane	Good, Recently Overlaid by Manipur PWD.
13	303+000	304+000	1.00	2-lane	Major Pothole, Cracking and Patching.
14	304+000	311+082	7.08	2-lane +PS	Good, Recently constructed by Manipur PWD in 2014-15

The project road has 1.0m to 1.5m wide shoulders on the both sides of road and condition of shoulders is generally poor, except for few locations near built up areas, where the condition can be stated as 'fair'.

2.7.5. Major and Minor Intersections

The project road has four major junctions, two with National Highways and two with State Highway/MDR. The Chainage of NH and SH junctions with Project road are shown below:

Table 2.5 : Major Junctions

SN	Ex. Chainage (Km)	Details of Cross Road		Starts From	Leading to
		Direction (LHS/RHS)	Road Type (NH/SH/MDR)		
1	219+300	LHS	NH-102A	Tadubi	Imphal via Tora
2	236+560	RHS	NH-129A	Maram	Dimapur via Jalukie
3	274+120	RHS	SH	Kangpokpi	Tamei
4	292+420	LHS	SH/MDR	Motbung Bazar	Imphal via Saikul

A number of connecting roads to NH 39 have been developed under MGNREGS, PMGSY and Black Topping of Rural Road Scheme. The bituminous cross roads are intersecting the project road at several locations and such locations of minor junctions are presented in **Table 2.6**.

Table 2.6: Minor junctions

SN	Ex. Chainage (Km)	Direction (LHS/RHS)	Surface Type	Leading to
1	187+050	LHS	BT	New Reserve Colony
2	187+700	LHS	BT	New Reserve Colony
3	191+600	RHS	BT	Phesama
4	191+650	LHS	BT	Phesama
5	192+200	RHS	BT	Hornbill Village
6	192+250	LHS	BT	Hornbill Village
7	192+560	RHS	BT	Hornbill Village
8	195+400	RHS	BT	HQ IGAR Camp
9	197+560	RHS	BT	HQ IGAR Camp
10	197+600	LHS	BT	Jakhaama
11	199+600	RHS	BT	Jakhaama
12	202+480	LHS	BT	Kidima
13	203+950	LHS	BT	Vishwema
14	209+460	LHS	BT	Khuzama Market
15	209+600	RHS	BT	Khuzama Market
16	212+700	RHS	BT	Mao Town
17	213+480	LHS	BT	Puranemei
18	214+200	RHS	BT	JNV College
19	219+600	RHS	BT	Assam Raifal
20	223+880	RHS	BT	Chukumai Village
21	227+500	RHS	BT	Mao-Pundung Rd
22	230+900	RHS	BT	New Makhan
23	234+600	RHS	BT	Maram bazar
24	234+720	LHS	BT	Maram bazar
25	235+850	RHS	BT	Maram bazar

SN	Ex. Chainage (Km)	Direction (LHS/RHS)	Surface Type	Leading to
26	237+800	RHS	BT	Das Vosco Collage
27	237+950	LHS	BT	Makhan kuman
28	239+700	RHS	BT	Lairouching
29	240+200	RHS	BT	Lairouching
30	240+850	RHS	BT	Lairouching
31	241+000	LHS	BT	Assam Raifal
32	253+300	RHS	BT	karong Town
33	253+400	LHS	BT	karong Town
34	254+650	Both	BT	karong Town
35	257+500	RHS	BT	Senapati Town
36	257+900	RHS	BT	Senapati Town
37	258+600	RHS	BT	Senapati Town
38	258+900	RHS	BT	Senapati Town
39	260+100	RHS	BT	Tophou Fahyami
40	266+800	LHS	BT	Thangal Central Park
41	268+150	LHS	BT	Tumuyon Khullen
42	269+500	RHS	BT	Tumuyon Khullen
43	273+300	RHS	BT	Kongpkpi Town
44	273+500	RHS	BT	Kongpkpi Town
45	273+700	Both	BT	Kongpkpi Town
46	274+500	RHS	BT	Kongpkpi Town
47	278+200	RHS	BT	Haipi Rd
48	280+200	Both	BT	Keithelmunbi
49	281+800	RHS	BT	Khaljung
50	282+300	RHS	BT	Khaljung
51	285+050	RHS	BT	S. Molnam
52	286+500	RHS	BT	Sampermenia Town
53	286+570	Both	BT	Sampermenia Town
54	287+180	LHS	BT	Thonamba
55	287+250	RHS	BT	Sampermenia Town
56	291+200	RHS	BT	Simol
57	292+480	Both	BT	Motbung Town
58	293+100	Both	BT	Leikot
59	293+350	RHS	BT	Khejung
60	294+900	RHS	BT	Santipur
61	295+100	RHS	BT	Santipur Town
62	295+400	Both	BT	Vijaynagar
63	296+400	RHS	BT	Lambi
64	297+800	RHS	BT	Konglatongbi
65	299+200	RHS	BT	Awang Sekmai
66	299+500	RHS	BT	Awang Sekmai
67	299+750	Both	BT	Awang Sekmai
68	300+960	LHS	BT	Meharabi
69	302+800	RHS	BT	Mayai Lekai
70	304+100	RHS	BT	Meharabi
71	304+120	RHS	BT	Meharabi
72	305+700	LHS	BT	Awang Lekmai
73	309+100	LHS	BT	Koeirengi

BT = Black Top (Bituminous Road)

2.7.6. Existing Major and Minor Bridges

There are 1 major bridge and 25 minor bridges along the project road. A detailed visual inventory and condition survey of structures has been conducted to finalize the structure proposal of project highway. The major bridge details are given in Table 2.7.

Table 2.7: Details of Major Bridges

S No.	Ex. Chainage (Km)	Ex. Span arrangement (No. x Span)	Total Outer Width (m)	Superstructure	Substructure	Foundation
1	254+605	3 x 30.0m	11.0	PSC I Beam with RCC Deck	RCC wall type Abutment/Pier	Open/Well

The major bridge is in fair condition which requires minor maintenance repair.

The carriageway width of the minor bridges are in the range of 6.65m to 11m with fair conditions which requires minor maintenance except the minor bridge at Km. 201+110 which has major distress in concrete deck slab.

The hydraulic performances of existing bridges are found fair. All bridges have concrete superstructures. The substructures are generally concrete or masonry work type. The details of Minor bridges are furnished in ***Table 2.8.***

Table 2.8: Details of Minor Bridges

S. No.	Ex. Chainage (Km)	Ex. Span arrangement (No. x Span)	Total Outer Width of Deck (m)	Superstructure	Substructure	Foundation
1	194+590	1 x 9.0	7.65	RCC deck with Steel Beam	CRM wall type Abutment	Open
2	198+855	1 x 9.1	7.8	RCC deck with Steel Beam	CRM wall type Abutment	Open
3	201+110	1 x 9.1	7.9	RCC deck with Steel Beam	CRM wall type Abutment	Open
4	207+490	1 x 24.75	8.5	RCC-T Beam	RCC wall type Abutment	Open
5	210+370	1 x 7.5	7.9	RCC deck with Steel Beam	CRM wall type Abutment	Open
6	212+340	1 x 8.8	8.4	RCC-T Beam	RCC wall type Abutment	Open
7	226+390	1 x 14.0	8.3	RCC-T Beam	RCC wall type Abutment	Open
8	232+407	1 x 40.5	8.5	PSC Box	RCC wall type Abutment	Open
9	259+145	1 x 40.0	11.0	PSC I Beam with RCC Deck	RCC wall type Abutment	Open
10	263+805	1 x 13.5	12	RCC-T Beam	RCC wall type Abutment	Open
11	272+283	1 x 6.5	8.5	RRM Arch+RCC Slab	RCC+CRM wall type Abutment	Open

S. No.	Ex. Chainage (Km)	Ex. Span arrangement (No. x Span)	Total Outer Width of Deck (m)	Superstructure	Substructure	Foundation
12	274+643	1 x 25.6	8.3	PSC I Beam with RCC Deck	RCC wall type Abutment	Open
13	275+780	1 x 9.0	11.0	Solid Slab	RCC wall type Abutment	Open
14	279+357	1 x 20.5	8.5	RCC-T Beam	RCC wall type Abutment	Open
15	281+333	1 x 17.0	10.5	RCC-T Beam	RCC wall type Abutment	Open
16	283+525	1 x 26.5	8.3	PSC I Beam with RCC Deck	RCC wall type Abutment	Open
17	286+411	1 x 6.5	12.0	Solid slab	RCC wall type Abutment	Open
18	287+381	1 x 14.5	12.0	RCC-T Beam	RCC wall type Abutment	Open
19	288+621	1 x 10.0	10.3	Solid slab	RCC wall type Abutment	Open
20	289+968	1 x 6.7	10.6	Solid Slab	RCC wall type Abutment	Open
21	293+279	1 x 14.0	8.5	RCC-T Beam	RCC wall type Abutment	Open
22	297+007	1 x 26.0	11.0	PSC I Beam	RCC wall type Abutment	Open
23	297+1067	1 x 11.5	11.2	RCC-T Beam	RCC wall type Abutment	Open
24	299+015	1 x 6.7	10	Solid Slab	RCC wall type Abutment	Open
25	305+629	1 x 13+ 1 x 17+ 1x13	8.5	RCC-T Beam	RCC wall type Abutment/Pier	Open/Well

CRM = Course Rubble Masonry

2.7.7. Culverts

The project road has 781 numbers along the project road which includes slab culverts besides pipe and Arch culverts. Few culverts have been constructed recently. Most of the culverts are in fair to poor condition, but there are few which are lying completely chocked. The details of existing culverts are given in ***Table 2.9***.

Table 2.9: Summary of Types of Existing Culverts

Arch		Slab		Slab+Steel		Slab+Pipe		Pipe		BOX		Chocked
Span	Nos.	Span	Nos.	Span	Nos.	Span	Nos.	dia	Nos.	Span	Nos.	Nos.
1.1 - 4.5m	**3**	0.6 - 6.0m	**544**	4.5 - 5.0m	**2**	1.0- 2.5m	**3**	0.9 - 1.2m	**212**	1.0 - 2.0m	**8**	**9**

2.7.8. Habitation/Settlements

At Senapati and Kongpokpi, there exists large chunk of population. The Project Highway passes through these crowded corridors and may justify the provision of bypasses while upgrading the Highway. The bypass proposals would be examined for Senapati and Kongpokpi towns which

have densely habitated settlements with poor geometry along the project road. The existing settlements at other village locations are scattered hence project proposal may be feasible without much social disturbance. The details of minor/major settlements along the Project Highway are presented in the ***Table 2.10***.

Table 2.10: Locations of Habitations/Settlements along the Project Corridor

SN	Ex. Chainage (m)		Habitation Length (m)	Settlement Side	Village Name
	From	To			
1	187000	188200	1200	Both	New Reserve Colony, Nagaland
2	188800	189000	200	Both	Phesama, Nagaland
3	191200	192100	900	Both	Phesama, Nagaland
4	194000	194300	300	Both	Zakhama, Nagaland
5	194900	200000	5100	Both	Zakhama, Nagaland
6	202400	203400	1000	Both	Kisama, Nagaland
7	203900	204100	200	Both	Viswema, Nagaland
8	209100	210000	900	Both	Khuzama, Nagaland
9	212900	213200	300	LHS	Mao, Manipur
	213200	215000	1800	Both	
10	218600	220100	1500	Both	Tadubi, Manipur
11	224400	224700	300	Both	Khridziiphi, Manipur
12	228300	228700	400	RHS	Makhan Centre, Manipur
	228700	230000	1300	Both	
13	234000	236600	2600	Both	Maram, Manipur
14	237500	238000	500	LHS	Maram Kabinam, Manipur
15	240200	241100	900	Both	Lairouching, Manipur
16	243400	243700	300	RHS	Puni Pfosemai, Manipur
17	245200	245600	400	LHS	Kathikho, Manipur
18	252700	254000	1300	Both	Karong, Manipur
19	254300	254900	600	Both	New Karong, Manipur
20	255800	261400	5600	Both	Senapati, Manipur
21	262800	263300	500	LHS	Taphou Kuki, Manipur
22	263800	264600	800	Both	Hengbung, Manipur
23	265100	265600	500	Both	-
24	267000	268000	1000	Both	Thangal, Manipur
25	268400	269500	1100	Both	Tumuyon Khullen, Manipur
26	272600	273000	400	RHS	Kangpokpi, Manipur
	273000	274700	1700	Both	
27	274900	275600	700	Both	Mao Daili, Manipur
28	276800	277700	900	Both	Tumnoupokpi, Manipur
29	277800	278500	700	Both	Kalapahar, Manipur
30	278700	279000	300	LHS	Keithelmanbi, Manipur
	279000	280500	1500	Both	
31	281700	282100	400	Both	Bongmoul, Manipur
32	283600	283900	300	Both	L Lhangjol, Manipur
33	285000	285200	200	Both	Phoibih, Manipur
34	286300	287400	1100	Both	Saparmeina, Manipur
35	289000	289200	200	LHS	Tokpa Khul, Manipur
36	291100	292100	1000	Both	Pangmoul
37	292100	294400	2300	Both	Motbung
38	294400	295400	1000	Both	Kuraopokpi
39	295400	296400	1000	Both	Kanglatongbi
40	296400	297100	700	Both	Sekmai, Manipur
41	297500	300000	2500	Both	Awang Sekmai, Manipur
	300000	300800	800	LHS	
42	302500	303100	600	Both	Tendongyan, Manipur

SN	Ex. Chainage (m)		Habitation Length (m)	Settlement Side	Village Name
	From	To			
43	303800	304500	700	Both	Pheidinga, Manipur
44	305100	306000	900	Both	Awang Leikai, Manipur
45	306000	306700	700	Both	Khonghampat, Manipur
46	306700	307400	700	Both	Mantri Leikai, Manipur
47	308500	309160	660	LHS	Koirengei, Potsangbam Khoiru, Manipur

2.7.9. Drainage

The water flowing over/along the road has been notices for some length at different locations of project corridor. The lined drains for small length were also noticed at Senapati and some other town locations.

It is also noticed that the water from the hill side is flowing over the road along/transversely and longitudinal direction is causing damage to bituminous road crust.

2.7.10. Sinking & Sliding Locations

The project area falls under heavy rainfall zone with hilly terrain involving an appreciable catchment. The hills along the road do not have rocky strata and generally contain soil mixed of boulders and pebbles of round shapes. Based on study at site of the identified Sinking of Sliding zones by the Geotechnical Expert, we consider that the water absorption tendency of soil mass and poor internal drainage creates the sinking and sliding problem.

The study of geology of hill slopes along the project corridor reveals that these generally constitute shale, slate, conglomerates and sandstone which are very steep and appears stable due to existing vegetation. The soil mass absorbs the rain water and gets additional weight. This added weight makes that portion unstable and force to slide due to shear on the project road. The sliding locations observed along the corridor are tabulated below:

Table 2.11: Sliding zones observed on NH-39

S No	Ex. Chainage (Km)		Length (km)	S No	Ex. Chainage (Km)		Length (km)	S No	Ex. Chainage (Km)		Length (km)
	From	To			From	To			From	To	
1	203.000	205.000	2.000	5	238.000	239.000	1.000	9	250.000	251.000	1.000
2	215.000	216.000	1.000	6	243.000	244.000	1.000	10	252.000	253.000	1.000
3	218.000	219.000	1.000	7	245.000	246.000	1.000	11	254.000	255.000	1.000
4	237.000	238.000	1.000	8	249.000	250.000	1.000	12	257.000	258.000	1.000

During Site visits, it has been notices that the embankment and formation of existing road has sunk at a number of location along the project corridor. Such Sinking locations noticed at site are tabulated in ***Table 2.12***.

Table 2.12: Sinking Zones observed on NH-39

S No	Ex. Chainage (Km)	Affected Length (m)		S No	Ex. Chainage	Affected Length (m)		S No	Ex. Chainage	Affected Length (m)
1	192+900	200		12	218+850	40		23	226+660	30
2	202+100	60		13	219+100	30		24	227+480	20
3	203+800	100		14	219+870	30		25	228+170	30
4	206+500	70		15	220+920	30		26	229+800	40
5	207+300	50		16	221+570	35		27	231+360	20
6	207+900	50		17	221+750	30		28	231+600	60
7	209+300	30		18	221+900	80		29	232+950	30
8	211+500	50		19	223+910	100		30	234+350	60
9	218+100	30		20	224+000	45		31	235+400	40
10	218+300	30		21	224+500	80				
11	218+700	60		22	224+900	60		**Total Length (m)**		**1670**

A detailed specific analysis will be conducted at these locations in the subsequent submission.

An expert team headed by a Geotechnical Expert with shortly visit the site to look into the problem of sliding/sinking and based on the Report prepared by them; the proactive measures suggested shall be incorporated in the cost estimate. The Report shall be submitted to NHIDCL for their consideration.

2.7.11. Bypass and Realignment

The project road does not have any existing bypass. As mentioned in para 3.7.3 above, there is scope of improvement of horizontal and vertical alignment as geometric deficiency of road exists at several locations envisaging realignment. The bypass proposals would be examined for Senapati and Kongpokpi towns which are densely habitated settlements with poor geometry along the project road.

2.7.12. Availability of Material for Construction

The processed materials like cement, steel and Bitumen are available involving long lead. The naturally occurring material like stone, sand etc. are also available within reasonable lead and therefore their characteristics would be investigated for suitability in view of Ministry's/IRC Specifications.

2.7.13. Impact on Economic Activities

The upgradation of the project highway is likely to impact, resulting in increase of economic activities. The travel time will reduce due to improved geometry and road condition. There exists enormous scope for increase of existing and new economic activities in the region, particularly along the road corridor and its linkage with Myanmar international border. Also, this road being part of Great Asian Highway is likely to increase trade and commerce by road using the Project Road.

Photos Near Km 264+000 and Km 277+000

Photos Near Km 304+000 & Km305+000)

Photos at Tadubi Junction and Tadubi Market

Photos Near Km 294+000 and Km195+000

Photos at Project End (Km 311+082)

Photos at Mao (Km 213+000)

Photos Near Km 245+000 & Km 246+000

Photos at Senapati

Photos at Kangpokpi

Photos Near Km 278+000 & Km 280+000

Photos Near Km 185+000 & Km187+000

Photos at Motbung and Saparmeina

Minor Bridge at Km194+590

Minor Bridge at Km232+407

Major Bridge at Km259+145

Minor Bridge at Km263+805

Minor Bridge at Km279+357

Minor Bridge at Km287+381

Minor Bridge at Km288+621

Minor Bridge at Km305+629

CHAPTER-3 DETAILED METHODOLOGY

3.1. INTRODUCTION

The feasibility study involves carrying out economic analysis, preliminary design and approximate cost estimation based on surveys, inventories, investigations etc. Secondary data is also required to be collected for analyzing various situations to evolve proper design. The Methodology adopted for different tasks is discussed in this chapter. Firstly, the methodology of topographic survey is given. Next follows the inventories, condition surveys for existing road (including pavement strength using Benkelman Beam Deflection), culverts and bridges along with hydrological studies. Methodology for subgrade and material investigation precedes pavement design.

Feasibility study has been broken into different appropriate tasks and the same is explained below.

3.2. MOBILISATION

The personnel and equipment were mobilized and site office during field activity was established immediately after signing of the Contract Agreement and receiving order to Commencement of the Services. The Site office was established during the engineering surveys along the project corridor and its address was as below.

Stanley Consultant in JV with Caritas Infra Consulting Pvt Ltd
Ride in Style
2nd Floor, Mantri Pukhri,
Opp. CRPF Camp, Near SP Building,
Imphal East,
Manipur - 795 002.

Contact Persons: Mr Niraj Tiwari
Mob: +91-98103 52613

3.3. GENERAL APPROACH

Based on the objectives and scope of the consultancy services, an appropriate methodology has been developed by the Consultants so as to address the prescribed requirements, also, especially with regard to various intermediate targets and completion period, manning schedule and interaction with client as indicated in TOR. A work plan has then been prepared on the basis of the methodology developed. A competent team of suitably qualified key professionals as per the requirements of TOR and other supporting staff has been selected for carrying out the services.

Since the scope of services covers both independent and inter-dependent activities, a TASK APPROACH has been followed to carry out the entire work comprehensively and accurately to the complete satisfaction of the client. The whole work has been divided into different tasks.

Detailed methodology for each Task has been prepared for ensuring quality through a quality assurance system.

3.4. METHODOLOGY FOR SURVEYING, DATA COLLECTION AND ANALYSIS

Field studies covering topographic field surveys, traffic (classified volume, turning movement, speed delay and OD surveys), investigations for Roads, bridges and structures and construction materials are the essential tasks for the assignment. The field studies have been performed as per the stipulations of the TOR which are quite elaborate and self-explanatory.

The Consultants has used the Total Station and Digital/Automatic levels while carrying out the topographic field surveys. The data collected in the site will be downloaded in the electronic format in computers for further processing and analysis after pre-processing and validation. The processing of the field survey data and the generation of the road drawings will be based on "digital terrain modelling" using MxRoad or equivalent Highway Design software. The data analysis for the design of bridges and structures will be done using sophisticated structural design software such as STADD PRO, ADAPT, and in house software prepared in conformity to MoRT&H/IRC specifications.

The traffic data will be analysed using the proven methods as per the IRC guidelines. Traffic demand estimates will be based on economic indicators besides the time-series data.

3.4.1. Sequence of Activities

Based on an in-depth study of the scope of services contained in the TOR for the project, the consultants have evolved a methodology wherein the work has been divided into a set of Task Series that are listed below.

Task ID			Description
Series	Task	Element	
1000			Project Initiation and Inception
	1100		Standards and Code of Practices
	1200		Desk Study and Mobilization
	1300		Collection/Review of Data and Documents
		1310	Detailed Field Reconnaissance
		1320	Collection of Secondary data
	1400		Quality Assurance Plan
2000			Traffic Studies
	2100		Review of Past Traffic Data
	2200		Classified Traffic Volume Count
	2300		Origin Destination Survey and Commodity Movement Characteristics
	2400		Axle Load Survey
	2500		Turning Movement Survey
	2600		Traffic Demand Estimates

Task ID			Description
Series	Task	Element	
3000			Engineering Surveys & Investigations
	3100		Reconnaissance and Alignment
	3200		Topographic survey
		3210	Establishment of main control Points by DGPS &Total Station and Traverse & Bench mark by Digital Level
		3220	Longitudinal and Cross-Sections
		3230	Details of utility services & other physical features
		3240	Identification of sliding & sinking zone.
	3300		Road and Pavement Investigations including Pavement Design
		3310	Road Inventory
		3320	Pavement Investigations & Pavement Design
			3321-General
			3322- Adopted Methodology for Feasibility Study
		3330	Investigation of sliding & sinking zone by an Expert & resolution thereof.
	3400		Investigations for Bridges/Structure
		3410	Inventory and Condition Survey of Bridges, Culverts and Structures
		3420	Hydraulic and Hydrological Investigations
		3430	Geo-technical Investigations, Sub-soil Exploration
	3500		Material Investigations
4000			Detailed Engineering Design
	4100		Design Standard
	4200		Geometric Design & Embankment Design
	4300		Design of Bridges, ROBs/ RUBs, Grade Separators; Drainage System
	4400		Traffic Safety
	4500		Estimation of Quantities and Project Costs

3.5. Detailed Methodology

The methodology evolved for the assignment has been structured into a set of inter-related but distinctive 'Task' elements, which are designed to carry out specific tasks. The output of each 'Task' element or activity in the network of various 'Tasks' is either an input to another 'Task' or a distinct output as per scope of works. The details concerning objectives and work assigned to each 'Task Series' and individual 'Task' elements are discussed in this section.

1000: Project Initiation and Inception

Preparation of FSR/DPR commenced on 2nd December 2015 and Inception Report (IR) was submitted on 4th January 2016.

1100: Standards and Code of Practices

All activities related to field studies, design and documentation have been done and will be done as per the Manual of Specifications and Standards for two lane of highways through Engineering, Procurement and Constructions (EPC) Mode **(IRC:SP:73-2007)** along with relevant IRC code. The latest guidelines/circulars of the MoRT&H and relevant publications of the Indian Roads Congress (IRC) and Bureau of Indian Standards (BIS) have been followed.

All notations, abbreviations and symbols used in the reports, documents and drawings are as per IRC: 71 – 1977.

1200: Desk Study and Mobilization

Desk study of the 'Terms of Reference' (TOR) as prescribed for the project road has been thoroughly done before undertaking any field surveys/investigations.

The team of experts for carrying out the services have been mobilised by the Consultant on receipt of the commencement order (Commencement of Services) from Client.

1300: Collection/Review of Data & Documents

Secondary data on traffic, soil characteristics, and pavement characteristics were collected from the state PWD and other agencies.

1310: Detailed Field Reconnaissance

The following documents and data have already been collected during the reconnaissance survey by the team:

- Climate of the area surrounding the project road
- Road inventory and condition data
- Year of original construction, year and type of major maintenance/rehabilitation works
- Condition of bridges and cross-drainage structures
- Type and location of existing utility services
- Survey and evaluation of locally available construction materials

The field team are also in the process of procurement of several other data as available from the site

- Hydraulic data
- Local information regarding HFL in the past

1320: Collection of Secondary data

During the course of Feasibility study of the project, several types of secondary data have been collected/in the process of procurement and these are as follows:

- Drawings and details of existing Bridges & Structures
- Historical data on classified traffic volume count
- RoW Details along the project road

1400: Quality Assurance Plan

Immediately upon the award of the consultancy work, based on our extensive experience in this field and our knowledge of the project, a detailed Quality Assurance Plan (QAP) has been prepared and submitted with Inception Report which covers all aspects of field studies, investigations, analysis, design and documentation. The system also ensures responsibilities to be shared by concerned key personnel.

The Consultant has followed the same to maintain the requisite quality.

2000: Traffic Studies

2100: Review of Past Traffic Data

The Consultant collected past traffic data from secondary sources during reconnaissance survey. Traffic volume counts (7 consecutive days; 24 hour) for the last few years conducted by the state PWD/other agency on the project road have been collected. The data has been analysed and have been considered during preparation of feasibility report.

2200: Classified Traffic Volume Count

The Consultant has carried out 7-days (continuous, both directions) classified traffic volume surveys at 4 selected locations (Km 213+500, Km 219+700, Km 260+300, Km 301+300) on the project road. The traffic volume data has been collected for every hour. The methodology for traffic surveys was as per the existing practices in the country and as per TOR/ IRC standards. The vehicle classification as recommended by IRC has been adopted for carrying out the traffic volume surveys. The training was given to the enumerators before starting the volume count survey.

The Consultant's senior personnel supervised the traffic survey.

The data from traffic volume surveys have been analysed for:

- Average Daily Traffic Volume (ADT);
- Traffic composition;
- Hourly variation of traffic volume; and,
- Daily variation of traffic volume.

The Annual Average Daily Traffic (AADT) volume have been worked out on the basis of ADT derived from the consultants' surveys and the seasonal traffic variation factors (SCF) estimated from the available historical traffic volume data or existing practices for the same in vogue in the project area and has been presented as part of Feasibility Report.

2300: Origin-Destination (O-D) Survey and Commodity Movement Characteristics

The O-D and Commodity Movement Surveys have been carried out for one day (24 hour, both directions) on the project road at two locations (km 265+000 and km 300+100). Survey has been carried out for an appreciable sample size to establish the potential divertible traffic on the project road.

Key professionals with sufficient number of sub-key professionals supervised the O-D survey. Several sub professionals and sufficient number of enumerators were deployed at the survey location and police help were sought during survey.

2400: Axle Load Survey

The Axle load survey has been carried out on the project road in both directions on random sample basis normally for trucks (both empty and loaded trucks) for two normal days (24 hrs.). The vehicle damage factor (VDF) have been calculated based on axle load survey and accordingly the number of equivalent standard axles has been arrived at and presented in the Feasibility Report.

The location of the axle load survey was near the volume count stations. The data was collected as per proforma submitted under QAP. The axle load survey was preceded by calibration of pads. Appreciable sample sizes of vehicles have been surveyed.

2500: Turning Movement Survey

After assessment of the peak hour traffic from the volume count, turning movement survey on major road crossing has been carried out to determine peak hour traffic, in terms of direction of traffic and vehicle category-wise. Sufficient numbers of enumerators at each corner of the junction were deployed for the survey.

2600: Speed-Delay Surveys

The consultant carried out moving car survey to determine running speed and journey speed.

2700: Pedestrian Traffic Count

Pedestrian traffic count survey has been carried out as per TOR requirement at selected suitable locations on the project road.

2800: Truck Terminal Surveys

The data derived from O-D, speed delay, other surveys and supplementary surveys has been analyzed to assess the requirements and location of Truck Terminal.

2900: Traffic Demand Estimates

The traffic demand estimates for the passenger as well as freight has been made by the consultant keeping in view the past and existing traffic levels, operational characteristics, divertible traffic from other road forecasts etc. Data on population and economic performance, and forecasts made for similar roads in the country were used for assessing the future growth rate. The growth rates were also compared with the trends observed in historical traffic volume data for the last few years. The projections from annual vehicle productions in India were also kept in view while analysing and determining the growth rates of traffic.

Traffic projections have been carried out using the growth rates derived above. The projections have been done for each type of vehicles carrying 3 tonne and above load. The projected

volumes were incorporated/utilised to obtain the total cumulative number of equivalent standard axles expected over 30 year period.

3000: Engineering Surveys & Investigations

The Consultant has carried out engineering Surveys investigations that includes Topographic Surveys, Road Inventory and Pavement Condition Surveys, Alignment Studies, Initial Environment Screening and Assessment, Social Screening Assessment; Pavement related aspects, Material Surveys, Condition Surveys of existing Bridge/culverts and other structures. The field studies were performed as per the stipulations of the TOR which are quite elaborate and self-explanatory.

3100: Reconnaissance and Alignment

Reconnaissance of the project road and corridor has been carried out by the team of experts after the contract of signing agreement. The data and information collected during field reconnaissance covered the following aspects:

- Terrain;
- Land-use;
- Major Rivers;
- Water Bodies near the project road, if any
- Forest area and/or Ecologically sensitive areas;
- Places of importance; and
- Congested areas.

Based on a preliminary study of the available data, maps (topographic, geology) and images supplemented by the general impression derived from the visits along the Project Road, planning for survey and investigations have been carried out.

3200: Topographic Survey

The complete methodology adopted for conducting topographical survey for the project road comprises of the following activities:

3210: Establishment of Main Control by DGPS

a) Fixing Monuments

Keeping in view the importance of stability of control points, RCC pillars of size 15cm x 15cm x 45cm with an iron pin fixed at top centre of each pillar were got pre-casted and after curing got embedded in ground projecting 15cm above ground level. The balance 30cm was embedded in concrete with cement concrete layer all round to ascertain stability of the pillars. The top 15cm of pillar was painted yellow. All pillars were uniquely numbered with red paint. The locations of pillars were arranged in such a way that twin inter-visible points about 200-250m apart are available at an interval of every 5km along the entire stretch. Pair of twin GPS pillars has the advantage that every 5 km stretch can be independently used for starting and closing the traverse by total station. This 5km traverse can be adjusted

and independent detailed survey can be carried out. The location of pillars is selected preferable in ROW at safe place which have no disturbance during construction.

b) GPS Observation

For the purpose of fixing starting control point to the best possible absolute accuracy, GPS observations were taken near the beginning of the project for a period of 5-6 hours. Based on such long observation, the coordinates of beginning point were computed in Single point positioning mode. Accepting this as the fixed point, the other points were observed in continuity and computed in 'base line'mode.

The GPS at all other points were carried out by the observation taken for a point of 45 minute to one hour for a base line of 5 km depending upon the availability of the satellites. Two GPS receivers were used for recording simultaneous satellite signal at both ends of the base line. Observations were taken in a Leap- Frog method using dual frequency Leica GPS receivers.

c) GPS Data Processing

GPS field observations were downloaded into the computer every day and the data was processed using Leica Geo-office software in base line mode. On successful computation of the base line, the Latitude and Longitude of each point of the base line were stored in the database. These latitude and longitude values were suitably projected on a plain surface to get X and Y grid coordinates of all GPS control points using the Universal Transverse Mercator (UTM) Projection.

3211: Establishment of Secondary Control Points by total Station Traverse

Secondary Control points/ Bench Marks have been fixed at an interval of 250m by embedding RCC pillars of same specifications as GPS pillars. All the pillars have been uniquely numbered by red paint.

After fixing secondary Control points, traverse observation were carried out with total station starting from one pair of GPS control points and closing at the next pair of GPS control points connecting all secondary control points in between them. These traverse observations were processed using standard method to compute the coordinates of all subsidiary control points thus establishing the secondary Control points network. The closing error of the traverse line was checked, to fall within permissible limits of 1:10000 and error as such was suitably adjusted to get the final X and Y coordinates of the subsidiary points.

3212: Establishment of Bench Marks by Digital Level

The elevations (Z value) of all the GPS control pillars as well as secondary control points were established by carrying out levelling from a GTS Bench mark already situated on project corridor. The project corridor connects another project enroute i.e. Tadubi – Toloi – Ukhrul, NH-112A at Tadubi. The levels are taken from the junction at Tadubi GPS – 114A & GPS-114 as 1692.528 and 1691.345 respectively. This level was connected to the available GTS BM at Ukhrul.

Double tertiary levelling was carried out by two levelling teams in fore and back direction using Digital Levels connecting all intermediate GPS and Traverse control points to establish accurate MSL height of all the control points.

Height (Z value) of all GPS control points obtained from GPS observation and traverse control points obtained by Total Station traverse were replaced by their respective levelling heights before using these control points for detailed Topographical Survey.

3220: Longitudinal and Cross Sections

The scope of topographical survey for this stretch of road encompasses creation of digital terrain model (DTM) using most modern methods. The main objective of the survey is to acquire terrain data for creation of accurate model required for final design of the road including production of cross sections, longitudinal sections and other relevant designs.

Survey for all details in the project corridor has been carried out using Total Station so as to get X, Y, Z co-ordinates of all details falling in the corridor of survey. The detailed field survey essentially includes the following:

i) Surveys for the existing road, berms, ditches and right of way pillars, KM stones, hecto-meter stones and all other relevant features will be connected with the existing road
ii) Details of all physical features along the alignment will be collected. These will include buildings, structures, monuments, burial grounds, cremation grounds, place of worship, railway lines, streams, rivers, canals, sewers, gas/oil pipe crossings, trees with girth greater than 0.3 m, plantation, services such as electric and telephone lines (overhead and underground), poles, etc.
iii) Normally the surveys will extend 30m on either side of existing centre-line of road or upto road boundary/building line from the existing centre line. For section of realignment/ bypass adequate width will be covered to meet the requirement of new ROW.
iv) Where existing roads/railways cross alignments, the survey extends to sufficient length and width to allow improvements, including at grade intersection to be designed.

Information collected during survey has been shown on plan and profile drawings so that the proposed improvements can be appreciated and with the land acquisition requirement, utility removals of each type can be assessed and suitable action can be initiated.

Topographical surveys for longitudinal and cross sections conform to the following: -

i) Longitudinal section level along final centre line at every 25 m interval and at the locations of curve points, small streams, intersections and at the locations of change in elevation have been taken, wherever possible.
ii) Cross sections at every 25/50 m interval in full extent of survey covering sufficient number of levels on existing carriageway for profile correction course and adjacent ground for widening purposes and earth work calculations.
iii) Longitudinal sections for cross roads for lengths adequate for design and quantity estimation purposes.

iv) Longitudinal and cross sections for major and minor streams as per recommendations contained in IRC

Topographical surveys for additional areas around bridge sites and road intersection points have been carried out so as to enable proper designing of bridges and junctions.

The above data was then made available to the digital format (X, Y, Z and feature code) for preparation of DTM (digital terrain model). Information of the right of way (ROW) was also collected so as to enable designing of the road alignment and to access quantity of land acquisition.

3230: Details of Utility services & Other Physical Features

During the topographic survey and road inventory survey, details of all important utility services and other physical features were collected along the project road. The utility services include buildings and structures, monuments, burial grounds/cremation grounds, if any, places of worship, railway lines, water pipelines, sewer, gas/oil pipelines and crossings, trees, plantations, electric and telephone lines (overhead and underground), poles, optical fibre cables (OFC) etc. which may require shifting at the time of execution.

The information collected during field surveys have been shown on plan and profile so that the proposed improvements can be appreciated and the extent of land acquisition with utility removals of each type can be assessed and suitable action can be initiated.

3240 Identification of Sliding & Sinking zone

During the reconnaissance survey of the alignment, the stretches affected by sliding and sinking have been specifically identified in detailed to be subsequently investigated by an Expert Team.

3300: Road and Pavement Investigations including Pavement Design

3310: Road Inventory

The Consultant carried out detailed field studies in respect of road inventory. The survey was carried out by visual observations supplemented with simple measurement. Detailed road inventory surveys were carried out to collect details of all existing road and pavement features along existing road sections including the following:

- Terrain
- Land-use
- Carriageway and Shoulder details
- Embankment and/or cut
- Land width, ROW
- Road intersection details
- Existing utility services
- Any major features

The data has been collected in sufficient detail and has been compiled in tabular as well as graphical form. It is stored in computer using utility packages as EXCEL. It will be submitted as annexures to Feasibility Report.

3320: Pavement Investigation and Pavement Design

3321 General

As part of the feasibility study, the consultants conducted pavement evaluation study of the existing road. The pavement evaluation enables us to know the pavement structural strength and involves investigation of the existing road pavement, analysis of sub-grade characteristics and strength properties of constructions materials. The consultant also undertook pavement design for rehabilitation of the existing pavement and new pavement design for selected weak stretches or realigned portion along the project corridor meeting the design requirements.

3322 Adopted Methodology for Feasibility Study

The methodology adopted for this study as per Terms of Reference (TOR) include the following:

Investigation for existing Pavement Composition: Test pits were dug at every 1000 m interval (and every change of features whichever is earlier) along the project corridor to obtain pavement composition details such as:

- Sub-grade characteristics.
- Test pit reference
- Pavement composition layers, material type and thickness of each such layer.

Road and Pavement Condition Surveys: Detail field studies were carried out to collect data on road and pavement surface condition. The objective was to identify defects (surface distress type and extent) and sections with similar characteristics. All observed defect types were systematically referenced, recorded and quantified for the purpose of determining mode of rehabilitation. The pavement condition survey was carried out using visual inspection means. The data so collected covered:

- Pavement condition (surface distress type and extent)
- Shoulder condition
- Embankment condition
- Drainage condition.

Pavement Investigation for:

a) **Sub-grade characteristics.**
b) **Structural strength of existing Pavement.**

- Test pits that were dug up to obtain pavement composition details were also utilized for in-situ soil samples collection and their evaluation of sub-grade properties in the soil laboratory by carrying out following Laboratory tests.
    - In-situ density and moisture content

- Grain size and Atterberg limits
- Laboratory moisture-density characteristics
- Laboratory CBR

- Structural strength evaluation studies for the existing two-lane/Intermediate lane/single-lane pavement of various sections of the project road were carried out using Benkelman Beam Deflection (BBD) technique in accordance with the CGRA procedure given in IRC: 81-1991 ("Guidelines for strengthening of Flexible road Pavement using Benkelman Beam Deflection Technique"). Deflection surveys were carried out as per the terms laid down in the TOR. BBD tests were not carried where existing pavement sections were found severely distressed warranting reconstruction.

Adopted Methodology for Pavement Design

The methodology adopted for pavement design as per the Terms of Reference (TOR) include the following:

Detailed Design of Pavement

The detailed design of pavements involved the following:

i) Strengthening of the existing weak pavement section by providing OVERLAYS.
ii) Design of the New Pavements- new 2-lane carriageway (Reconstruction/realigned section of road) and widening of retained Intermediate lane/single lane road sections.

Design Standards for Pavement Design

The design standards followed are:

i) Overlay design undertaken as per IRC: 81-1997
ii) The new flexible pavement design as per IRC: 37-2012

Design Traffic

For pavement design, the information is required with regard to the parameters such as the volume of traffic, growth rate and axle loads spectrum (and configuration) that are expected to use the proposed facility during its design life.

i. Cumulative Number of Standard Axles

The design traffic is considered in terms of cumulative number of equivalent standard axles to be carried during the design life of the road. Design traffic is computed using the following equation:

$$N = \frac{365*\{(1+r)^n - 1\}}{r} \times A \times LD \times VDF$$

Where,

N = Cumulative number of standard axles to be catered for the design life in terms of msa.
r = Annual growth rate of commercial vehicles

n = Design life in years
A = Initial traffic in the year of completion of construction in terms of number of commercial vehicles per day
LD = Lane distribution factor
VDF = Vehicle Damage Factor

ii. Design Traffic

In order to determine the design traffic, volume count surveys were conducted for 24 hours continuously for 7 days along the Project Road. Traffic for pavement design purpose constitutes of commercial vehicles of greater than 3.0 tonnes gross vehicle weight. The base year traffic in different categories for various road sections is estimated and projected by adopted growth rates for the entire design period and presented in Traffic Survey and Analysis Chapter.

iii. Design Lane Traffic

Project Road is improved as NH double lane with paved shoulder facility. Therefore Design lane traffic is determined by application of:

- Directional Distribution factor of 0.5, and
- Lane Distribution factor of 0.5 for two lane single carriageway

The above values are considered as per IRC 37-2012.

iv. Vehicle Damage Factor

The value of Vehicle damage factor (VDF) has been determined on the basis of the comparison of VDF values obtained from axle load surveys carried out for the project road (Chapter on Traffic Surveys and Analysis), Theoretical analysis of future Overloading Characteristics of commercial vehicles and VDF values given in IRC: 37-2012.

v. Selection of Optimum Homogenous Sections

To delineate the project corridor into homogenous sections and to evaluate sections requiring reconstruction and strengthening, the following parameters were considered while analysing the data.

a) Representative soaked CBR of existing Subgrade and degree of compaction
b) Composition of existing pavement
c) Characteristic deflection
d) Existing pavement condition and
e) Design traffic

Accordingly, the homogeneous sections adopted for pavement design are as follows:

Sl. No.	From	To	Start (km)	End (km)	Length (km)
1	Kohima	Tadubi	185+540	219+600	34.06
2	Tadubi	Senapati	219+600	259.250	39.6
3	Senapati	Kangpokpi	259.250	275+700	16.5
4	Kangpokpi	Imphal	275+700	311+082	35.3

Design Life

The ***Design Life*** for the project has been considered as 15 years for Granular Sub-base, Base and Asphalt surfacing.

Design Methodology

The design methodology included the following:

Design Process: The design process followed both for rehabilitation and new construction is comprehensively presented in Flow Charts 1 and 2.

Design Inputs: Following design inputs have been considered while carrying out pavement design.

A. **OVERLAYS for rehabilitation of existing pavement:**

i) Characteristics Deflection: as found during BBD tests carried out on the pavement surface

ii) **Design Traffic (MSA):** Design traffic estimated for Design life of project corridor for the design of OVERLAYS for strengthening of existing weak pavement sections.

iii) Design of Overlay: As guided in IRC: 81-1997.

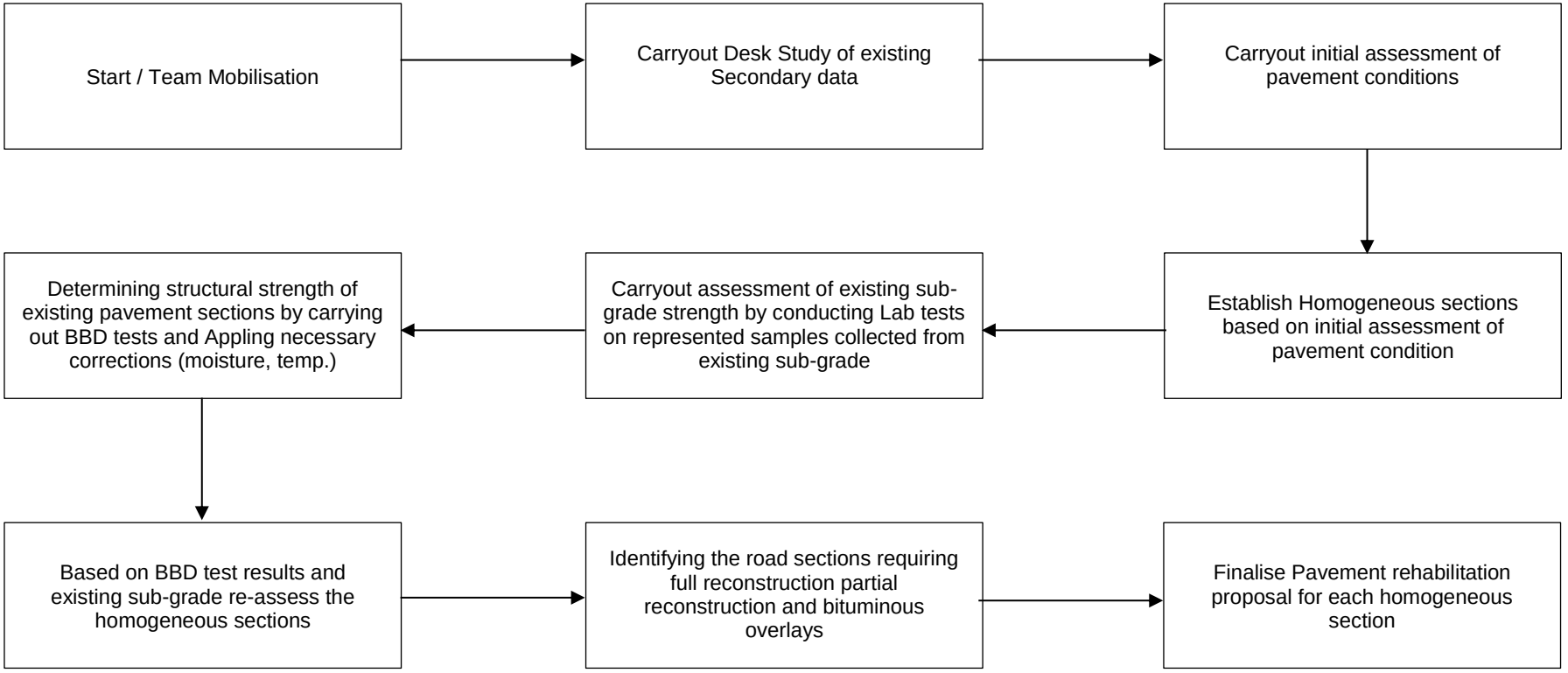
B. **Flexible Pavement for new construction:**

i) Design Sub-grade strength: Design sub-grade strength in terms of 4-days soaked CBR has been adopted in the design.

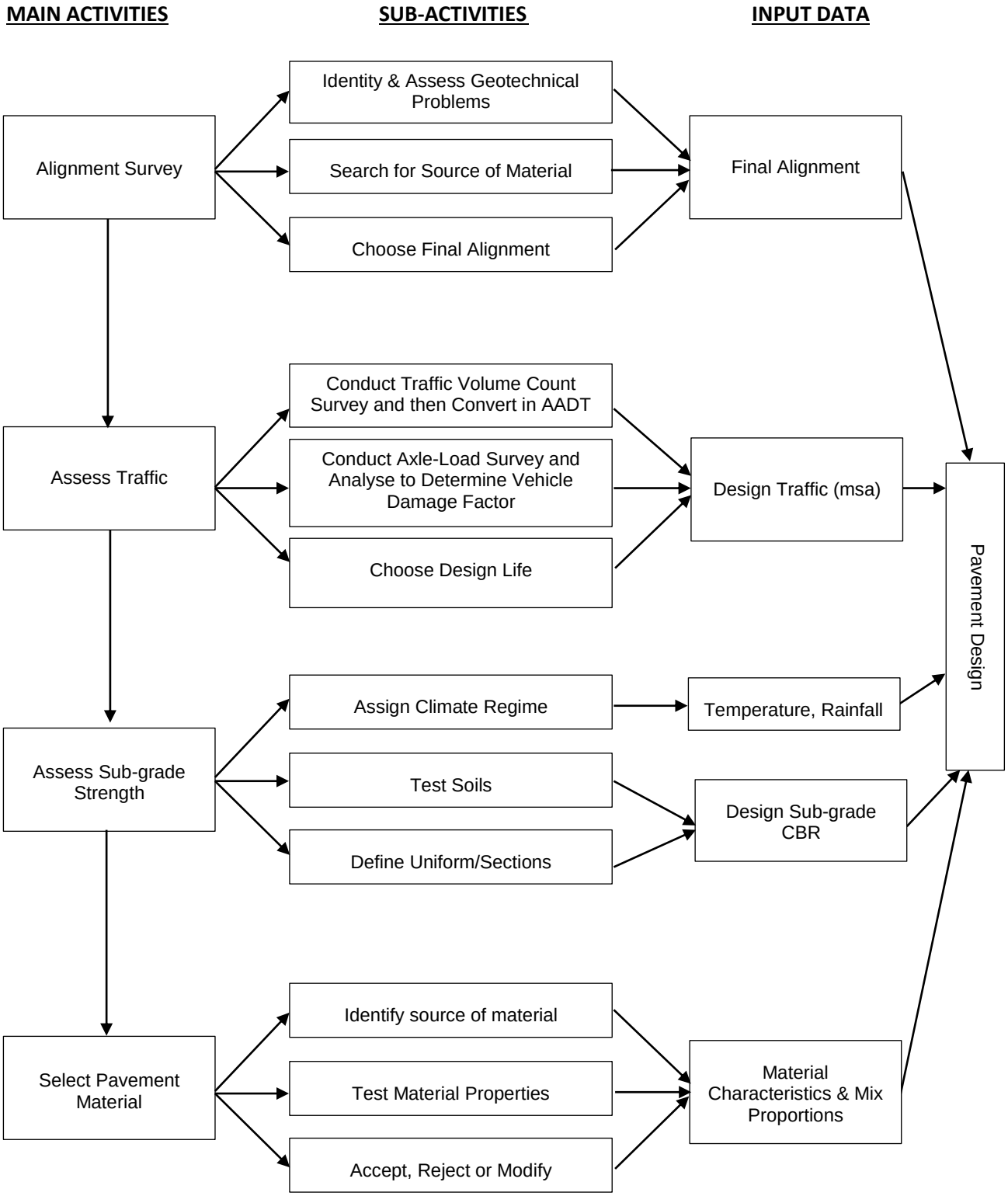
ii) Design Traffic: The design traffic (msa) for each traffic homogeneous section has been estimated considering 15 years as design life in Million equivalent standard axles (8160 kg) after taking into consideration the VDF as found from Axle Load survey data, directional distribution factor and the lane distribution factor.

Based on the traffic loading (MSA) and subgrade strength (CBR), the design thickness including composition of pavement is determined using IRC: 37-2012 guidelines for flexible pavement design for each homogeneous section. The composition of pavement has been recommended keeping in view the construction and maintenance.

FLOW CHART-1: PAVEMENT EVALUATION AND REHABILITATION



FLOW CHART-2: PAVEMENT DESIGN PROCESS



3330 Investigation of identified Sliding & Sinking zone by an Expert Team

An expert team shall be deputed to visit identified affected stretches and investigate the various causes and suggest the necessary treatment.

3400: Investigations for Bridges/Structure

3410: Inventory and Condition Survey for Bridges, Culverts and Structures

Detailed inventory of bridge, culverts and other cross drainage structures were carried out mainly by visual means, with the use of standard tools, such as tapes, folding rules, chipping hammers and binoculars.

The condition surveys of all the culverts and other cross drainage structures were also carried out.

Relevant proforma for the above condition surveys for all the major and minor bridges, and culverts were presented as annexure to Feasibility Report. The above proforma for the bridges and culverts adequately cater for the recording of the locations and the extents of the defects/damages, along with the remedial measures suggested by the official who inspected the structures.

3420: Hydrological Investigations

Hydrological investigations have been undertaken for the location of new bridges and inadequate / distress bridges. The consultants are trying to collect data/information on Full Supply level (FSL), Low water levels (LWL), Discharge and maximum velocity from past records of Irrigation Department.

3430: Geo-technical Investigations

Detailed Geotechnical and sub-surface investigations conforming to the established standards have been carried out as per the TOR at necessary locations.

The sub-soil investigations will be carried out for finalizing the span arrangements and designing the foundations for bridges/flyovers. The data of particular importance for the design of structures include:

- Soil profile;
- Soil parameters;
- Foundation strata;
- Safe bearing capacity; and,
- Rock strata

The strength of soil layers will be evaluated in the field using SPT tests. The laboratory testing of soil samples will normally include:

- Soil characterisation (grain size distribution and Atterberg Limits);
- Moisture content, natural density and chemical tests;

- Shear strength parameters; and,
- Consolidation parameters.

The parameters for design will be selected after careful consideration of the engineering strength values and geological information. Sub-soil investigations will be done as per IRC 78-2014. For proposing fill materials behind the abutments requisite tests will be done.
The scheme for bore hole locations and depth of boring will be prepared by the Consultant and submitted to the client for approval and will be finalized in consultation with client.

3500: Material Investigations

The Consultants has identified the sources of quarry sites and borrow areas as suggested in TOR. Test pits were dug at 0.5m to 1m depth in the borrow areas from where the embankment material is decided to be obtained. The borrow areas adjacent to the right of way and off-road locations has been primarily explored.

Sufficient samples were taken to get strength results for soils demarcated on the basis of expected similar performance. The tests include Gradation Test, Atterberg Limits, Swell Index, deleterious constituents and density-moisture relationship. Laboratory CBR (4 days soaked) at OMC and modified AASHTO density (IS 2720-Part 8) was also determined for use of material in sub grade. Three samples were tested under the same condition for determination of CBR and the tolerance prescribed in IRC/BIS codes was adhered to.

Gravel quarries were investigated and tested in laboratory to establish their suitability as sub grade/ sub base material. The test includes:

- Grain size and Atterberg limits
- Density – moisture content relationship (modified AASHTO)
- 4 days soaked CBR (3 samples per set) (modified AASHTO compaction).

The investigation for hard stones comprised qualitative and quantitative assessment of potential quarries and determination of their suitability for use in:

- graded crushed stone base and sub-base
- bituminous base and wearing courses; and,
- Concrete works.

The potential sources of hard stone samples for ascertaining their suitability in road construction and concrete works includes:

- specific gravity;
- water absorption;
- Los Angeles Abrasion Value (LAV)/Aggregate impact value (AIV);
- Bitumen affinity and stripping value;
- Chemical tests (total soluble salts, chloride content, sulphate content, alkali-silica reaction); and,
- Sodium sulphate soundness.

Potential sources of sand were identified. The testing for sand samples in the laboratory includes.

- Grain size analysis;
- Sand equivalent; and,
- Chemical tests (sulphate and chloride)

For each of the borrow pits, quarry and source identified, the Consultants determined:

- Location and extent;
- Material type;
- Overburden type and depth;
- Depth of weathered mantle; and,
- Quantity available

Each potential borrow area and source were assigned a unique code number for easy reference. The material investigation aspect includes preparation and testing of bituminous and concrete mixes using suitable materials.

4000: Detailed Engineering Design

4100: Design Standard

Geometric Design Standards

Geometric design is the process whereby the layout of the road in a terrain is designed to meet the needs of the road user. The Principle elements of this process are the selection of suitable design speed, horizontal and vertical alignments and road and shoulder widths. The geometric design standards provide the link between the cost of building the road and the costs to the road users. Usually, the higher the geometric standard, the higher the constructions cost and lower the vehicle operating costs and road accident costs.

The design standards to be adopted for the study have been evolved on the basis of a study of the existing standards and practices in the country keeping in view the standards recommended by IRC:SP:73-2007 and are dealt with in details in Chapter 2 of Volume II- Design Report with this drfat DPR submission.

Pavement Design Standards

The design standards for pavements have been evolved on the basis of recommendations currently in practice in the country and also those contained in IRC standards and other international practices and are already explained in para 3322 above.

Bridge Design Standards

The design standards for bridges have been evolved on the basis of recommendations concerning loading and material strength characteristics contained in the current bridge design

practices in the country and those contained in IRC Standards. Typical references generally used in Bridge Design are:

IRC:5-1998	Standard Specifications & Code of Practice for Road Bridges, Section-I, General Features of Design
IRC:6-2014	Standard Specifications & Code of Practice for Road Bridges, Section-II, Loads and stresses
IRC:78-2014	Standard Specifications & Code of Practice for Road Bridges, Section-VII, Foundation and sub-structure
IRC:83-1999	Standard Specifications & Code of practice for Road Bridges, Section-IX, Bearings, part-I; Metallic Bearings(First Revision)
IRC:83-2015	Standard Specifications & Code of practice for Road Bridges, Section-IX, Bearings, part-II, Elastomeric bearings(First Revision)
IRC:112-2011	Code of Practice for Concrete Road Bridges
IRC:83-2002	Standard Specifications & Code of practice for Road Bridges, Section-IX, Bearings, part-III,POT, POT-CUM-PTFE, PIN AND METALLIC GUIDE bearings
Reinforced Concrete Engineers handbook by Reynolds	

4200: Geometric Design & Embankment Design

The design of horizontal and vertical elements has been carried out as per the design standards evolved under task 4100 taking into consideration, the specific site conditions, aesthetics and economics. Major aspects which are relevant in respect of the geometric design of highway include:

- Smooth curves will be provided and the sharp curves will be avoided.
- For small deflection angles, the length of curves will be sufficiently long so as to avoid the appearance of kink;
- An abrupt reversal of alignment will be kept to a minimum; and,
- Proper co-ordination between the horizontal alignment and vertical profile will be aimed at and achieved.
- The existing steep gradients

A liberal approach has been adopted for geometric design, wherever possible. The basic philosophy was that the geometric and cross-sectional elements were so designed that future geometric improvements are possible and the construction works do not cause much inconvenience to traffic flows during the implementation phase.

The Consultant carried out detailed analysis and design for all embankments of height greater than 6m based on relevant IRC publications. Embankment design will provide for maximum utilization of locally available materials consistent with economy.

4300: Design of Bridges and Structures; Drainage System

According to the conceptual design of various improvement proposals, the consultant has identified the tentative structural arrangement of Bridges for the project road section. The Consultant also prepared General Arrangement Drawing (GAD) supplemented by preliminary design for of all structures. Dismantling / reconstruction of existing structure have been avoided as far as possible except where considered in view of poor structural condition and inadequate carriageway. The design has been done considering following:

- use of modern construction technologies, such as precasting, composite constructions etc.,
- adequate diversion facility during construction,
- minimal maintenance costs,
- topographical and geotechnical characteristics of the embankments,
- aesthetic requirement, and
- cost considerations

Consideration has been given as far as possible to the possibilities of standardisation of structures and adoption of the construction methods to the practices in India, in accordance with acceptable international practice.

General arrangement drawings have been prepared which is suitable for preliminary quantity estimates. The consultant will carry out the structural design for the bridges as will be required including design of foundations, geometric features and typical sections.

The drawings include sufficient details suitable for estimating, bidding and construction purposes.

The General Arrangement Drawings (GAD) has been prepared and the same was done in accordance with design standards under Task 4100, the relevant IRC and Bureau of Indian Standards Codes:

- Geometry;
- Preliminary Structural design of Bridges components;
- The following types of loading will generally be considered while evolving GADs
    - Dead load;
    - Superimposed dead loads;
    - Live loads with impacts
    - Wind loads and seismic effects;
    - Temperature forces;
    - Water current forces if any; and
    - Earth pressures

The design of longitudinal and sub-surface drainage is based on:

- Site conditions;
- Topographical information including longitudinal profile characteristics;
- Location of cross-drainage;
- Soil type; and
- Pavement composition

The basic philosophy for design was to provide the road-side drains of adequate size, shape and type so as to drain road surface run-off most efficiently. Safety considerations was also given due attention in the design.

4400: Traffic Safety

Suitable designs has been furnished for traffic safety features and road furniture including traffic signals in urban areas, signs, markings, overhead sign boards, crash barriers, delineators, fencing in selected stretches etc. Generally, IRC guidelines and MORT&H Specifications will be followed. The locations of these features will be given in the reports and also shown in the drawings.

4800: Estimation of Quantities & Project Cost

Based on the designs and drawings, preliminary bill of quantities has been prepared by the consultants as under:

- Detailed and general items;
- site clearance and earthworks;
- sub-base, base and surfacing courses;
- drains, culverts and protection works;
- bridges and culverts;
- road furniture;
- ancillary works; and
- miscellaneous items of works

The format for bill of quantities was as adopted by the consultants for similar type of National Highway projects in India.

Cost estimates for entire project (civil package wise) will be prepared. The quarry charts form part of the cost estimates. The unit rate of all items of work has been prepared as realistically as possible, taking into account the expected leads for earthwork and other structural materials as obtained from soil and material investigations. The prices of materials like cement, steel, bitumen etc. and labour are based on market rates. Consistent with the high qualitative standard of the facility, the consultants considered mechanised construction methods for the analysis of unit rates. Rate analysis for various items for roads & bridge works has been worked out based on the co-efficient for labour, material, machinery etc., as adopted in the “Updated Standard Data Book for Analysis of Rates”.

With the unit costs derived as explained above and the quantities developed by detailed engineering design activity, the project base costs have been worked out.

3.6. DELIVERABLES

3.6.1. Inception Report

The Inception Report with Quality Assurance Plan has already been submitted.

3.6.2. Feasibility Study Report

This report includes Project description, GAD of Bridges and Structures, Typical cross section of Project proposal, Traffic survey and analysis, Environmental screening and preliminary environmental assessment, preliminary land acquisition plan, cost estimate and economic analysis.

3.6.3. Preliminary Project Report

The Preliminary Project Report will include the following:

Volume – I	Preliminary Design Report - Includes Project description, Summary of EIA/IEE and Action Plan, updated cost estimate and economic analysis and suggested method of procurement and packaging
Volume – II	Design Reports - Includes Road & bridge Inventory, Findings of Survey and Investigation, Design basis and Specifications, Pavement design and Preliminary structure design
Volume – III	Drawings
Volume – IV	Environmental Impact Assessment Plan

The Consultant will submit 4 copies of the Draft Preliminary Project report and 6 copies of Final Preliminary Project reports to the Client.

3.6.4. Detailed Project Report

The Detailed Project Report will include the following:

Volume – I	Main Report
Volume – II	Design Reports
Volume – III	Material Report
Volume – IV	Environmental Assessment Report
Volume – V	Technical Specification
Volume – VI	Rate Analysis
Volume – VII	Cost Estimate
Volume – VIII	Bill of Quantities
Volume – IX	Drawings
Volume – X	Civil Work Contract Agreement

The Consultant will submit 4 copies of the Draft Detailed Project report and 6 copies in bound volume of Final Detailed Project reports to the Client.

CHAPTER-4 ENGINEERING SURVEY AND INVESTIGATIONS

4.1. GENERAL

This chapter deals with the Field studies involving Engineering Surveys & Investigation conducted on the project road to gather the data and information required for Feasibility study as per TOR. The aim of these surveys is to capture adequate database so that a feasible project proposal which is functionally and structurally efficient and sound in nature as per site condition with adequate safety requirement for road users is prepared conforming to the requirement of TOR.

4.2. PRIMARY SURVEYS AND INVESTIGATIONS

Based on the reconnaissance survey, the engineering surveys were conducted in line with the specification laid in IRC:SP:19-2001. The field surveys and investigations carried out in this Study are:

- Inventory & Condition of Road, Culvert, Bridges and Structures
- Topographic Survey
- Pavement Investigations (Trial Pit Investigation, Soil & Material Lab Testing and Deflection Survey)
- Traffic Surveys (traffic volume count, O-D Survey, turning movement and Axle load Survey)
- Geotechnical Investigations
- Environmental and Social Surveys

Traffic studies carried out by the consultants include 7 days 'Classified Volume Count', 'Origin – Destination Survey', 'Axle Load Survey' and 'Turning Movement Survey' etc., and reported in details with analysis and findings in "Chapter – 4: Traffic Surveys and Analysis"of Volume 1: Preliminary Design Report of this submission.

4.3. SECONDARY SURVEYS/DATA COLLECTION

Consultant collected all relevant data from respective State PWD/Authorities and studied the data in detail keeping in view of the carried out reconnaissance survey earlier. The consultant also made an in-depth desk study of the available maps so as to make an overall assessment of road condition, geometry, topographic features, drainage characteristics and ROW constraints. Consultative meetings were also held with State Govt. officials while collecting secondary data.

Collection of underground /over ground utility details of water lines; electric line and poles, telephone lines & sewerage lines (if any) etc., were collected from various concerned agencies and incorporated in the survey plan to ascertain necessary remedial measures.

4.4. APPROACH FOR FIELD INVESTIGATIONS

The consultants adopted a sound engineering approach based on a clear understanding of the Terms of Reference (TOR) and the relevant planning and systems approach.

The Team: The consultants selected key and sub professionals from a pool of engineers with extensive experience in the fields of planning, programming field studies and investigations, design for major highway projects. The selected personnel have wide exposure in international and domestic projects.

Communication: Consultant had series of Consultative meetings, discussions and site visits in order to get details of project, constraints and other relevant first-hand information. Consultants have maintained close and efficient communication with NHIDCL, PWD and NH Wing of Manipur & Nagaland and other concerned departments and agencies and worked as an integral part of the whole system responsible for the successful implementation of the project.

Existing Data and Information: The Consultant carried out a study of all the earlier relevant reports and also the data and information on costs, design standards, traffic loading behaviour, pavement performance, construction and maintenance of roads. Information on the type of material available and feasibility of their usage in the proposed upgradation were also discussed with local agencies.

Reconnaissance and Inventory were carried out along the project road corridor to have in-situ data & information.

4.5. INVENTORY & CONDITION SURVEY OF PROJECT CORRIDOR

Consultants have carried out Inventory & condition surveys of existing features (Road, Culvert, Bridges and Structures) specific to the alignment in order to assess structural and functional adequacy of the project road.

4.5.1. Road Inventory

A detailed inventory was carried out along the project road corridor in order to collect relevant information in respect of:

- Terrain (plain/rolling/hilly)
- Land-use (built-up/agriculture/forest/industrial/barren)
- Name of village/town/city
- Formation width
- Carriageway details - Type (bituminous/cement concrete/gravel/earthen),layer composition, Width and condition
- Shoulder Type (bituminous/cement concrete/gravel/earthen), Width and condition
- Embankment height/depth of cut
- Cross road details
- Utilities/services/facilities

- Rivers/streams/water courses
- Other environmentally sensitive features
- Misc. items

The road inventory data for the project road length was collected for each kilometre and part thereof as warranted by appreciable change in the physical features. The summary of Road Inventory has been shown in ***Table 4.1*** and detailed Km wise Road inventory has been presented in ***Appendix 2-1*** *of Volume II: Appendix to Design Report*.

Table 4.1: Typical Carriageway width of the Existing Road

Sl. No.	Existing Chainage (Km)		Length (km)	Carriageway width	Terrain
	From	To			
1	185+540	259+600	74.1	6m-7.7m	Hilly
2	259+600	260+000	0.4	20m	Hilly
2	260+000	266+000	6.0	7.5m	Hilly
4	266+000	304+000	38.0	6.2-7.5	Plain/Rolling
5	304+000	311+082	7.082	2-lanes+ Paved Shoulder	Plain/Rolling
Total length			**125.3**		

A detailed visual pavement condition survey was carried out along the project road corridor in order to collect relevant information about the following:

- Riding quality (good/fair/poor/very poor)
- Pavement condition (Cracking, Rutting, Ravelling, Pot holes and Patching)
- Shoulder condition (fair/poor/failed)
- Embankment condition (good/fair/poor)
- Road side drain (non existing/partially functional/functional)

Visual pavement condition surveys were carried out in the month of April 2016 and supplemented by sample measurements. Additional care/attention was accorded to the sections showing more distresses. The summary of pavement condition is shown in ***Table 4.2*** and detailed km wise condition data are presented in ***Appendix 2-2*** *of Volume II: Appendix to Design Report.*

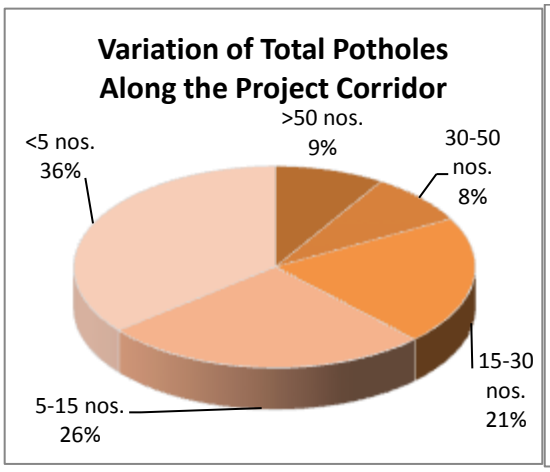
The condition of the pavement is in variable state. Relatively 'Fair' riding surface is seen between Senapati and Imphal. Rest of the stretch is in 'Poor' to 'Fair' or 'Very Poor' condition; in some of the stretches the road is completely distressed. The summary of the visual pavement condition is presented in the table below.

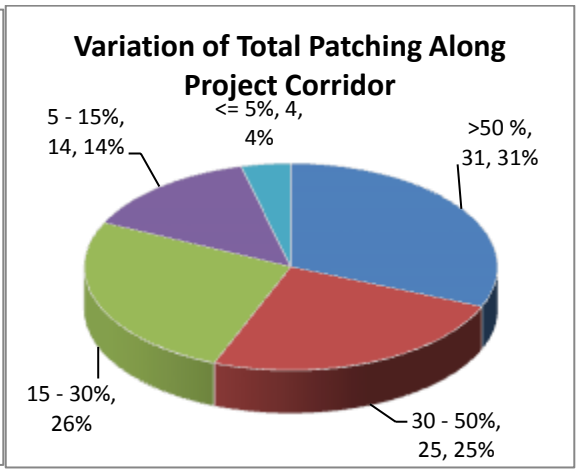
Table 4.2: Summary of the Pavement condition

Sl. No.	Ex. Chainage (Km)		Length (km)	Carriageway width	Pavement Condition
	From	To			
1	185+540	205+800	20.26	2-lane	Good to Fair in Major Portion

Sl. No.	Ex. Chainage (Km)		Length (km)	Carriageway width	Pavement Condition
	From	To			
2	205+800	208+000	2.20	2-lane	Major Pothole, Cracking and Patching. In Some Portion, WBM Exposed.
3	208+000	210+600	2.60	2-lane	Good to Fair in Major Portion
4	210+600	212+600	2.00	2-lane	Major Pothole, Cracking and Patching. In Some Portion, WBM Exposed.
5	212+600	217+800	5.20	2-lane	Good to Fair in Major Portion
6	217+800	231+000	13.20	2-lane	Major Pothole, Cracking and Patching. In Some Portion, WBM Exposed.
7	231+000	235+600	4.60	2-lane	Good to Fair in Major Portion
8	235+600	238+200	2.60	2-lane	Major Pothole, Cracking and Patching. In Some Portion, WBM Exposed.
9	238+200	286+800	48.60	2-lane	Good to Fair in Major Portion
10	286+800	291+400	4.60	2-lane	Major Pothole, Cracking and Patching. In Some Portion, WBM Exposed.
11	291+400	297+000	5.60	2-lane	Good to Fair in Major Portion
12	297+000	303+000	6.00	2-lane	Good, Recently Overlaid by Manipur PWD.
13	303+000	304+000	1.00	2-lane	Major Pothole, Cracking and Patching.
14	304+000	311+082	7.08	2-lane +PS	Good, Recently constructed by Manipur PWD in 2014-15

The overall condition of the pavement throughout the project corridor is 'Very Poor' to 'Fair'. The very common distress types like Cracking, Rutting, Depressions, Sinking & Sliding and Potholes are very common on the bituminous surface along the corridor. Generally, deep rutting (>20mm) was observed at several places in the wheel path involving substantial reach of the project road.





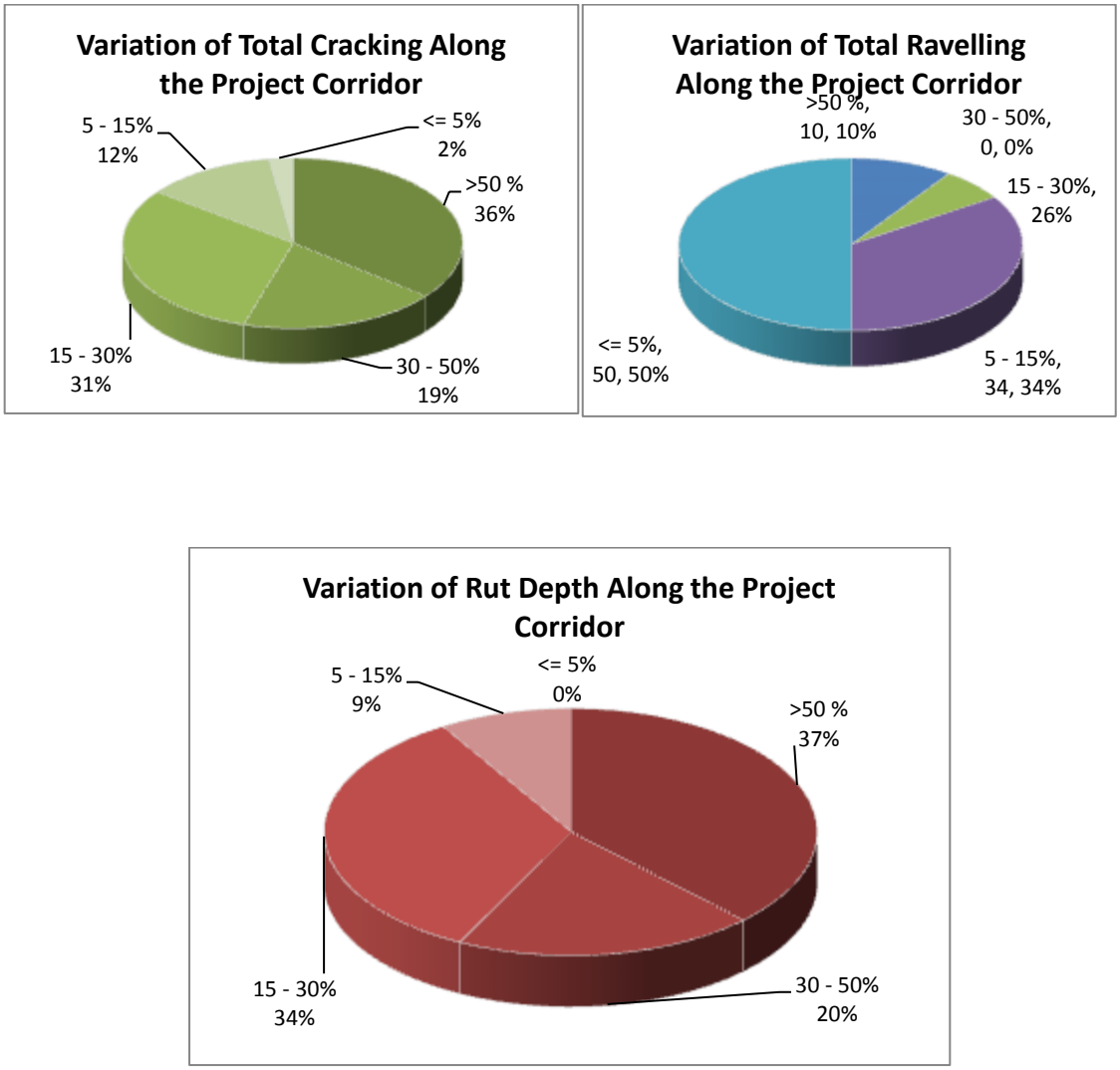


Figure 4.1: Pavement Distresses

All the visual observations/ tests have been conducted in accordance with the applicable National codes and Standards. Where such codes do not exist, the tests have been performed according to international best practices.

4.5.2. Culvert Inventory & Condition Survey

Detailed inventory and condition surveys have been carried out for all the cross drainage structures using visual means supplemented by simple measurements, local inquires and discussions with NH Wing, Manipur & Nagaland & PWD officials. The data so collected have been compiled so as to make an assessment concerning the structural and hydraulic adequacies of the existing cross drainage structures.

Inventory data of cross-drainage structures collected at the site are summarised in ***Table 4.3***.

Table 4.3: Summary of Existing Culverts

Arch		**Slab**		**Slab+Steel**		**Slab+Pipe**		**Pipe**		**BOX**		**Chocked**
Span	Nos.	Span	Nos.	Span	Nos.	Span	Nos.	dia	Nos.	Span	Nos.	Nos.
1.1 - 4.5m	**3**	0.6 - 6.0m	**544**	4.5 - 5.0m	**2**	1.0-2.5m	**3**	0.9 - 1.2m	**212**	1.0 - 2.0m	**8**	**9**

A detailed condition survey for all cross drainage structures were carried out along the project road in order to collect relevant information in respect of:

- Slab/Pipe/Box/Arch
- Head Wall
- Wing Wall/Return Wall
- Parapet/Handrail
- Presence of Scour
- Inlet
- Outlet
- Adequacy of Waterway
- Protection Works
- Special problem, if any

There are total 781 culverts that exist along the project road in a length of 125.5 km. Of these are 212 pipe culverts, 544 slab culverts, 3 slab+pipe, 2 slab+steel culverts, 9 chocked culverts and 3 Arch culverts.

The Condition of most of the culverts is 'Fair' to 'Poor' and cannot be retained. There are 9 culverts found either blocked or waterway is inadequate, where reconstructions have been proposed.

The detail Culverts Inventory and Conditions for package 4&5: Senapati to Imphal section of project road are presented in ***Appendix 2-3*** *of Volume II: Design Report*.

4.5.3. Bridges Inventory & Condition Survey

While carrying out detail inventory, sufficient data were also collected for the existing structures such as minor/major bridges and other structures along the project road corridor in order to collect relevant information in respect of:

- Structure /Bridge No.
- Location (km)
- Type of Structure and details
- Span Arrangement and Total Waterway (no. x length, m)
- Carriageway Width (m)
- Width of structure (m)

The bridge condition survey was planned and carried out so that both qualitative and quantitative aspects of the distresses/deficiencies could be examined. Conditions of the following components of the bridges were evaluated:

- Wearing coat, kerb, footpath and railing;
- Expansion joints;
- Drainage system and spouts;
- Reinforced concrete deck with special reference to distresses such as cracking, leaching, spalling of soffit and edges;
- Exposed reinforcement and corrosion;
- Bearings;
- Abutments, piers, wing walls and return walls;
- Hydraulics with special reference to adequacy of waterway, change in flow pattern, erosion/degradation of bed/banks and condition of protective works.

The structural and other details of the bridges including the conditions are presented in Bridge Inventory and Condition Survey in ***Appendix 2-4*** *of Volume II: Appendix to Design Report*.

4.6. TOPOGRAPHICAL SURVEY

Topographic survey was carried out using sophisticated instruments i.e. Global Positioning System (GPS), Total Station, Digital Level and Auto Level. The procedure adopted for carrying out topographic survey is such that will result in the expeditious development of a computer based terrain model of the accuracy required for the design of the proposed upgrading.

Detailed topographical survey of all natural and manmade topographical features on both side of centre-line was carried out by picking up their X, Y and Z coordinates using Total Stations having automatic data recording devices with appropriate features codes attached to each point. In general, these include:

- Road Centre-line
- Pavement edges
- Outer Shoulder edges
- Existing retaining walls/breast walls
- Toe lines of fills and cut
- Longitudinal and Traverse drain / ditches

All man-made and natural topographical features were surveyed, including:

- Water sources, rivers
- Structures
- Buildings
- Utilities

At locations, where existing project road alignment cross other roads, the survey was extended to 100-150m on either side of the road centre to allow the geometric improvements. Cross-sections at every suitable interval were also taken using Total Stations.

Based on the detail reconnaissance as well the project requirement and detail discussion with the client officials, the need for realignment was finalized considering the following.

- To minimise steeper gradient
- To minimise huge cutting
- Fluency of the geometry
- Availability of land
- Minimum constraints

Accordingly, the topographic survey was carried out on the re-alignments identified along the corridor for upgradation of existing road as 2-lane with paved shoulder/4-lane divided carriageway configuration.

The data collected from the topographic surveys was processed through road design software "Mx Road". The GPS points established along the project road are presented in ***Table 4.4.***

Table 4.4: GPS Details along the Project Road

S. No.	*Northing (Y)*	*Easting (X)*	*RL (m)*	*GPS Station ID*	*Existing Chainage (Km)*	*Distance from Ex.CL*	*Side*
	Package 4: Senapati to Saparmeina						
1	2791187.905	601130.217	1119.334	10	264+912	26	RHS
2	2791032.143	601140.139	1126.801	10A	265+069	24	RHS
3	2787293.175	599852.99	1149.682	9	269+219	43	RHS
4	2787212.119	599785.717	1151.323	9A	269+309	89	RHS
5	2781723.876	597928.963	1040.173	8	275+247	111	LHS
6	2778272.052	596650.965	993.348	7A	278+965	53	RHS
7	2778159.407	596556.94	988.664	7	279+115	79	RHS
8	2773416.031	594327.411	955.659	6	284+421	89	LHS
9	2773370.237	594254.3	955.395	6A	284+510	45	LHS
	Package 5: Saparmeina to Imphal						
10	2768662.401	593397.88	920.381	5A	289+599	32	LHS
11	2768478.677	593355.645	918.729	5	289+785	42	LHS
12	2763325.355	589950.373	902.914	4A	296+346	66	LHS
13	2763276.523	589912.166	903.604	4	296+402	39	LHS
14	2759836.063	589170.817	849.154	3A	299+749	73	LHS
15	2759639.315	589134.457	847.514	3	299+947	81	LHS
16	2755189.348	589213.179	828.733	2A	304+716	43	RHS
17	2755111.068	589241.563	828.381	2	304+799	46	RHS
18	2752902.325	592530.248	817.407	1A	310+306	581	LHS
19	2752830.339	592513.053	817.065	1	310+311	507	LHS

4.7. PAVEMENT INVESTIGATION SURVEY

Pavement investigations involved establishing the adequacy and effectiveness of in-service pavement to undergo the traffic loading and identifying potential sources of construction material in the near vicinity of the project corridor. These investigations would involve collecting data on existing pavement crust, sub-grade, embankment, and locally available material for construction and examining their suitability.

The tasks involved were visual estimation of the various distresses (cracks, edge drops, roughness, sinking and sliding zones etc.), determining residual structural strength by conducting Benkelman Beam Deflection (BBD) test, digging test pits, measurement of field density of subgrade soil using DCP test apparatus, determination of field moisture content and carrying out laboratory tests on field soil samples for soil classification and strength characteristics and clear-cut recommendation in respect of their suitability as subgrade for pavement structure.

The BBD survey analysis is presented in ***Appendix 2-5*** *of Volume II: Appendix to Design Report.* The BBD deflections were not considered because the Cracking and Rutting observed on the project road is more permissible limits, hence the existing pavement composition is considered as failed and no overlay is recommended.

4.8. TRIAL PITS INVESTIGATION

Trial pits were excavated at the pavement/shoulder interface at intervals of 1.0km to determine pavement composition details (pavement course, material type and thickness) and classification of subgrade material. The data would be used to estimate the overlay thickness of the existing pavement if found appropriate for the design. For each trial pit, the following information was recorded:

- ◊ *test pit reference (Identification number, location);*
- ◊ *pavement composition (material type and thickness); and,*
- ◊ *Sub-grade type (textural classification)*.

The details of existing pavement composition obtained from trial pit investigation are given in ***Appendix 3-1*** *of Volume III: Appendix to Material Report* and grouped in ***Table 4.5***.

Table 4.5: Summary of Existing Pavement Composition

Sl. No.	Existing Chainage (Km)		Length (km)	Lane Configurations	Terrain	Bituminous thickness (mm)	Base & Subbase thickness (mm)
	From	To					
1	185+540	219+600	34.1	2-lanes	Hilly	60-200	130-810
2	219+600	259+600	40.0	2-lanes	Hilly	50-150	175-685
3	259+600	260+000	0.4	20m	Hilly	70	460

4	260+000	275+700	15.7	2-lanes	Plain/Rolling	60-130	200-525
5	275+700	304+000	28.3	2-lanes	Plain/Rolling	30-160	220-650
6	304+000	311+082	7.0	2-lanes+ Paved Shoulder	Plain/Rolling	40-130	250-750

4.8.1. Sub-grade Investigation

Sub-grade soil samples were collected from the existing pavement through trial pit excavation at each point, for determination of following characteristics of sub-grade:

- ◊ *soil type (classification and Atterberg limits), and*
- ◊ *in-situ density*
- ◊ *field moisture content*
- ◊ *characterisation (grain size and Atterberg limits)*
- ◊ *laboratory moisture-density characteristics (modified AASHO compaction)*
- ◊ *laboratory CBR (unsoak and 4-day soak compacted at three energy levels)*

The field results obtained from existing sub-grade investigations have been presented in ***Appendix 3-2*** *of Volume III: Appendix to Material Report* and summarised in ***Table 4.6***.

Table 4.6: Subgrade Strength (CBR) of Existing Pavement

Sl. No.	From	To	Start (Km)	End (Km)	CBR of Existing Subgrade (%)
1	Kohima	Mao	185+540	213+500	5.2%- 8.1%
2	Mao	Senapati	213+500	260+000	4.4% - 8.2%
3	Senapati	Saparmeina	260+000	289+000	5.0% - 8.5%
4	Saparmeina	Imphal	289+000	311+080	4.5% - 8.0%

4.8.2. Soil and Construction Material Investigation along the Project Corridor

The main thrust of the soil and material investigation was to ascertain the availability of locally suitable soil and material along the alignment with minimal lead so as to ensure economy and also to avoid time-consuming operation for haulage of construction materials. To ascertain the suitability of locally available soil along the project road for construction of the embankment by testing the soil samples, soil samples were collected all along the project road depending upon the terrain, visible change in soil profile and the site approachability with a special attention to the clayey soils. Soil samples were collected after removing the topsoil to the depth of about one metre to obtain soil free from roots, sods and organic matters.

The soil CBR observed between Senapati to Imphal section of project highway from Barrow areas are in the range of 8.5% to 10%.

Survey for road construction materials such as moorum, gravel, sand and stone aggregate was also carried out. Information regarding the material quarries was collected from concerned Sub-Division & Divisions of State PWD or on going similar road projects in the close vicinity. The location and type of materials availability around the close vicinity of the project road are

collected. The construction material source and its average lead from the project road are presented in ***Table 4.7.***

Table 4.7: Identified Construction Material Sources

S. No.	Village Name	Locations
Stone Boulder/Aggregate Quarry		
1	Bongmol	Ex. Km290+500 of NH-39 +2km for approach
2	Bishama	20km from Km185+540 of NH-39+ 2km approach
	Sekmai bazar	Ex. Km303 of NH-39+2km approach
3	Koirengei	Ex. Km309+700 of NH-39+ 2km approach
Sand/Stone Shingle Quarry		
1	Sekmai Quarry	Ex. Km300+000 of NH-39 +2km for approach
2	Dimapur	80 km from Km185+540 of NH-39

4.9. GEOTECHNICAL INVESTIGATION SURVEY

Detailed Geotechnical and sub-surface investigations conforming to the established standards and as deemed necessary, were carried out as per the Terms of Reference (TOR) for proposed bridges and high embankment locations. The sub-soil investigations were carried out after finalizing the proposal for structures and its span arrangements for designing the foundations for bridges and structures. The data of particular importance for the design of structures include:

- ✓ Soil profile;
- ✓ Soil parameters;
- ✓ Foundation strata;
- ✓ Safe bearing capacity; and,
- ✓ Rock strata

The strength of soil layers were evaluated in the field using SPT tests. The laboratory testing of soil samples normally include:

- ✓ Soil characterization (grain size distribution and Atterberg Limits);
- ✓ Moisture content, natural density and chemical tests;
- ✓ Shear strength parameters; and,
- ✓ Consolidation parameters.

The parameters for design shall be selected during preparation of PPR (Stage 3) after careful consideration of the engineering strength values and geological information. The investigations for high embankment will be carried out as per IRC Special Publications No.75. For proposing fill materials behind the abutments requisite tests will be done. The geotechnical investigations conducted at new bridge locations on project corridor are presented in ***Table 4.8.***

Table 4.8: Bore-Hole Locations for Geotechnical Survey

S. No.	Chainages (Km)			Ex.Bridge Length (m)	Bore Hole			
	GT Report	Ex KM Stone	Design		Side	Numbers	Depth(m)	Total Depth (m)
1	305+500	305+629	302+795	43	RHS	2	25	50
2	299+025	299+015	297+177	6.7	RHS	1	15	15
3	297+970	297+1067	296+209	11.5	RHS	1	25	25
4	297+020	297+007	295+148	26	LHS	1	25	25
5	293+285	293+279	291+276	14	RHS	1	25	25
6	289+985	289+968	288+129	6.7	RHS	1	15	15
7	287+285	287+261	285+450	14.5	RHS	1	25	25
8	286+412	286+410	284+607	6.5	RHS	1	15	15
9	283+543	283+534	281+821	26.5	RHS	1	25	25
10	281+340	281+337	279+642	17	RHS	1	25	25
11	279+350	279+354	277+655	20.5	RHS	1	25	25
12	275+850	275+160		9	RHS	1	25	25
13	274+360	274+647		25.6	LHS	1	25	25
14	Kangpokpi bypass		274+162			1	25	25
15	272+350	272+188	269+986	6.5	RHS	1	15	15
16	263+900	263+900		13.5	RHS	1	25	25
18	Senapati Bypass					2	25	50
19	Sinking Locations					5	50	250

4.10. ENVIRONMENTAL & SOCIAL ANALYSIS

Environmental and Social impact analysis were carried out for the entire length of the project road in conformity to “Term of Reference” and based on the data collected & its findings and analysis, a separate report is being submitted as per TOR as Volume IV: Environmental Impact Assessment and Environment Management Plan.

4.11. ENGINEERING SURVEY & INVESTIGATION – PHOTOGRAPHS

GPS Machine at site – Work in Progress

GPS Pillar at site

OD Survey

Road Condition Survey

Structure Condition Survey by Visual means

Topographic Survey in Progress

BBD Survey Near Km 255	Pillar Fixing
	
Turning Movement At Tadubi junction	DCP Test
	
Trail Pit	Culvert Inventory

LiDAR Survey Photographs

CHAPTER-5 TRAFFIC SURVEYS AND ANALYSIS

5.1. INTRODUCTION

The Primary mode of travel by the people and commodity is by motorised vehicles using the existing road network. There are no Railways existing at present. This chapter describe the estimation of traffic volume and its variations including study of overloading phenomenon etc. for the Project road for addressing various objectives and issues pertaining to 2-lane with paved shoulder/ four Laning of existing project road section of NH-39 (New NH-2).

The Project Highway starts from Lerie Colony Jn, Kohima at Km185+540 of NH 39 and terminates at Km311+082 of NH 39 where the existing road is already four lanes carriageway and passing through Phesama, Zakhama, Viswema, Khuzama, Mao, Tadubi, Maram, Senapati, Kalapahar, Pheidinga and Koirengei, Potsangbam Khoiru.

The traffic study aims at data collection and analysis, traffic projection, capacity of the road and level of service (LOS) analysis. Various aspects of traffic study are presented in subsequent sections of this chapter.

Results of the analysis will form inputs for designing the pavement, developing capacity augmentation proposals, carrying out economic and financial analysis, design of intersections on the widened project road and the possibility of upgrading the road with Private participation from the Industry.

5.2. TRAFFIC SURVEYS – COLLECTION OF TRAFFIC DATA

The Planning for carrying out the traffic surveys started after signing of the Agreement. A reconnaissance survey was taken up for the project road in the month of January 2016 and all the possible diversions identified for the traffic in the project stretch of NH-39 from Kohima to Imphal. The proposed locations of the surveys in conjunction with the road network were identified. The road network was also verified by visiting all the associated road junctions and links so as to assess the traffic level and logistics of traffic surveys.

To capture traffic flow characteristics and travel pattern of the road users passing through the project corridor and also other characteristics related to miscellaneous requirements as per TOR, the following primary traffic surveys and data collection were conducted:

- Classified Traffic Volume Count (TVC)
- Origin-Destination Survey (O-D)
- Axle Load Surveys (AL)
- Turning Movement Survey (TMC)
- Speed and Delay Survey
- Planned developmental activities by the State Planning Organization and their impact on the Traffic.

Traffic survey stations for carrying out "Classified Traffic Volume Count" and "Origin & Destination" have been identified after a site reconnaissance study and in due consultation with the Client and considering the following parameters:

- The station should represent homogeneous traffic section
- The station should be outside urban and local market influence
- The station should be located in a reasonably level terrain with good visibility of road alignment for at least 200 m in either direction
- The 'O-D' stations should preferably be located away from locality, having wide roadside spaces and safety of stopping vehicles for roadside interview survey

5.2.1. Traffic Homogeneous Sections

Based on the results of Reconnaissance Survey of the Project area carried out by the Consultants, existing traffic flow pattern especially intensity of cars and commercial vehicles traffic condition of project road and the following important dispersal locations identified along the project road that includes:

- Kohima, start of project road
- Tadubi, NH-102A Crossing
- Maram, NH-129A Crossing
- Kangpokpi, SH Crossing
- Imphal, end of project road

The project road is presented in **Figure 5.1**. The following 4 traffic homogeneous road sections were identified for the purpose of conducting primary survey as given in ***Table 5.1.***

Table 5.1: Traffic Homogeneous sections along the Project Corridor

Sl. No.	From	To	Start (km)	End (km)	Length (km)
1	Kohima	Tadubi (NH-102A Jn)	185+540	219+600	34.06
2	Tadubi (NH-102A Jn)	Senapati	219+600	259.250	39.6
3	Senapati	Kangpokpi (SH Jn)	259.250	275+700	16.5
4	Kangpokpi (SH Jn)	Imphal (Koirengei)	275+700	311+082	35.3

Figure 5.1: Project Corridor

5.2.2. Classified Traffic Volume Counts

The Classified Traffic Volume Count was conducted continuously for 7 (seven) consecutive days for 24 hours on each day at four locations (as recommended in IRC: SP: 19-2001 "Manual for Survey, Investigation and Preparation of Road Projects). Each location, represent a mid-block count station for different homogeneous sections of the project road. Traffic surveys were carried out in both directions using manual counting method. The detailed vehicle classification system followed during the Traffic Survey is presented below in ***Table 5.2***.

Table 5.2: Vehicle Classification System.

Motorized / Fast Vehicles		Non-Motorized / Slow Vehicles
2-Wheeler		Bicycle
3-Wheeler		Cycle Rickshaw
Passenger Car/ Taxi/ Jeep		Animal Drawn
Others Vehicles		
Bus	Mini Bus	
	Standard Bus	
LCV	Mini-LCV	
	LCV	
Truck	2-Axle Truck	
	3-Axle Truck	
	MAV/ HCM	
Tractors with Trailer		
Tractors without Trailer		

LCV=Light Commercial Vehicles, MAV=Multi Axle Vehicle, HCM=Heavy Capacity Vehicle

5.2.3. Origin-Destination Survey

The origin-destination survey was carried out with the primary objective of studying the travel pattern of goods and passenger traffic along the study corridor. The results have also been useful for identifying the Influence area of the project road and estimating the growth rates of traffic on the project road within its Area of Influence.

The O-D survey was carried out for one day at two locations along with the classified traffic volume counts. Roadside interview method as described in IRC: 102-1988 was adopted for the O-D traffic survey. The Traffic survey was carried out for both passenger and goods vehicles in both directions. The vehicles were stopped on random sample basis with the help of police, and the drivers were interviewed by trained enumerators to obtain the required data on a pre-defined format. During the surveys the information pertaining to origin, destination, trip length, commodity types and loading pattern as applicable for various vehicle types were recorded. Trained enumerators under the supervision of Traffic Engineers collected the trip characteristics using the survey forms designed for this purpose.

5.2.4. Axle-Load Survey

The axle-load survey provides data to enable us the assessment of the damaging effect of the heavily loaded vehicles on the existing pavement structure. The survey was carried out using the electronic axle-weighing pad at two locations (km 265+100 and km 300+100) for 24 hours. Due to the requirement of stopping the vehicle for weighing, it was not possible to weigh all the commercial vehicles passing the site. So the commercial vehicles were weighed on a random sampling basis. Vehicles selected for axle load survey comprised of LCV, 2-axle trucks and 3-axle truck, Bus etc.

5.2.5. Turning movement Survey

The turning movement survey was conducted at major intersections falling on the project corridor to obtain information on turning movement of traffic along the project road. Each turning movement at the intersection was recorded by deploying enumerators in sufficient numbers at suitable locations. The data collected on peak hourly directional movement would be used to analyse and design the intersection.

5.2.6. Speed Delay Survey

The speed and delay survey was conducted using the moving observer method. It has been carried out for the project road by suitably dividing the project length into segments. The test vehicle was made to travel in both directions of travel covering different peak and off peak traffic flow conditions on the project road.

The details of the primary traffic survey schedule as followed on the project are presented in ***Table 5.3*** and their locations are shown in ***Figure 5.2***.

Table 5.3: Traffic Survey Location and Schedule

Type of Survey		Survey Location	Chainage (Km)	Duration (in date)
Classified Volume Count	TVC-1	Mao	213+500	15-02-2016 to 21-02-2016
	TVC-2	Tadubi	219+700	14-02-2016 to 20-02-2016
	TVC-3	Senapati	260+300	16-02-2016 to 22-02-2016
	TVC-4	Sekmai	301+300	16-02-2016 to 22-02-2016
Origin Destination	OD-1	Hangbung Checkpost	265+000	18-02-2016 (24 hours)

Type of Survey		Survey Location	Chainage (Km)	Duration (in date)
Survey	OD-2	Sekmai	300+100	18-02-2016 (24 hours)
Axle Load Survey	AL-1	Hangbung Checkpost	265+100	18-02-2016
	AL-2	Sekmai	300+100	18-02-2016
Turning Movement Survey	TMC-1	Tadubi (3 arm) (NH)	219+600	13-05-2016
	TMC-2	Maram (3 arm) (NH)	236+400	13-05-2016
	TMC-3	Kangpokpi (3 arm) (SH)	275+000	13-05-2016

Figure 5.2: Project Corridor and Survey locations

5.3. SECONDARY DATA

Secondary Data from various sources were collected to find trend in growth of traffic and various Socio-Economic parameters like population, NSDP, GSDP and PCI etc.

Traffic volume counts for the last few years conducted by the state PWD or any other agency, on the project road have been collected and compiled in a tabular form in ***Table 5.4***.

Table 5.4: Secondary Traffic Survey Data

Location	Car/ Jeep/ 3W	Two wheelers	LCV	Bus	2 Axle Trucks	Multi Axle Trucks	Tractor
Nagaland : July –December 2004							
Kohima (km 199)	858	88	327	920	2352		
Manipur: March 2006							
Senapati (km 260)	1381	285	354	139	277	27	2
Kangpokpi (km275)	289	90	104	143	228	8	3

Exact location of Traffic Survey Station in Kohima is not known. High truck volume is likely to be result of local roads/cross traffic. As such it is too high volume compared to rest of the section. The high volumes of Car/3W at Senapati have included multiple trips.

5.4. ANALYSIS OF TRAFFIC SURVEY DATA

5.4.1. Classified Traffic Volume Count

Average Daily Traffic (ADT)

Classified traffic volume count data collected for 7-days at each location were averaged to determine the Average Daily Traffic (ADT).

The traffic data (in vehicles) collected during field surveys have been compiled and converted into equivalent Passenger Car Units (PCU) to determine the Average Daily Traffic (ADT) in PCU as well.

Passenger Car Unit for various vehicles are adopted based on recommendations of Indian Road Congress prescribed in IRC-64-1990, "Guidelines for Capacity of Roads in Rural areas". The adopted Passenger Car Unit values (PCU) equivalent are presented in ***Table 5.5.***

Table 5.5: Adopted PCU Equivalent for Different Vehicle Type

Fast Vehicles	PCU	Slow Vehicles	PCU
2-Wheeler	0.5	Bicycle	0.5
3-Wheeler	1.0	Cycle Rickshaw	2.0
Passenger Car/ Taxi/ Jeep	1.0	Animal Drawn	8.0
Mini Bus	1.5		
Standard Bus	3.0		
Mini-LCV	1.0		
LCV	1.5		
2-Axle Truck	3.0		
3-Axle Truck	3.0		
MAV/ HCM/ EMV (4-6 Axles)	4.5		
OV (>6 Axles)	4.5		
Tractors with Trailer	4.5		
Tractor without Trailer	1.5		

The location wise observed traffic in ADT in vehicles and in PCUs is presented in the ***Table 5.6***.

Table 5.6: Average Daily Traffic (ADT) on Project Corridor

Homogeneous Sections >>> / Vehicle Type		Kohima-Tadubi (Mao)	Tadubi-Senapati (Tadubi)	Senapati-Kongpokpi (Senapati)	Kongpokpi-Imphal (Sekmai)
Motorised Passenger Vehicles	Car/Jeep/Van	1,013	928	2,059	3,561
	Police Jeep / Ambulance	37	29	66	65
	Two Wheeler	62	47	380	2,502
	Three Wheeler	39	74	1,400	594
	Mini Bus	104	15	26	176
	Private/ Tourist Bus	40	47	106	95
	State Bus	31	6	7	8
Motorised Goods Vehicles	Mini LCV	176	90	256	134
	Tempo/ LCV	33	14	11	263
	2 Axle Truck	337	401	591	1,313
	3 Axle Truck	109	143	251	145
	More Than 3 Axle	85	117	197	108
	Tractor	1	2	11	17

Homogeneous Sections >>> / Vehicle Type		Kohima-Tadubi (Mao)	Tadubi-Senapati (Tadubi)	Senapati-Kongpokpi (Senapati)	Kongpokpi-Imphal (Sekmai)
	Tractor with Trolley	-	2	-	11
Non-Motorised Vehicles	Cycle	94	75	116	106
	Tri-Cycle/ Van	3	2	34	475
	Others	-	-	6	22
Vehicles	Motorised	2,067	1,915	5,361	8,992
	Non-Motorised	97	77	156	603
	Total	**2,164**	**1,992**	**5,517**	**9,595**
PCU	Motorised	3,525	3,563	7,923	11,575
	Non-Motorised	53	42	162	1,135
	Total	**3,578**	**3,605**	**8,085**	**12,710**

The daily traffic volume counts at all above locations are presented in ***Appendix 1-1*** *of Volume I: Appendix to Main Report.*

Hourly variation of Traffic

The hourly variation of total traffic (PCU) at four locations along the project corridor is presented in the Figure 4.3 to Figure 4.6 below. It is observed that generally all type of vehicles movement are noticed during daytime only because of security reasons.

Maximum peak hour share in terms of PCUs has been observed as 12.7% at Mao. This shows optimum utilization of the road capacity and predominance of long distance commercial goods traffic.

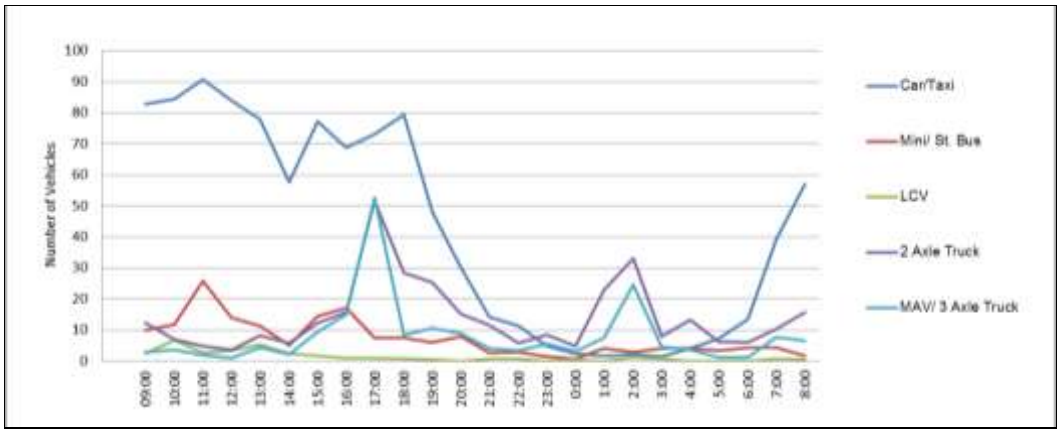


Figure 5.3 : Hourly Variation of Traffic at Km213+500

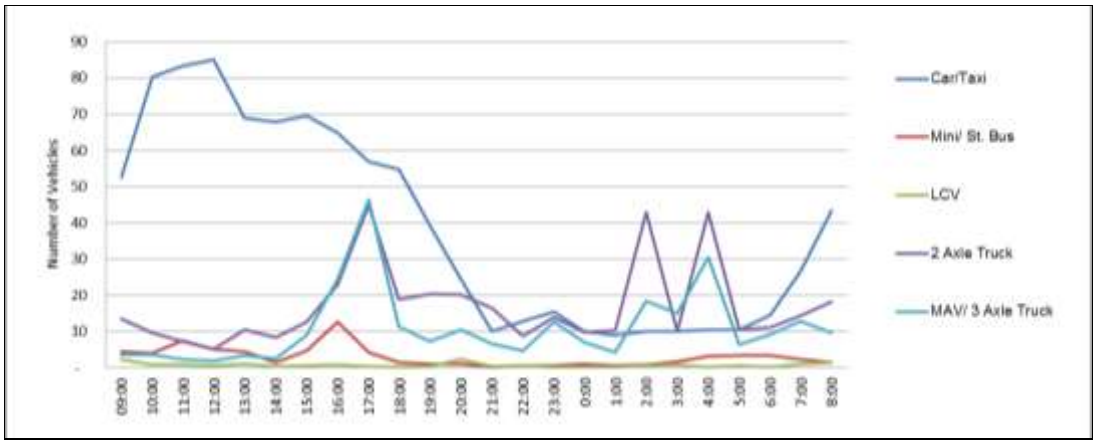


Figure 5.4: Hourly Variation of Traffic at Km219+700

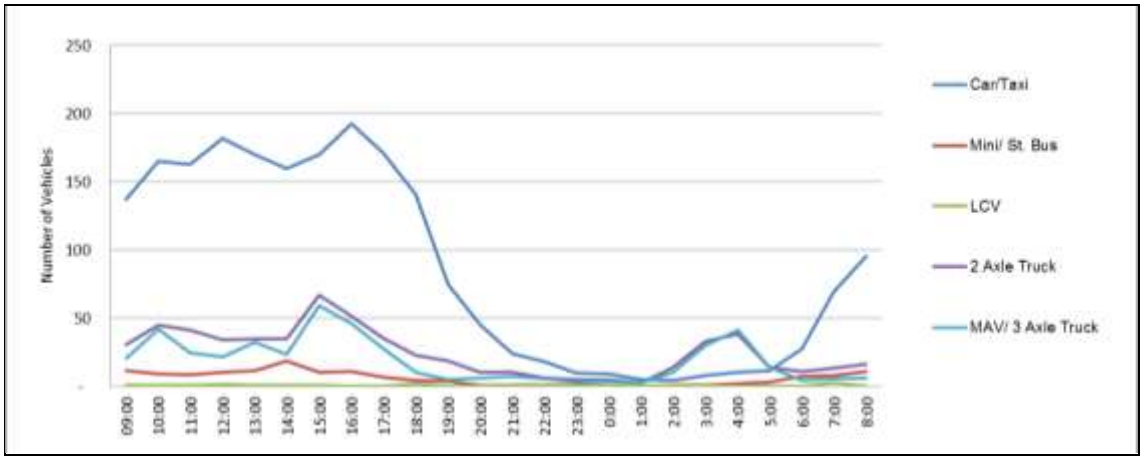


Figure 5.5 : Hourly Variation of Traffic at Km260+300

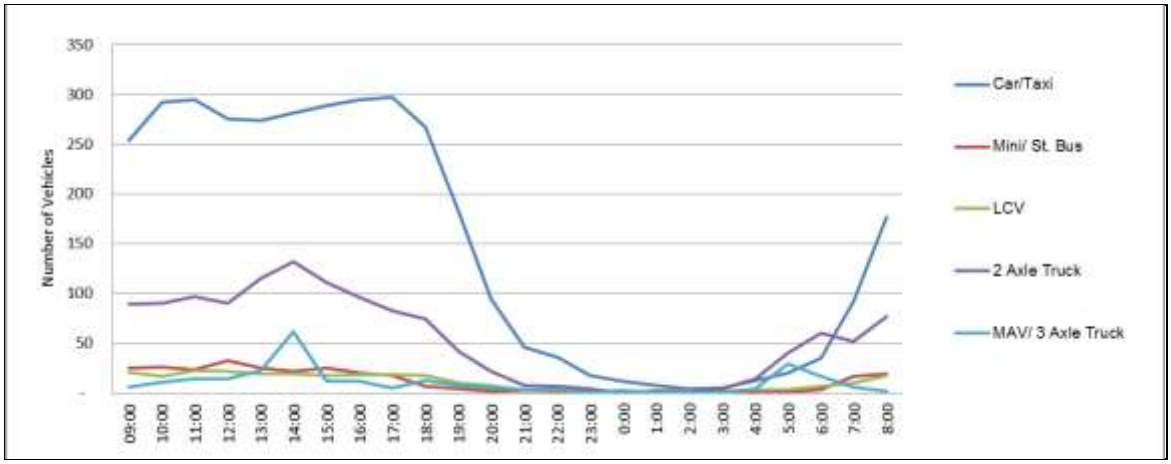


Figure 5.6: Hourly Variation in Traffic at Km301+300

Traffic Composition

The traffic composition on the project road has been analysed to derive the vehicle mode which travels on the project road and the travel pattern and presented in ***Figure 5.7***. It is observed that traffic comprising car/jeeps are dominating on the project corridor with their share in the range of 54.9 to 63%. Next to the share of Car/Jeeps, is the 2-axle Trucks whose share varies between 19% and 24.3%.

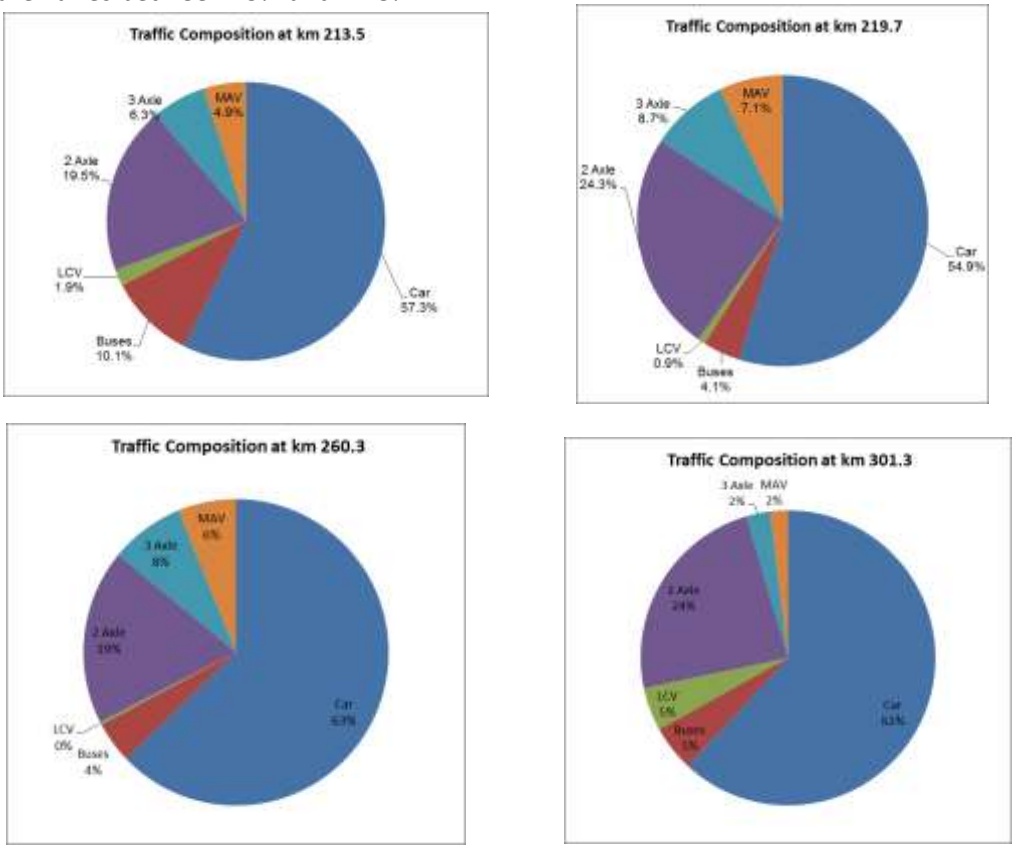


Figure 5.7: Traffic Composition on the Project Corridor at Count Locations

From the analysis of the data it can be seen that cars are dominating in share the range of 55 to 63%. Share is followed by the 2-Axle trucks varying between 20 to 25%. Multi-Axle trucks/truck trolleys exhibits very low proportion in overall traffic volume.

Annual Average Daily Traffic (AADT)

Traffic fluctuates by hour, by day and by month. While hourly and daily fluctuation have been accounted for by conducting survey for continuous 168 hours (7 days), a seasonal correction factor (SCF) will be required which can best describe relation between monthly and yearly traffic. In other words, to estimate AADT it is essential to estimate a factor which provides relationship between Annual Average Daily Traffic (AADT) and Average Daily Traffic (ADT) for corresponding month of survey.

The SCF is normally derived based on the month wise fuel sale data collected from fuel stations situated along the project road section. It is calculated separately for petrol driven and diesel driven vehicles on the project road. The SCF for the different vehicles based on fuel sale are presented in ***Table 5.7***.

Table 5.7: Seasonal Correction Factors (SCF) for Passenger Vehicles

Months	Petrol (KL)	Diesel (KL)	2 Wheeler	Bus/Truck	Cars
April	19	87	1.22	0.99	1.11
May	24	96	0.97	0.90	0.93
June	27	95	0.85	0.91	0.88
July	25	72	0.93	1.20	1.06
August	24	65	0.99	1.32	1.15
September	18	55	1.26	1.57	1.41
October	22	77	1.06	1.12	1.09
November	22	85	1.03	1.01	1.02
December	26	100	0.88	0.86	0.87
January	22	99	1.08	0.87	0.97
February	**29**	**96**	**0.79**	**0.90**	**0.85**
March	20	108	1.17	0.80	0.99

Based on the above analysis, The SCF for the month of February adopted for the Bus/trucks, Car and 2wheeler are 0.90, 0.85 and 0.79 respectively.

The estimated Seasonal Correction Factor (SCF) for the month of January has been applied to the Average Daily Traffic to estimate the Annual Average Daily Traffic in PCU/day.

$$AADT = SCF * ADT_{Jan}$$

The section wise AADT on the project corridor after applying the SCF are presented in ***Table 5.8.***

Table 5.8: Annual Average Daily Traffic (AADT) on Project Corridor

Homogeneous Sections >>>		Kohima-Tadubi (Mao)	Tadubi-Senapati (Tadubi)	Senapati-Kongpokpi (Senapati)	Kongpokpi-Imphal (Sekmai)
Vehicle Type					
Motorised Passenger Vehicles	Car/Jeep/Van	861	789	1,750	3,027
	Police Jeep / Ambulance	31	25	56	55
	Two Wheeler	49	37	300	1,977
	Three Wheeler	35	67	1,260	535
	Mini Bus	94	14	23	158
	Private/ Tourist Bus	36	42	95	86
	State Bus	28	5	6	7
Motorised Goods Vehicles	Mini LCV	158	81	230	121
	Tempo/ LCV	30	13	10	237
	2 Axle Truck	303	361	532	1,182
	3 Axle Truck	98	129	226	131
	More Than 3 Axle	77	105	177	97
	Tractor	1	2	10	15
	Tractor with Trolley	-	2	-	10
Non-Motorised Vehicles	Cycle	94	75	116	106
	Tri-Cycle/ Van	3	2	34	475
	Others	-	-	6	22

Homogeneous Sections >>> / Vehicle Type		Kohima-Tadubi (Mao)	Tadubi-Senapati (Tadubi)	Senapati-Kongpokpi (Senapati)	Kongpokpi-Imphal (Sekmai)
Vehicles	Motorised	1,801	1,670	4,677	7,636
	Non-Motorised	97	77	156	603
	Total	**1,898**	**1,747**	**4,833**	**8,239**
PCU	Motorised	3,116	3,156	7,003	10,098
	Non-Motorised	53	42	162	1,135
	Total	**3,169**	**3,198**	**7,165**	**11,233**

5.4.2. Analysis of O-D Survey Data

Trip End Characteristics

Background

To estimate travel characteristics in the region and the traffic streams, Origin & Destination (O-D) survey was carried out at 2 locations along the project road for 24 hours respectively. Both passenger and commercial vehicles plying on the project corridor were stopped on a random sampling basis and interviewed. Along with the OD survey, volume count survey has been carried out at both locations to observe the sample size.

Travel characteristics like origin, destination and frequency of trip collected for passenger vehicles. For goods vehicles, the survey elicited characteristics like origin, destination, frequency and commodity being transported.

The data collected was analysed to obtain the travel characteristics of the road users of different categories and to establish travel desire pattern on project corridor. The desire pattern of the road users have been established on the basis of the O-D survey data and traffic zones formulated for the same.

The daily raw origin distination data of survey are presented in ***Appendix 1-2*** *of Volume I: Appendix to Main Report.*

Traffic Zoning System

A traffic zone is the smallest spatial unit on which trip ends are analysed. Keeping in view the impact of project corridor, which falls in Imphal, Senapati and Kohima districts, the study area (India) is divided into a three-stage zoning system.

- The first stage is at the district level where urban area/taluka/block or even a portion of the taluka/ block has been considered as a traffic zone.
- In the second-stage (i.e. at state level) individual or groups of districts form a traffic zone.
- In the third-stage of the zoning system (i.e. at national level), individual states or group of states form a traffic zone based on their influence on the project corridor. Overall, the entire study area has been divided into 39 traffic zones.

Overall, the entire study area has been divided into 39 traffic zones. The zone descriptions are tabulated in ***Table 5.9*** and External Traffic Zones are also presented in ***Figure 5.8***.

Table 5.9: List of Traffic Zones

	Zone No.	Zone Name	Details
Internal Project Corridor Zones	1	Kohima	
	2	Jakhama	
	3	North Senapati	Mao, Tadubi
	4	Senapati	Hang, Karong
	5	Sekmai	
	6	Sadar Hills East	Saikul
	7	Sadar Hills West	Kangpokpi
	8	Kunglatongh	
	9	Imphal City	
	10	Imphal East	Porompat, Khongman, Torban, kairobitra
	11	Imphal West	Lamshang, Patsoi, Buri Bazar, Wango, mayang
Internal State Zones	12	Thoubal	District in Manipur
	13	Bishnupur	District in Manipur
	14	Chandel	District in Manipur
	15	Churachandpur	District in Manipur
	16	Ukhrul	District in Manipur
	17	Tamenglong	District in Manipur
	18	Dimapur	District in Nagaland
	19	Phek	District in Nagaland
	20	Zunheboto	District in Nagaland
	21	Marogaon	District in Nagaland
	22	Mokokchung	District in Nagaland
	23	Tuensang	District in Nagaland
	24	Mon	District in Nagaland
External Zones	25	Arunachal Pradesh	State in India
	26	Mizoram	State in India
	27	Assam	State in India
	28	Tripura	State in India
	29	Meghalaya	State in India
	30	Sikkim	State in India
	31	West Bengal	State in India
	32	Bihar& Jharkhand	State in India
	33	Odisha &Chhattisgarh	State in India
	34	Uttar Pradesh	State in India
	35	NCR	State in India

	Zone No.	Zone Name	Details
	36	Norther States	Uttarakhand, Himachal Pradesh, Punjab, Jummu&Kashmir and Haryana
	37	Northwest India	Rajasthan and Gujarat
	38	Central India	Madhya Pradesh &Maharashtra
	39	Southern States	Telangana, Andhra Pradesh, Karnataka, Tamilnadu, Karnataka, Goa, Kerala

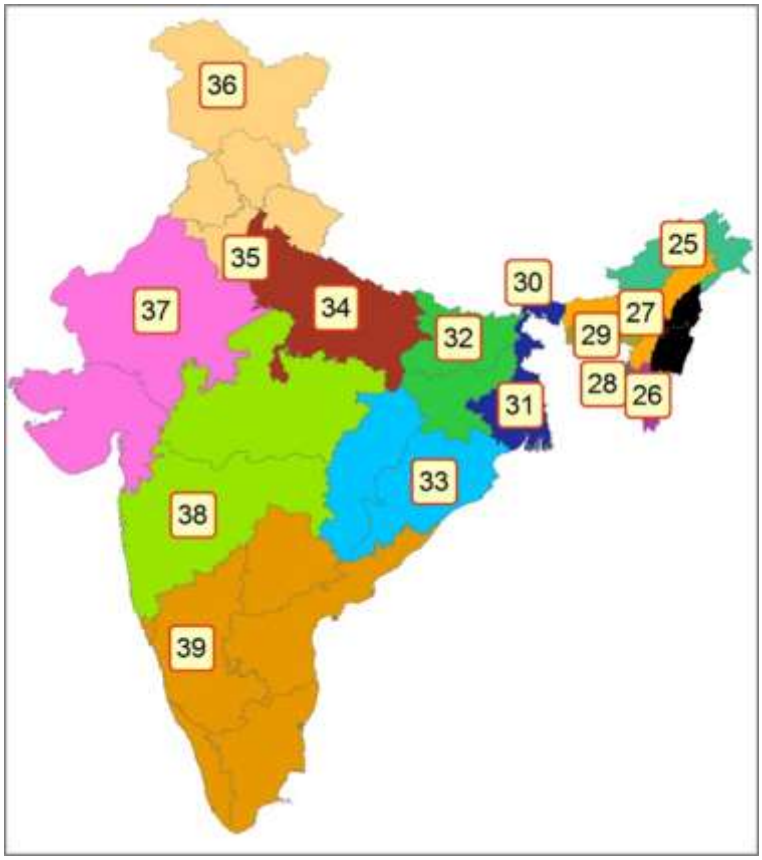


Figure 5.8: External Traffic Zones

Travel Characteristics

Goods Vehicles

Distribution of Trips by Vehicle Type and Commodity Carried

The commodities carried by vehicle type on the project corridor are presented in ***Table 5.10*** & ***Table 5.11***.

Table 5.10: Distribution of Trips by Vehicle Type and Commodity Carried at km 265+100

Vehicle/ Commodity Type	Food Grains	Fruits & Vegetables	Textiles & Clothing	Petroleum Products	Iron Ore and Other Minerals	Iron & Steel (Finished / Scrap)	Building Material	Electronic goods	Machine Parts/Vehicles	Fertilizers/Chemicals	Wood and Prod.	Empty	Others (Pl specify)	Total
LCVs	2.0%	14.4%	4.4%	0.0%	0.0%	0.0%	0.0%	2.4%	0.0%	2.4%	0.0%	70.1%	4.36%	100%
2-Axle Trucks	1.2%	17.4%	20.8%	3.0%	1.5%	0.0%	11.9%	7.6%	0.0%	3.0%	4.6%	0.0%	28.83%	100%
3-Axle Trucks	7.4%	8.1%	3.3%	3.3%	4.1%	0.0%	48.9%	0.0%	0.0%	6.7%	0.0%	14.1%	4.07%	100%
M-axle Trucks	0.0%	5.6%	9.2%	0.0%	5.6%	13.8%	28.0%	0.0%	5.6%	4.6%	27.6%	0.0%	0.00%	100%
All Vehicles	**2.3%**	**13.7%**	**12.0%**	**1.9%**	**2.0%**	**1.6%**	**16.6%**	**4.0%**	**0.7%**	**3.6%**	**5.3%**	**21.8%**	**14.5%**	**100%**

Table 5.11: Distribution of Trips by Vehicle Type and Commodity Carried at km 300+100

Vehicle/ Commodity Type	Food Grains	Fruits & Vegetables	Textiles & Clothing	Petroleum Products	Iron Ore and Other Minerals	Iron & Steel (Finished / Scrap)	Building Material	Electronic goods	Machine Parts/Vehicles	Fertilizers/Chemicals	Wood and Prod.	Empty	Others (Pl specify)	Total
LCVs	6.7%	0.0%	10.1%	5.6%	0.0%	0.0%	0.0%	0.0%	4.5%	0.0%	5.6%	67.5%	0.00%	100%
2-Axle Trucks	14.6%	2.7%	7.8%	9.5%	0.4%	0.0%	42.4%	0.0%	5.3%	2.7%	3.2%	0.0%	11.51%	100%
3-Axle Trucks	7.2%	3.5%	3.6%	5.4%	1.8%	3.5%	13.9%	0.0%	0.0%	0.0%	1.8%	48.8%	10.55%	100%
M-axle Trucks	0.0%	0.0%	0.0%	10.3%	10.3%	0.0%	59.5%	9.9%	0.0%	0.0%	0.0%	0.0%	9.92%	100%
All Vehicles	11.5%	2.2%	7.4%	8.2%	0.9%	0.4%	31.1%	0.4%	4.2%	1.7%	3.3%	19.5%	9.03%	**100%**

The corridor, being one of the major arteries in the region, caters to a large variety of transported goods. Though it is impossible to classify all the possible types into categories, effort has been made to group the various types of goods into 13 categories to cover the broad spectrum of commodities in transit.

The major commodity types carried by goods vehicles at km300+100 are Building materials (31.1%) followed by Food grains (11.5%), and other (9 %) which constitutes the remainder of the 11 categories discussed, also has a considerable share. In overall composition around 20% of goods vehicular trips are observed to be moving empty on the project corridor.

Distribution of Trips by Vehicle Type and Frequency of Travel

Table 5.12 & Table 5.13 present the distribution of trips by frequency of travel for goods vehicles on the project corridor.

Table 5.12: Distribution of Trips by Frequency of Travel at km 265+100

Vehicle Type/ Frequency of Travel	> 2 trips/day	Daily trip (up / dn)	2/3 times a week	Once a week	Occasional	Total
LCVs	1.97%	1.97%	3.93%	53.72%	38.41%	100%
2-Axle Trucks	1.25%	1.52%	5.54%	47.64%	44.05%	100%
3-Axle Trucks	0.00%	14.82%	0.00%	54.07%	31.11%	100%
M-axle Trucks	0.00%	0.00%	5.60%	50.00%	44.40%	100%
Total	**1.10%**	**3.64%**	**4.19%**	**50.67%**	**40.40%**	**100%**

Table 5.13: Distribution of Trips by Frequency of Travel at km 300+100

Vehicle Type/ Frequency of Travel	> 2 trips/day	Daily trip (up / dn)	2/3 times a week	Once a week	Occasional	Total
LCVs	14.30%	11.20%	17.83%	22.40%	34.28%	100%
2-Axle Trucks	10.30%	11.76%	3.50%	9.65%	64.81%	100%
3-Axle Trucks	0.00%	5.42%	5.42%	23.05%	66.11%	100%
M-axle Trucks	0.00%	0.00%	0.00%	9.92%	90.08%	100%
Total	**9.37%**	**10.35%**	**6.44%**	**13.86%**	**59.97%**	**100%**

The good vehicles movement frequency on project corridor is generally once a week or Occasional. Whereas, frequency of daily movement vehicles are in the range of 3.6 to 10% only.

Trip Length Frequency Distribution (TLFD)

Figure 4.9 & Figure 4.10 present the Trip Length Frequency distribution curve for goods vehicles on the project corridor at Km265+100 and Km365+100). TLFD is followed same trend at both the locations.

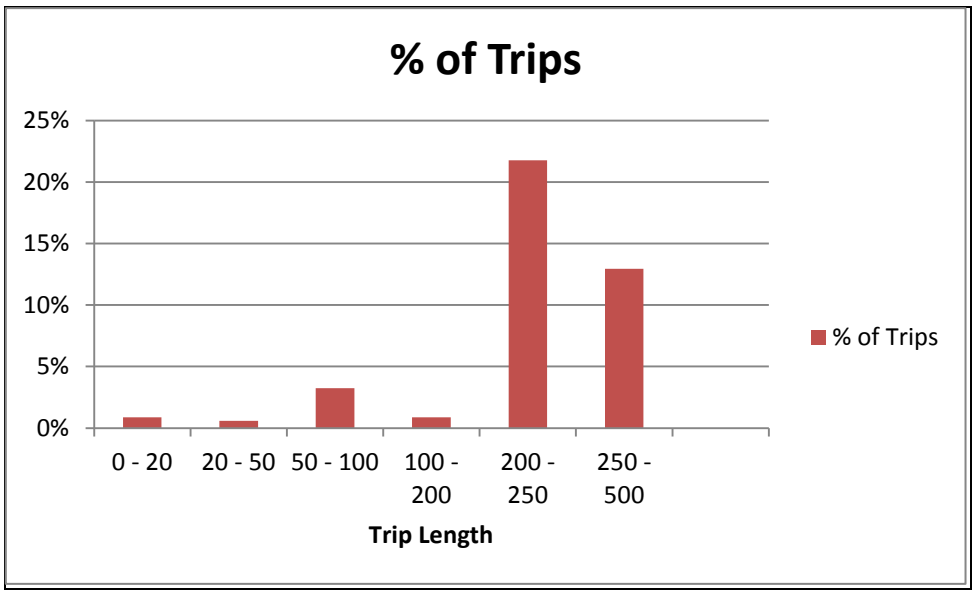


Figure 5.9: Trip Length Distribution for Goods Vehicles at Km 265+100

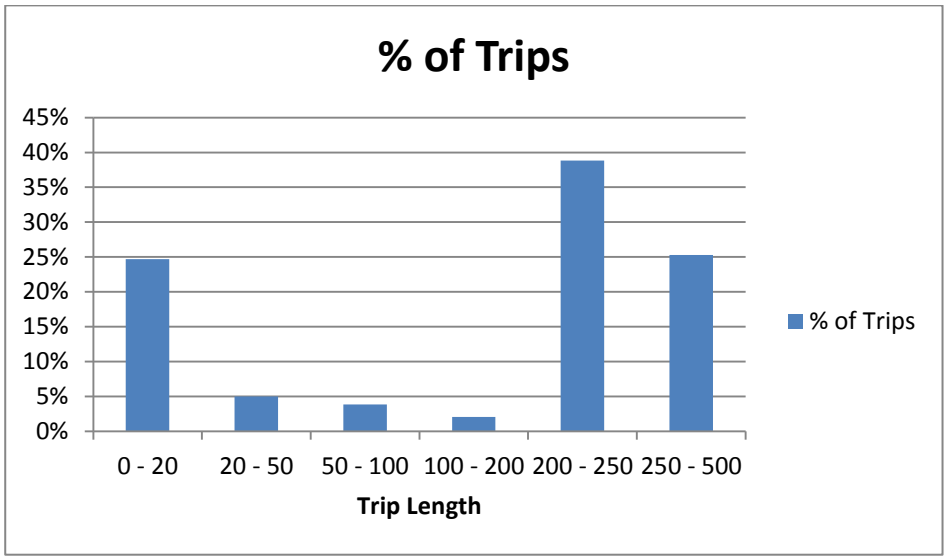


Figure 5.10: Trip Length Distribution for Goods Vehicles at Km 365+100

Trip length frequency distribution curve of goods vehicles reveals 36% of the trips having trip length less than 200 km and maximum number of trips were observed a trip length of between 200 to 500 km. It can be inferred from the above that there are high number of long distance trips on the project corridor. This can also be correlated with the frequency of goods vehicles observed on the project corridor.

Average Trip Length and Trip Time of Goods Vehicles

Table 5.14 shows the mode-wise average trip length, trip time and payload for goods vehicles on the project corridor. The highest Average trip length and average trip time are observed for Multi Axle Trucks at around 761 Kms and 19 hours respectively, followed by 3-Axle and 2-Axle Trucks. The least trip length and trip time are observed for LCVs. The average maximum load carried by goods vehicles is 12.6tonnes by M-Axle Trucks, followed by 3-Axle Trucks and 2-Axle Trucks. We have not considered empty vehicles for the calculation of average pay load.

Table 5.14: Average Trip Length and Trip Time of the Goods Vehicles

Vehicle Type	Average Trip Length (km)	Average Total Trip Time (Hr.)	Average Pay Load (Tonnes)
LCV	152	9.1	1.5
2-Axle Truck	155	9.5	9.7
3-Axle Trucks	180	9.7	13.0
M-axle Trucks	189	10.5	21.8
All Modes	**159**	**9.0**	**9.0**

Passenger Vehicles

Passenger vehicles are generally local traffic with long trips to Dimapur & Guwahati on the corridor. The available bus trips are: Imphal-Kongpokpi, Imphal- Senapati, Imphal- Dimapur and Imphal Guwahati.

5.4.3. Analysis of Axle Load Survey

Axle load survey was carried out to get the spectrum of vehicle loading pattern on the project corridor and also to arrive at Vehicle Damage Factor (VDF) for pavement design. Axle load survey was integrated with classified volume count simultaneously for expansion of the sampled data collected for various categories of freight vehicle to their individual daily average volume. The value of VDF was calculated by dividing the sum of all the Equivalency Factor by number of samples.

To calculate the cumulative number of equivalent Standard axles to be catered for in the design of msa, category-wise VDF was used and presented in ***Table 5.15***.

Table 5.15: Vehicle Damage Factor (VDF) Observed for Commercial Vehicles

Location of Survey Stn.	Direction	Calculated VDF				
		Trucks				Bus
		LCV	2-Axle	Tandem	MAV	
Km 265+100	Up (Kohima - Imphal)	1.17	3.66	3.61	4.68	0.84
	Dn (Imphal - Kohima)	0.18	2.80	2.39	2.99	0.75
VDF Considered for Design as per IRC 37 2012 Para 4.5.1(ii)		1.17	3.66	3.61	4.68	0.84
Km 300+100	Up (Kohima - Imphal)	1.45	3.26	3.43	4.14	0.65
	Dn (Imphal - Kohima)	1.37	1.63	1.00	0.45	0.88
VDF Considered for Design as per IRC 37 2012 Para 4.5.1(ii)		1.45	3.26	3.43	4.14	0.88

The Axle load Survey data and their analysis are presented in ***Appendix 1-3*** *of Volume I: Appendix to Main Report.*

5.4.4. Analysis of Turning Movement Count Survey

Turning movement surveys were conducted at three major junction locations on project corridor.

Tadubi Jn (km219+600): Tadubi Junction is the major three legged intersection with National Highway number 102A (NH-102A). It has traffic equivalent to 4,737 PCU's with peak hour share of about 11% during 16:00-17:00 hours. Peak Hour traffic at Tadubi Jn are as shown in ***Figure 4.11***.

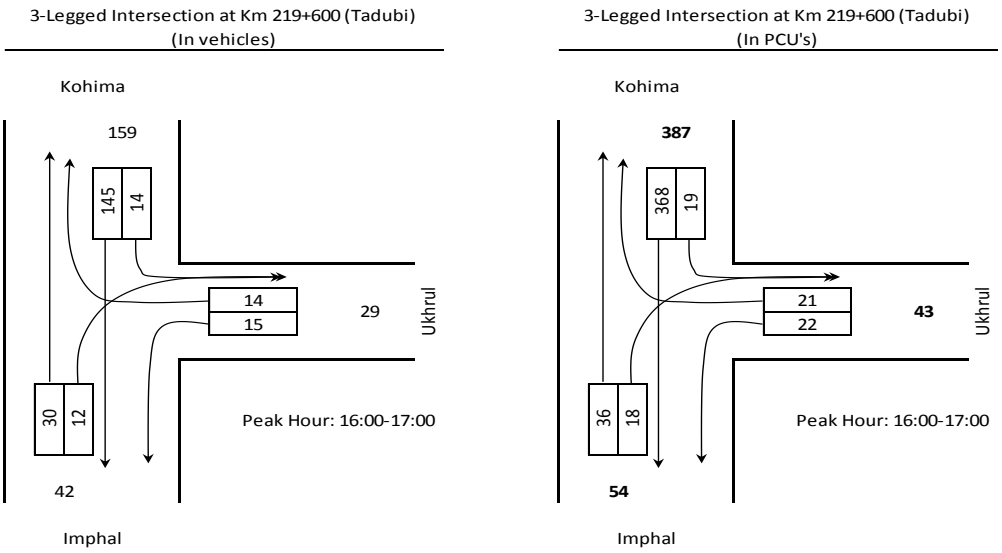


Figure 5.11: Peak Our Traffic at Tadubi Jn (Km219+600)

Maram Jn (km237+400): It is a major three legged junction with NH 129A. A total of 4,039 PCU's are observed at this junction. Hourly variation and traffic composition at the junction are presented in ***Figure 5.12***. Peak hour share is about 12.8% during 16:00-17:00 hours. The peak hour traffic in number and PCUs are presented in ***Figure 5.13.***

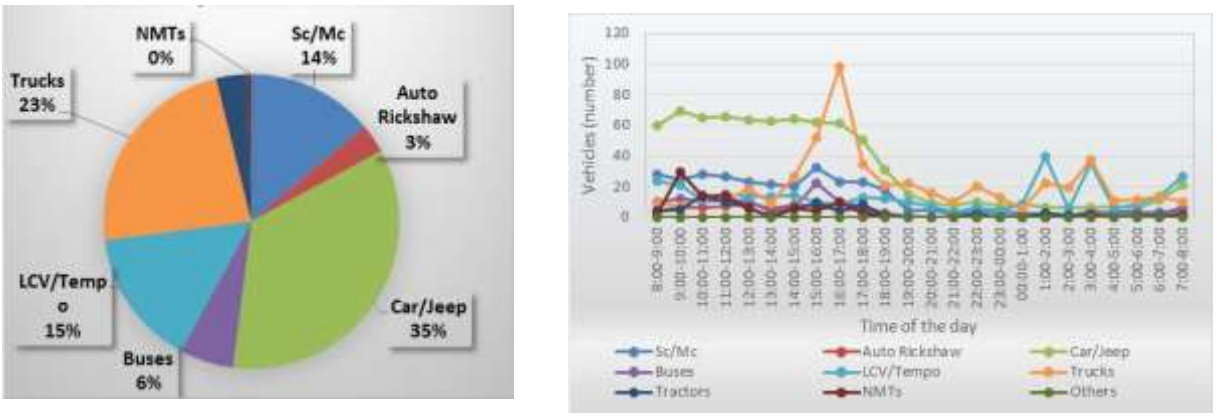


Figure 5.12: Traffic composition and Hourly variation at Maram Jn (Km237+400)

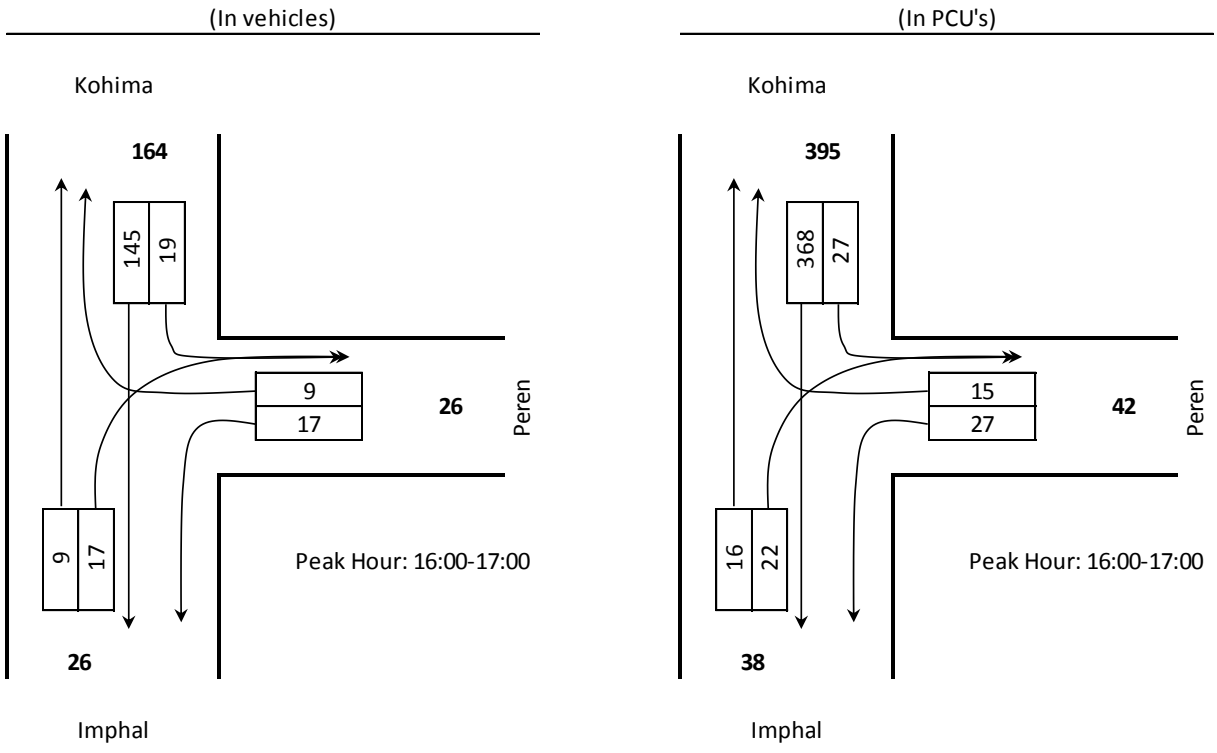


Figure 5.13: Peak Our Traffic at Maram Jn (Km237+400)

Kangpokpi Jn (km275+700): Kongpokpi is a three legged intersection with State Highway. A total of 13,804 PCU's are observed at this location. Hourly variation and traffic composition at

the junction is as shown on ***Figure 5.14***. Peak hour share is about 9.8% during 13:00-14:00 hours. The peck hour traffic in number and PCUs are presented in ***Figure 5.15.***

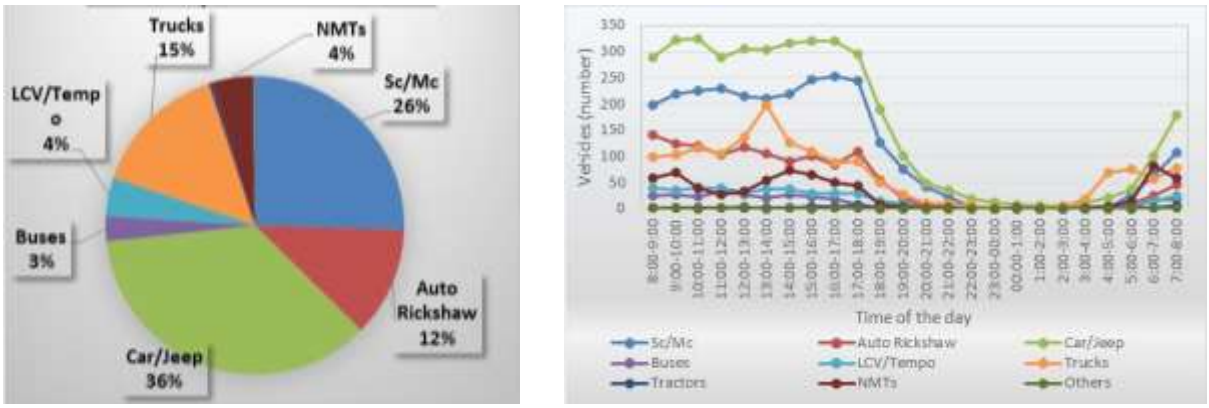


Figure 5.14: Traffic composition and Hourly variation at Kangpokpi Jn (Km275+700)

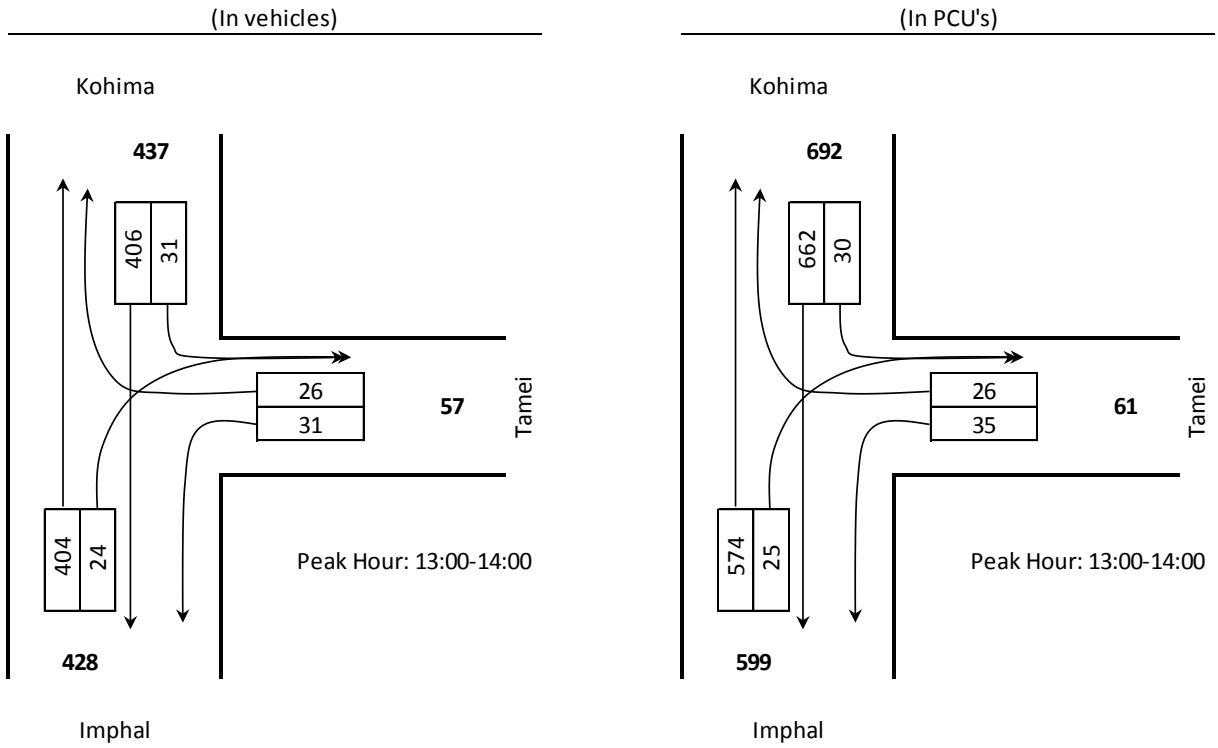


Figure 5.15: Peak hour Traffic at Kangpokpi Jn (Km275+700)

5.5. TRAFFIC FORECAST

5.5.1. General

It is always a tough task to predict traffic volume levels for future years considering uncertainties as persisted in the past and as perceived in the future. These uncertainties are in policy, investment priorities, etc. and hence impact on overall growth patterns. The investment priorities as known are governed by various factors apart from the demand, assessed benefits, and cost of the project. Demand is a factor governing which type of facility / infrastructure is to be created. This in turn determines likely benefits and costs to develop the same. A road development project on budgetary resources requires a realistic estimate of future traffic and hence revenue against capital investment. Prediction of traffic demand hence becomes an important task and has to be carried out as accurately as possible. The estimation of traffic forms the basis for the design of the facility and governs the bidding strategy depending on expected revenue in future years. Recognizing this, efforts are made to carefully assess all the parameters that govern the traffic demand in the future. It is also important to note that realistic assumptions are back-bone of traffic prediction. The following sections discuss traffic projections based on trip end factor method which relates economic growth with vehicular growth. Finally, traffic has been projected up to the year 2046, i.e. 30 years hence.

The transport demand is estimated from growth of population, growth of real per capita Income, State Domestic Product (SDP) etc. For passenger vehicles growth of population and growth in per capita income are considered. For freight vehicles state domestic product is considered.

5.5.2. Population Growth

The decadal population growths for Manipur, Nagaland States and India from 1971 to 2011 are presented in ***Table 5.16.***

Table 5.16: Population Growth of Manipur, Nagaland and India

Year	Population (Nos.)			Decadal Growth (%)		
	Manipur	Nagaland	India	Manipur	Nagaland	India
1971	10,73,000	5,16,000	54,81,59,652			
1981	14,21,000	7,75,000	68,33,29,097	2.8%	4.2%	2.2%
1991	18,37,000	12,10,000	84,63,02,688	2.6%	4.6%	2.2%
2001	22,94,000	19,90,000	1,02,86,10,328	2.25%	5.1%	2.0%
2011	28,55,794	19,80,602	1,21,01,93,422	2.21%	-0.05%	1.6%

The population decadal growth rate for Manipur, Nagaland and India indicates a general tendency of decline over past decades.

However, with due consideration to literacy rate, low sex ratio, various health interventions, and people's awareness of small family due to the Government initiatives it is expected to have less growth rate in future. It would be appropriate to adopt a growth rate of 2.0% for Manipur and 4.5 for Nagaland.

The project corridor has 98.5km length in Manipur state and balance 27.5km in Nagaland. Accordingly, the weighted population growth rate for project road is considered as 2.55% for further analysis.

5.5.3. Per Capita Income Growth

The Per capita income growth for Manipur, Nagaland States and India from 2011-12 to 2014-15 at constant price (2011-12) are presented in ***Table 5.17.***

Table 5.17: Per Capita Income for Manipur, Nagaland and India

Year	Per Capita Income (Rs)		
	Manipur	**Nagaland**	**India**
2011-12	39,762	51,314	63,460
2012-13	38,927	53,364	65,568
2013-14	41,445	58,784	68,717
2014-15	43,348	58,998	72,862
Compound Growth (%)	**2.92**	**4.76**	**4.71**

The per capita income shows increase trend over the years for Manipur, Nagaland and India.

The project corridor has 98.5km length in Manipur state and balance 27.5km in Nagaland. Accordingly, the weighted per capita income for project road is considered as 3.32% for further analysis.

5.5.4. Gross State Domestic Product (GSDP)

The Gross State Domestic Product for Manipur, Nagaland States and India from 2011-12 to 2014-15 at constant price (2011-12) are presented in ***Table 5.18.***

Table 5.18: GSDP for Manipur, Nagaland and India

Year	GSDP (in Crores)		
	Manipur	**Nagaland**	**India**
2011-12	12,915	11,839	87,36,329
2012-13	12,985	12,442	92,13,017
2013-14	14,116	13,826	98,01,370
2014-15	15,030	14,115	1,05,36,984
Compound Growth (%)	**5.19**	**6.04**	**6.45**

Net State Domestic Product is an indicator of economic strength of the state and the same reflects the growth in freight traffic and overall economic performance of the state.

The project corridor has 98.5km length in Manipur state and balance 27.5km in Nagaland. Accordingly, the weighted GSDP is considered as 5.37% for further analysis.

The project corridor has 98.5km length in Manipur state and balance 27.5km in Nagaland. Accordingly, the weighted per capita income for project road is considered as 3.32% for further analysis.

5.5.5. Growth of Registered Vehicles

The growth of registered motorized vehicles in the state of Nagaland as per office of Commissioner of Transport is presented in ***Table 5.19***.

Table 5.19: Registered Vehicles- Nagaland

Year	Registered Vehicles - Nagaland			
	2W	Cars	Bus	Truck
2011	57,581	83,278	5,892	75,891
2012	61,546	87,127	6,039	84,008
2013	66,150	91,764	6,245	90,886
2014	70,858	96,267	6,448	98,144
Compound Growth (%)	**7.16**	**4.95**	**3.05**	**8.95**

Source: Commissioner of Transport, Govt. of Nagaland

The growth of registered motorized vehicles in the state of Manipur as per office of Directorate of Transport is presented in ***Table 5.20.***

Table 5.20: Registered Vehicles- Manipur

Year	Registered Vehicles - Manipur			
	2W	Cars	Bus	Truck
2011	1,30,100	30,066	2,705	10,577
2012	1,38,702	34,491	3,730	10,809
2013	1,50,854	38,882	3,781	12,530
2014	1,89,691	40,323	4,031	12,633
Compound Growth (%)	**13.39**	**10.28**	**14.22**	**6.10**

Source: Directorate of Transport, Govt. of Manipur

5.5.6. Transport Demand Elasticity

Transport demand elasticity is one of the methods of establishing relationships between transport demand (i.e. number of vehicles) and the parameters (prices, NSDP, per capita income etc.) affecting the demand for vehicles (passenger and freight). This relationship may remain static or may change in future due to disproportionate changes in the future growth or parameters and/or technological changes in vehicle characteristics. Transport elasticity is a measure of percentage change in transport demand w.r.t. percentage change in the parameters (such as prices, per capita income, population etc.) influencing the demand.

On the basis of the above formulation the transport demand elasticity for passenger and freight vehicles were estimated by using the following equations:

Elasticity for Passenger Traffic

$E = G/((1+G_P) \times (1+G_{PCI}) - 1)$

Where, E = Elasticity of Transport Demand

G_P = Population growth rate

G_{PCI} = Per Capita income growth rate

G = growth factor

Elasticity for Freight Traffic

$E = G/G_{GSDP}$

Where, E = Elasticity of Transport Demand

G_{GSDP} = Gross State Domestic Product growth rate

G = growth factor

Based on the above parameters the elasticity for Car, 2-Wheeler, Bus and truck for Nagaland and Manipur States are worked out and elasticity value suggested in IRC:SP:19-2001 are presented in ***Table 5.21.***

Table 5.21: Comparison of Elasticity for Vehicles

Vehicle Type	State	Elasticity		Vehicle Type	State	Elasticity
Car	Nagaland	0.5		Bus	Nagaland	0.3
	Manipur	2.1			Manipur	2.9
	IRC:SP19-2001	2.0			IRC:SP19-2001	1.6
Two Wheelers	Nagaland	0.8		Truck	Nagaland	1.5
	Manipur	2.7			Manipur	1.2
	IRC:SP19-2001	2.5			IRC:SP19-2001	2.0

The elasticity value obtained from the regression of vehicle registration is generally high in case of personal mode compare to the public mode. Further, the elasticity will drop over a period of time. The reason being, the economic development induces changes in the spatial distribution of the activities. As region become more and more self-sufficient, the need for long distance transport diminishes. According, it is assumed that transport demand elasticity, for both freight and passenger traffic, would tend to decline over time, despite growth in per capita income. The proposed elasticity for the project road adopted for the traffic forecasting is presented in ***Table 5.22.***

Table 5.22: Elasticity Adopted for Vehicle types

Vehicle Type	Elasticity Adopted			
	2016-2020	2021-2025	2026-2030	> 2031
Car	1.7	1.5	1.3	1.2
Two Wheelers	1.8	1.5	1.2	0.9
Bus	1.5	1.3	1.1	0.9
Truck	1.3	1.2	1.1	1

5.5.7. Proposed Growth Rates

The growth rate for different vehicle types have been estimated based on the economic indicator study of the both states and guidelines given in the IRC:SP:19-2001. The estimated growth rates for the project road are presented in ***Table 5.23.***

Table 5.23: Vehicle wise Proposed Annual Growth Rate

Vehicle Type	Growth Rate Adopted			
	2016-2020	2021-2025	2026-2030	> 2031
Car	10.1%	8.9%	7.7%	7.1%
Two Wheelers	10.7%	8.9%	7.1%	5.4%
Bus	8.9%	7.7%	6.5%	5.4%
Truck	7.0%	6.4%	5.9%	5.4%

The above obtained growth rate for trucks will be applicable for the 3 Axle Trucks & Multi axle Vehicles (MAV) because there is increasing trend of MAV compared to the 2 Axle Trucks. The growth rates adopted for the 2 Axle trucks and the slow moving vehicles is ***Table 5.24.***

Table 5.24: Vehicle wise Proposed Annual Growth Rate

Vehicle Type	Growth Rate Adopted			
	2016-2020	2021-2025	2026-2030	> 2031
2 Axle Trucks	5.5%	5.1%	4.9%	4.5%
LCV	5.5%	5.1%	4.9%	4.5%
3- Wheelers & Tractor	4.0%	3.8%	3.5%	3.0%
Cycle	2.0%	2.0%	2.0%	2.0%
Cycle Rickshaw	1.0%	1.0%	1.0%	1.0%

5.6. GENERATED TRAFFIC

During the field visits and consultative meetings, it was discussed with supporting arguments, that once a road is widened with improved geometrics and safety features, the Vehicle Operating Costs (VOCs) would go down significantly, which leads to faster movement, decreased transportation cost resulting increased demand for transportation- passenger and freight and that would generally provide a boost to the economy of the project influent area to

grow at a great pace. The volume of generated traffic on the corridor in future is expected to be mainly freight traffic due to large scope of investments in the region. The proximity of Myanmar border would also result in international trade as this link (NH-39) being a part of Great Asian Highway is likely to serve the neighbouring Countries thus expanding trade and commerce activities.

Generated traffic would be around 25% increase in commercial vehicles estimated based on comprehensive study of the surrounding network of the project road (for advantage to be taken by travelling on the Project road) anticipated development pattern within the project influence area, and travel pattern observed on project road due to travel to/from the surrounding areas as observed while analysing O-D data.

However, the scope of 'Diverted Traffic' does not exist as there is no alternate route or mode of transport on the project road after upgradation.

5.7. PROJECTED TRAFFIC ON PROJECT CORRIDOR

Table 5.24, Table 5.25, Table 5.26 and ***Table 5.27*** show projected mode wise traffic in PCU's and vehicles at Mao (Km213+500), Tadubi(Km219+700), Senapati (Km260+300) and at Sekmai (Km301+300) respectively.

Table 5.24: Traffic Projection at Mao (Km 213+500)

Road Section >>>		Kohima-Tadubi Section of NH-39						
Vehicle Type		2016	2020	2025	2030	2035	2040	2045
Motorised Passenger Vehicles	Car/Jeep/Van	861	1,266	1,942	2,819	3,980	5,619	7,932
	Police Jeep / Ambulan	31	46	71	103	145	205	290
	Two Wheeler	49	74	113	159	207	269	349
	Three Wheeler	35	41	49	59	68	79	92
	Mini Bus	94	132	239	328	426	554	719
	Private/ Tourist Bus	36	51	92	126	164	213	277
	State Bus	28	39	71	98	127	165	214
Motorised Goods Vehicles	Mini LCV	158	196	314	398	497	619	771
	Tempo/ LCV	30	37	59	75	93	116	145
	2 Axle Truck	303	375	600	763	951	1,185	1,476
	3 Axle Truck	98	128	220	293	380	494	641
	More Than 3 Axle	77	100	171	228	297	385	500
	Tractor	1	1	2	2	2	2	3
	Tractor with Trolly	-	-	-	-	-	-	-
Non-Motorised Vehicles	Cycle	94	102	112	124	137	151	167
	Tri-Cycle/ Van	3	3	3	3	4	4	4
	Others	-	-	-	-	-	-	-
Vehicles	Motorised	1,801	2,487	3,943	5,452	7,337	9,904	13,408
	Non Motorised	97	105	116	127	141	155	171
	Total	**1,898**	**2,592**	**4,058**	**5,579**	**7,478**	**10,059**	**13,579**
PCU	Motorised	3,116	4,171	6,759	9,132	12,025	15,876	21,021
	Non Motorised	53	57	63	69	76	83	91
	Total	**3,169**	**4,228**	**6,822**	**9,201**	**12,101**	**15,959**	**21,112**

Table 5.25: Traffic Projection at Tadubi (Km 219+700)

Road Section >>>		Tadubi Senapati Section of NH-39						
Vehicle Type		2016	2020	2025	2030	2035	2040	2045
Motorised Passenger Vehicles	Car/Jeep/Van	789	1,160	1,779	2,583	3,646	5,147	7,267
	Police Jeep / Ambulan	25	36	56	81	114	161	227
	Two Wheeler	37	56	86	121	157	204	264
	Three Wheeler	67	78	94	112	129	150	174
	Mini Bus	14	19	34	47	61	79	103
	Private/ Tourist Bus	42	60	108	148	193	250	325
	State Bus	5	8	14	19	24	32	41
Motorised Goods Vehicles	Mini LCV	81	100	160	204	254	316	394
	Tempo/ LCV	13	16	25	32	39	49	61
	2 Axle Truck	361	447	714	908	1,131	1,410	1,757
	3 Axle Truck	129	169	288	384	498	647	841
	More Than 3 Axle	105	138	236	314	408	530	688
	Tractor	2	2	3	4	4	5	6
	Tractor with Trolly	2	2	3	4	4	5	6
Non-Motorised Vehicles	Cycle	75	81	90	99	109	121	133
	Tri-Cycle/ Van	2	2	2	2	2	3	3
	Others	-	-	-	-	-	-	-
Vehicles	Motorised	1,670	2,289	3,599	4,958	6,663	8,985	12,153
	Non Motorised	77	83	92	101	112	123	136
	Total	**1,747**	**2,373**	**3,691**	**5,059**	**6,775**	**9,108**	**12,289**
PCU	Motorised	3,156	4,185	6,752	9,070	11,901	15,658	20,660
	Non Motorised	42	45	49	54	59	65	72
	Total	**3,198**	**4,230**	**6,801**	**9,124**	**11,960**	**15,723**	**20,732**

Table 5.26: Traffic Projection at Senapati (Km 260+300)

Road Section >>>		Senapati Kongpokpi Section of NH-39						
Vehicle Type		2016	2020	2025	2030	2035	2040	2045
Motorised Passenger Vehicles	Car/Jeep/Van	1,750	2,574	3,947	5,730	8,089	11,420	16,123
	Police Jeep / Ambulan	56	82	127	184	259	366	517
	Two Wheeler	300	451	692	976	1,268	1,646	2,137
	Three Wheeler	1,260	1,474	1,776	2,110	2,446	2,835	3,287
	Mini Bus	23	33	60	82	106	138	179
	Private/ Tourist Bus	95	134	261	358	465	603	783
	State Bus	6	9	16	22	29	38	49
Motorised Goods Vehicles	Mini LCV	230	285	456	580	722	900	1,122
	Tempo/ LCV	10	12	20	25	31	39	48
	2 Axle Truck	532	658	1,053	1,338	1,668	2,078	2,590
	3 Axle Truck	226	296	506	674	875	1,137	1,476
	More Than 3 Axle	177	232	397	529	687	892	1,159
	Tractor	10	12	17	20	23	27	31
	Tractor with Trolly	-	-	-	-	-	-	-
Non-Motorised Vehicles	Cycle	116	126	139	153	169	187	206
	Tri-Cycle/ Van	34	35	37	39	41	43	45
	Others	6	6	7	7	7	8	8
Vehicles	Motorised	4,677	6,253	9,326	12,627	16,668	22,119	29,501
	Non Motorised	156	167	182	199	217	237	259
	Total	**4,833**	**6,420**	**9,508**	**12,826**	**16,886**	**22,357**	**29,760**
PCU	Motorised	7,003	9,206	14,316	19,127	24,952	32,682	42,975
	Non Motorised	162	171	183	196	210	225	242
	Total	**7,165**	**9,377**	**14,499**	**19,323**	**25,162**	**32,907**	**43,217**

Table 5.27: Traffic Projection at Sekmai (Km 301+300)

Road Section >>>		Kongpokpi Imphal Section of NH-39						
Vehicle Type		2016	2020	2025	2030	2035	2040	2045
Motorised Passenger Vehicles	Car/Jeep/Van	3,027	4,451	6,826	9,910	13,991	19,751	27,884
	Police Jeep / Ambulan	55	81	125	181	255	361	509
	Two Wheeler	1,977	2,969	4,554	6,429	8,347	10,837	14,070
	Three Wheeler	535	625	754	895	1,038	1,203	1,394
	Mini Bus	158	223	405	556	721	937	1,216
	Private/ Tourist Bus	86	120	219	300	390	506	657
	State Bus	7	10	18	25	33	43	55
Motorised Goods Vehicles	Mini LCV	121	149	239	303	378	471	587
	Tempo/ LCV	237	293	469	596	742	925	1,153
	2 Axle Truck	1,182	1,463	2,339	2,973	3,705	4,617	5,753
	3 Axle Truck	131	171	292	389	506	657	853
	More Than 3 Axle	97	127	218	290	377	489	636
	Tractor	15	18	26	31	36	42	49
	Tractor with Trolly	10	12	17	20	23	27	31
Non-Motorised Vehicles	Cycle	106	115	127	140	154	170	188
	Tri-Cycle/ Van	475	494	520	546	574	603	634
	Others	22	23	24	25	27	28	29
Vehicles	Motorised	7,636	10,713	16,500	22,899	30,541	40,865	54,847
	Non Motorised	603	632	670	711	755	802	851
	Total	**8,239**	**11,345**	**17,170**	**23,610**	**31,296**	**41,666**	**55,699**
PCU	Motorised	10,098	13,585	21,350	28,887	37,972	50,085	66,285
	Non Motorised	1,135	1,183	1,247	1,314	1,384	1,459	1,538
	Total	**11,233**	**14,768**	**22,597**	**30,201**	**39,356**	**51,544**	**67,823**

5.7.1. Capacity warrants

Capacity analysis for the project road has been carried out in order to determine the Lane Configuration for the project road sections. IRC 64: 1990 recommends Level of Service B for rural roads. Thus, it is desirable to ensure traffic flow in LOS B while LOS C may be permitted before need for capacity augmentation is established. The Design Service Volume (DSV) in PCUs/day for 2-lane and 4-Lane carriageway is presented in ***Table 5.28.***

Table 5.28: Design Service Volume (DSV) for Project Highway

Description	Level of Service	DSV (PCU/day)	Reference
Two Lane with minimum 1.5m Paved Shoulder in Rolling Terrain			
	LOS B	13000	Table 2.8 of IRC SP:73 - 2007
	LOS C	18570	V/C @ 0.7
Two Lane with minimum 1.5m Paved Shoulder in Mountainous Terrain			
	LOS B	9000	Table 2.8 of IRC SP:73 - 2007
	LOS C	12860	V/C @ 0.7
Four Lane Highway in Plain/Rolling Terrain			
	LOS B	40000	Table 2.9 of IRC SP:84 - 2014
	LOS C	60000	Table 2.9 of IRC SP:84 - 2014

As per MoRT&H Circular No NH-14019/6/2012-p&M dated 5th October 2012; all new highway projects of widening/ bypass/ realignment are to be taken up with minimum two lanes with paved shoulders irrespective of the traffic thereon.

Following capacity warrants are drawn for each of the homogenous sections considering the estimated Traffic growth for project corridor and the capacity Analysis are presented in ***Table 5.29.***

Table 5.29: Traffic Capacity warranted for Project Highway

Sl. No.	From	To	Length (km)	Year of Achieving 2-lane Capacity		Recommendation
				LOS B	LOS C	
1	Kohima	Tadubi	33.9	2030	2036	Two Lane with Paved Shoulder
2	Tadubi	Senapati	39.6	2030	2036	
3	Senapati	Kongpokpi	16.5	2024	2029	Four lane Divided Carriageway
4	Kongpokpi	Imphal	35.3	2018	2023	

Hence, the project road from Kohima to Senapati is recommended for upgradation to 2-lane with Paved Shoulder and from Senapati to Imphal as four lane dual carriageway.

CHAPTER-6 IMPROVEMENT PROPOSAL

6.1. GENERAL

The Himalayan ranges from North to North-East of India has a vast area in hilly regions which include the states of Manipur & Nagaland besides other states. Economic development and strategic needs have resulted in launching of massive road construction programme in the regions and in the recent past, such activities have increased manifold.

Design and construction of roads in hills/mountains are more complex than in the plain terrain. It is due to several factors associated with the region. They may include highly broken terrain with vastly differing elevations and steep slopes, quick variation in geological formation, variation in hydro-geological conditions, variation in climatic conditions such as temperature due to altitude difference, pressure variation, precipitation increases at higher altitudes, landslide and sinking zone at vulnerable locations and need to design hairpin bends to attain heights. The cost of construction of hill roads is several times higher than the cost in plain terrain.

The proposed upgradation of project road by widening/reconstruction of NH-39 (now christened as NH-2) having existing two lane to two lane with paved shoulders/4-laning has been based on the findings of the field investigations carried out in consonance with the TOR of the project. The improvement proposal includes provisions for the following major items of works:

- Alignment Proposal.
- Geometric Improvements.
- Cross Sections.
- Design of Pavement Structure.
- Reconstruction of damaged cross-drainage structures; construction of additional drainage structure and provision of additional Retaining Walls and Brest Wall.
- Bridges and other structures.
- Provision of Road safety measures; road furniture and other appurtenances.
- Provision for arresting sinking and/or sliding tendencies of hilly project road.

6.2. ALIGNMENT DEFICIENCIES OF THE PROJECT HIGHWAY

6.2.1. Existing Horizontal Alignment Deficiencies

From Kohima to Senapati, the existing alignment passes through Mountainous/steep terrain. The road alignment in this reach suffers from the geometric deficiencies at several places. Besides, sinking zones also exist in the reach between Maram and Kohima in addition to landslides in this reach.

The existing alignment after Senapati town to Imphal passes through the plain/rolling terrain with some stretches of Mountainous/Steep terrain. The alignment of this section is generally good with some geometric deficient location.

Table 6.1 shows the existing status of the horizontal curves along the entire alignment from Kohima to Imphal section of the project road.

Table 6.1: Existing Horizontal Curves of Kohima-Imphal Road

S. No.	Radius (m)		No of Deficient Horizontal Curves
	From	To	
1	Below 20.00 m		32
2	21.00	50	294
3	51.00	80	203
4	81.00	100	100
5	101.00	300	248
6	301.00	1000	46
7	Above 1000.00 m		7
		Total	**930**

Table 6.1 highlights the phenomenal existence of deficient horizontal curves and in a way convey the feel of the bad alignment at several locations. The required sight distances are not available at these locations resulting accident prone stretches.

6.2.2. Existing Vertical Alignment Deficiencies

The existing vertical alignment is generally within permissible limits except some locations where gradient is exceeding the ruling gradient (6%) making traffic to move very slowly while negotiating, involving higher vehicle operating cost beside unsafe travel. ***Table 6.2*** shows the existing status in this regard. Further, several summit and valley curves are also found to be deficient.

Table 6.2 Existing Steeper Gradient Sections

Design Chainages (Km)		Length (m)	Existing Grade
From	To		
207+120	207+440	320	7.25%
216+460	216+580	120	8.00%
216+860	217+080	220	9.60%
223+360	224+240	880	6.50%
224+380	224+550	170	7.19%
230+200	230+320	120	6.75%
235+420	235+560	140	8.19%
235+560	235+740	180	9.62%
236+670	237+000	330	9.32%
237+000	237+220	220	7.50%

The Table 6.2 highlights that the project highway has gradient deficiency in Kohima to Senapati section of project highway only and Senapati to Imphal section have no gradient more than 6%.

6.2.3. Sinking and Sliding Locations

The project area falls under heavy rainfall zone with hilly terrain involving an appreciable catchment. The hills along the road do not have rocky strata and generally contain soil mixed of boulders and pebbles of rounded shapes. The absorption by soil mass appears to be the reason of sliding and sinking at several places along the project corridor. The cumulative affected length along the project corridor is about 13km length in Kohima to Maram Section of project corridor.

The embankment and formation of existing road has sunk at a number of locations along the project corridor. The Sinking alone has affected 1.67km length of the existing road also in Kohima to Marram section of project corridor.

6.3. PROPOSAL FOR IMPROVEMENT OF ALIGNMENT OF PROJECT ROAD

From Kohima to Senapati, the existing alignment of project road passes through mountainous terrain and after Senapati towards Imphal it has plain/rolling terrain with some stretches of mountainous terrain. The road alignment in these stretches suffers from geometric deficiencies at several places. The existing pavement structure of the project road is quite weak to survive the existing spectrum of wheel loads. The deficiencies in the alignment raises several issues like higher operating cost, safety and environmental degradation, these issues being important need to be addressed suitably during upgradation of road to achieve the goal of saving in operational cost, enhancing the safety of road users and improving the environment of the road corridor.
In order to accomplish these challenges, sometime the road may have to be altogether rebuilt when same is upgraded as is the case with this project road.

The project proposal from Kohima to Imphal and correlation between Exiting road Chainages and Design Chainages are presented in ***Table 6.3***.

Table 6.3: Proposed upgradation of Project Proposal

S No.	Existing Chainage (km)		Design Chainage (km)		Design Length (km)	Project Proposal	
	From	To	From	To			
1	185+540	254+700	185+540	249+140	63.60	2L+PS	
2	254+070	264+540	249+140	262+400	13.26		Senapati Bypass
3	264+540	274+600	262+400	272+535	10.60	4L divided	
4	274+600	276+307	272+535	274+610	2.075		Kongpokpi Bypass
5	276+307	311+080	274+610	308+460	33.85		

During presentation held on 2nd February 2018 at NHIDCL, HQ; five construction packages were decided for Kohima to Imphal section of NH-39. The Minutes of Meeting (MoM) of this presentation were issued vide letter reference NHIDCL/Manipur Nagaland/NH-39/DPR-Imphal – Kohima/2015/Vol-II/645 dated 27th February 2018. The details of construction packages are presented in Table 6.4.

Table 6.4: Details of Construction Packages

Package Nos.	Design Chainage		Length (km)
	From	To	
1	Lerie Colony, Kohima (Km185+540)	Nagaland Border (Km210+700)	25.16
2	Nagaland Border (Km210+700)	Maram Centre (Km237+900)	27.20
3	Maram Centre (Km237+900)	End of Senapati Bypass (Km262+370)	24.47
4	End of Senapati Bypass (Km262+370)	Saparmeina (Km286+750)	24.38
5	Saparmeina (Km286+750)	Imphal (Km309+315)	22.565

Final Feasibility report and other deliverables for Package 4 and Package 5 were asked by NHIDCL for submissions vide NHIDCL letter reference NHIDCL/Manipur Nagaland/NH-39/DPR-Imphal – Kohima/2018/531 dated 12th June 2018.

Accordingly, this report covers the primary surveys and their analysis carried out for entire project highway from Kohima to Imphal by the Consultants upto "Stage 2: Feasibility Study Report". However, at present the project proposal and cost estimates have been carried out for Package 4 and 5 i.e. from Senapati to Imphal section of NH-39 only. There are minor deviations due to geometric improvement in package lengths as discussed during presentation held on 2nd February 2018 and finalized packages details are presented in ***Table 6.5.***

Table 6.5: Details of Civil Contract -Package 4 and Package 5

Pkg. No.	Existing Chainage		Design Chainage		Length (km)
	From	To	From	To	
Package 4	264+313	288+815	262+175	287+000	24.82
Package 5	288+815	311+082	287+000	308+460	21.46

The Plan & Profile of the Alignment proposal for Package 4 & 5 are submitted in ***Volume IX:*** Drawing Volume.

6.3.1. Improvement of Horizontal Geometry

The geometry of the road influences its safety performance. The existing centre-line of the road has been considered during alignment improvement. The numbers of existing curves have been reduced by straightening the involved stretches if feasible, the radii of such curves have been suitably increased to comply the requirements given in manual (IRC:SP: 73-2007).

All existing geometric deficient curves in Package 4 & 5 have been either eliminated or improved by increasing the radii of the curves corresponding to ruling/minimum speed as is applicable to the terrain type, wherever feasible. The summary of horizontal alignment improvement from Senapati to Imphal section is presented in ***Table 6.6***.

Table 6.6: Improved Horizontal Alignment

S No	Radius (m)		Number of Horizontal Curves			
			Package 4		Package 5	
	From	To	Existing	Proposed	Existing	Proposed
1	Below 20.00 m		2	0	0	
2	21	90	29	0	10	
3	91	229	52	0	18	
4	230	359	9	0	3	3
5	360 or Above		14	56	11	40
	Total		106	56	42	43

Spiral transition curves have been included in the design of curves and sufficient super elevations of value not exceeding 7% have been introduced.

6.3.2. Improvement of Vertical Alignment

The improvement effected in the horizontal geometry by increasing the radii of the horizontal curves, resulted into additional length which has been deployed in the improvement of gradient involving cutting of hill slopes and depressing the elevations. Simultaneously, the peaks of the hills involving summit curves have been lowered as much as feasible to attain improved gradients involving appreciable cutting. The protective works have been proposed at all such locations involving deep cuts. The spectrum of proposed longitudinal gradients for Package 4 & 5 of the project road in percentage of road length is presented in ***Table 6.7.***

Table 6.7: Improvement Vertical Alignment- Gradient

Package No	Project Length (%) with Gradients		
	<=2.5%	2.5%- 3.3%	>3.3%
Package 4	78%	22%	-
Package 5	94%	6%	-

Several valley curves are proposed to be improved by filling earthworks attempts, have also been made to maintain balance between the cutting and filling of earthwork. Such steps also improve the drainage at the location of valley curves. The unnecessary rise and fall of the gradient have been minimised effecting reduction in the length and cost of the road. The soil type at site has been considered while deciding the height of cut and fill as the fill slopes typically display weaker shear strength than cut slopes.

6.4. GEOMETRIC IMPROVEMENTS DETAILS

The improvements of horizontal alignments and vertical gradients envisaged for Senapati to Imphal section of project road are described below.

6.4.1. Horizontal Geometrics

The horizontal curves have been generally designed with ruling design speed of 100 kmph and minimum design speed of 80 kmph as per IRC-SP: 73-2007 for Plain/rolling terrain. The horizontal alignment proposal of project highway is described below:

6.4.1.1 Package 4: Senapati to Saparmeina (Design Chainage- Km262+175 to Km287+000- length=24.82km)

The terrain of this section generally passes through plain/rolling terrain except some stretches of Steep/Mountainous terrain. The existing road has 2-lane carriageways with number of geometric deficient locations. The existing right of way (ROW) for this section as stated by State Government record is 12m only.

The efforts have been made to confine improvement of geometry of the existing road to achieve the project proposal of 4-lane divided carriageways with paved shoulder utilizing the available ROW to minimise the requirement of additional Land Acquisition except where curve improvement/minor realignments are involved. The efforts have been made to improve the geometry of project road by cutting the hill in general.

6.4.1.1.1 Senapati to Start of Kongpokpi Bypass (Design Chainage- Km262+175 to Km272+535- length=10.36km)

The locations of horizontal curve improvement along the project highway are presented in ***Table 6.8.***

Table 6.8: Location of Horizontal curve Improvements

S. No.	Design Chainage		S. No.	Design Chainage
1	263+100		3	266+000
2	263+275			

The geometric improvement/minor realignment locations along the project highway are presented in ***Table 6.9.***

Table 6.9: Location of Geometric Improvements/Minor Re alignment

S. No.	Design Chainage		Length (m)		S. No.	Design Chainage		Length (m)
	From	To				From	To	
1	262+400	262+700	300		5	267+650	267+850	200
2	263+425	263+800	375		6	268+600	269+000	400
3	265+600	265+900	300		7	269+250	272+300	3050
4	266+160	266+400	240		**Total Length(m)**			**4865**

6.4.1.1.2 Kongpokpi Bypass (Design Chainage- Km272+535 to Km274+610- length=2.075km)

Kangpokpi is a settlement on the project road in between km 274+800 & 276+050 of existing chainage of NH-39. There is habitation on both sides including market/commercial

area of the project road leaving hardly 16m/19m between building lines causing non availability of land as required for 4-lane configuration.

Based on detailed desk and site study, following Bypass options have been proposed:

- Option1: LHS of the Existing road take off before Minor Bridge
- Option2: RHS of the Existing road
- Option3: Project proposal along the existing road

The proposed bypass options are presented in ***Figure 6.1*** and detailed comparisons of these options are presented in ***Table 6.10***.

The Kongpokpi bypass is proposed to circumvent dense settlement in Kongpokpi town where settlements on both sides of the existing road having geometric deficiencies exists. It is a short bypass around 2.26 km length for which 45 m wide ROW is proposed in the vacant land. The feasibility of stable side slopes has been studied along the proposed alignment of Kongpokpi bypass.

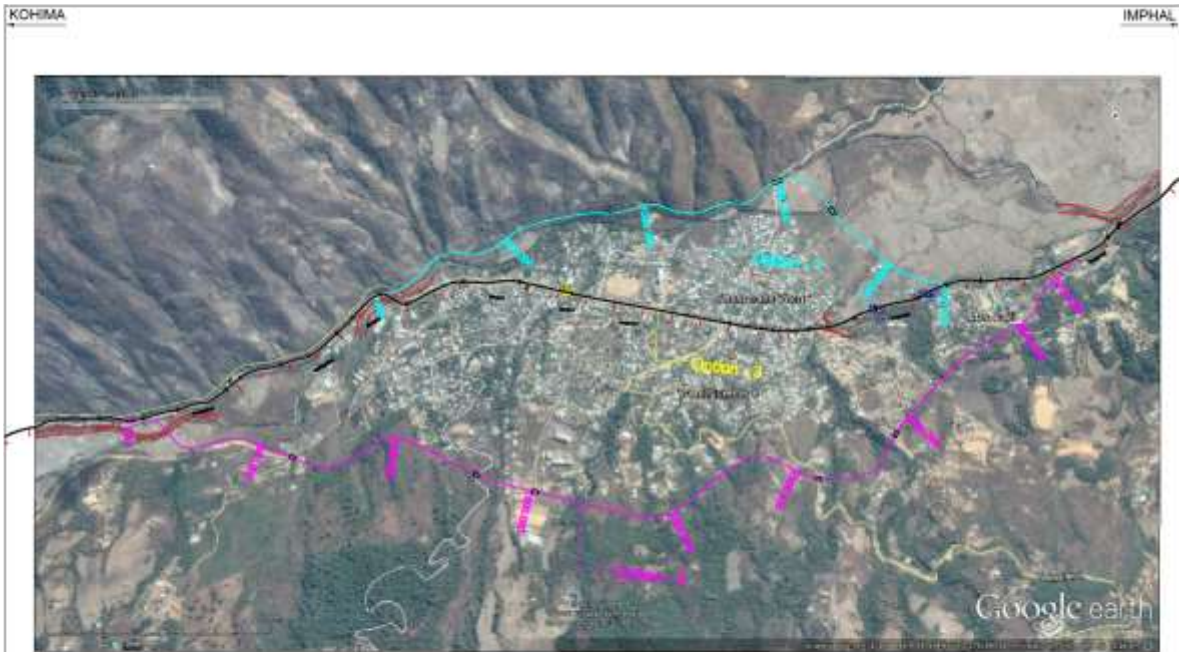


Figure 6.1: Option for Kongpokpi Bypass

Table 6.10: Comparison of alignment option for Kongpokpi Bypass

S No	Particulars	Option - I	Option - 3	Option - 2
		Bypass on LHS	Existing	Bypass on RHS
1	Start and End	km 274+600 to km 276+750		Km273+600 to km 277+150
2	Length	2.075 km	2.150 km	3.800 km
3	Geometric Constrains	No	Yes	No
4	Elevated section	0	0	0

S No	Particulars	Option - I	Option - 3	Option - 2
		Bypass on LHS	Existing	Bypass on RHS
5	ROB	0	0	0
6	Underpass / Grade Separator	1	0	4
7	Interchange	0	0	0
8	MNB	1	1	1
9	Cut/fill impact	Hill side cutting	less	Require Deep cutting
10	Social Impacts	Minor	Major	Minor
11	LA			
12	Built-up	No	Dense	Light
13	Commercial Establishment	No	Yes	No
14	Environmental Impacts			
15	Civil cost (Cr)	34	32	57
		Recommendation		

The option 1 is recommended based on length and minimum disturbance to the society. Accordingly, the detailed topographical survey has been conducted along this option.

The option 1 - bypass alignment takes off from LHS of existing road before the minor bridge because the Kongpokpi town habitation starts after this bridge. The alignment runs parallel to river and requires hill cutting to accumulate the 4-lane divided carriageway bypass proposal. This alignment merges the existing road near Church at Mao Daili village.

6.4.1.1.3 End of Kongpokpi Bypass to Saparmeina (Design Chainage- Km274+610 to Km287+000- length=12.39km)

The existing curve on project highway at design Chainage km285+800 has been improved for design speed of 100kmph.

The geometric improvement/minor realignment locations along the project highway are presented in ***Table 6.11.***

Table 6.11: Location of Geometric Improvement

S. No.	Design Chainage		Length (m)		S. No.	Design Chainage		Length (m)
	From	To				From	To	
1	275+200	275+400	200		9	283+500	284+550	1050
2	275+980	276+550	570		10	284+840	285+050	210
4	282+120	283+250	1130		**Total Length(m)**			**3160**

6.4.1.2 Package 5: Saparmeina to Imphal (Design Chainage- Km287+000 to Km308+460- length=21.46km)

The curves improvement locations along the project highway are presented in ***Table 6.12.***

Table 6.12: Curve Improvement of NH-39 beyond Kongpokpi Bypass

S. No.	Chainage	S. No.	Chainage	S. No.	Chainage
1	285+580	5	289+475	9	304+000
2	286+820	6	291+640	10	305+250
3	287+200	7	291+950	11	306+640
4	289+000	8	292+320	12	309+160

The geometric improvement/minor realignment locations along the project highway are presented in ***Table 6.13.***

Table 6.13: Geometric Improvement of NH-39 beyond Kongpokpi Bypass

S. No.	Design Chainage (Km)		Length (m)
	From	To	
1	277+020	278+200	1180
2	284+720	285+080	360
3	285+780	286+480	700
4	305+540	305+920	380
5	309+340	310+300	960

The Horizontal alignment details of designed alignment are presented in ***Volume IX****: Drawing Volume.*

A few typical cases of horizontal improvement has been shown from *Figure 6.2* to *Figure 6.9* below.

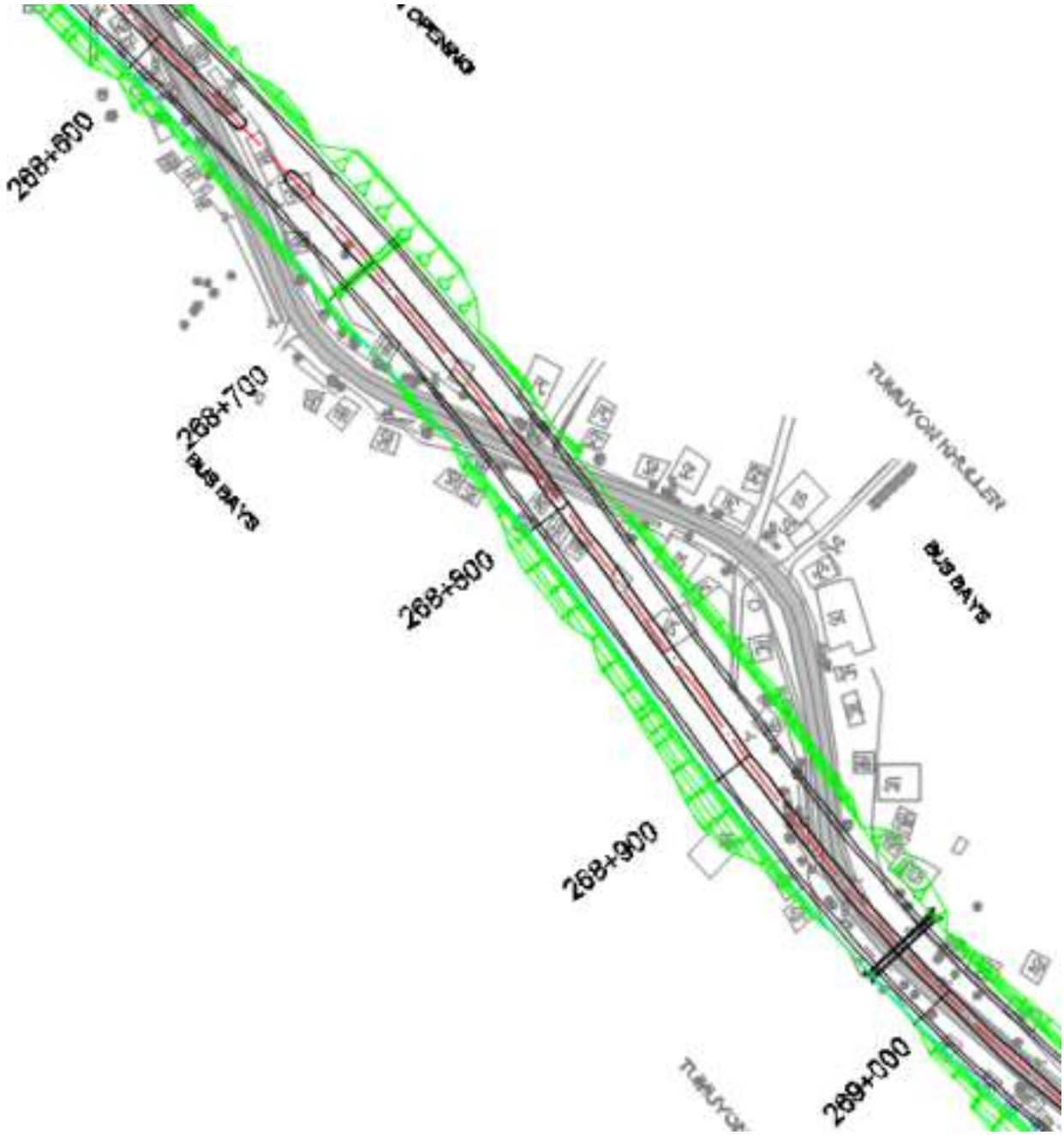


Figure 6.2: Typical Improvement from Km 268+600 to km 269+000

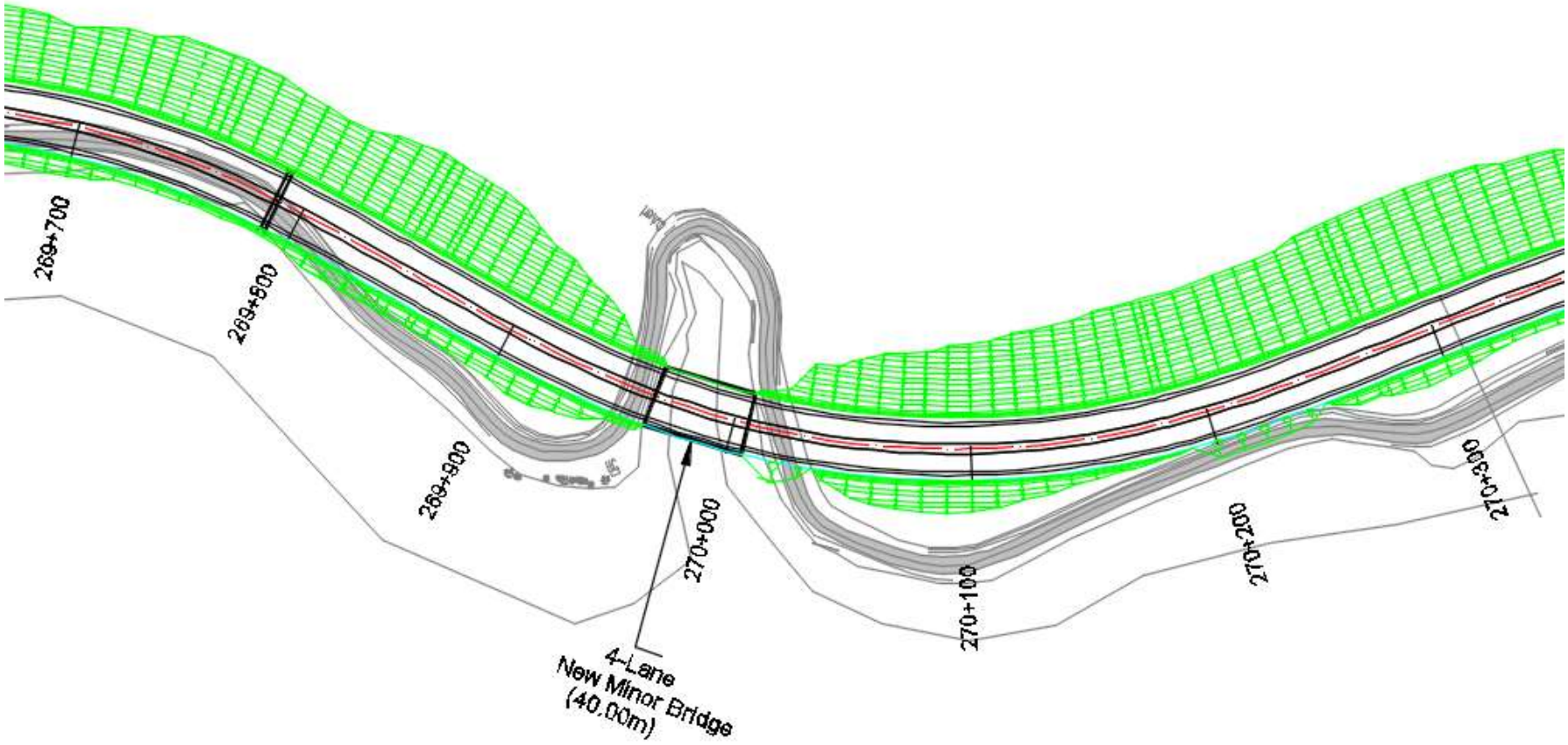


Figure 6.3: Typical Improvement from Km 269+700 to Km 270+300

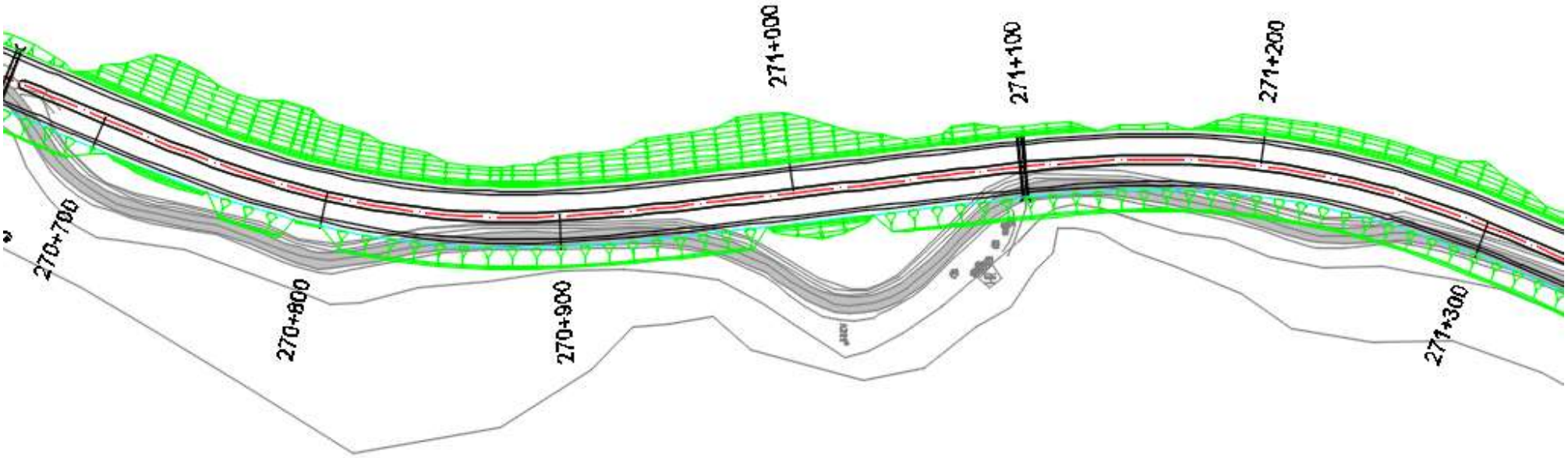


Figure 6.4: Typical Improvement from Km 270+700 to Km 271+200

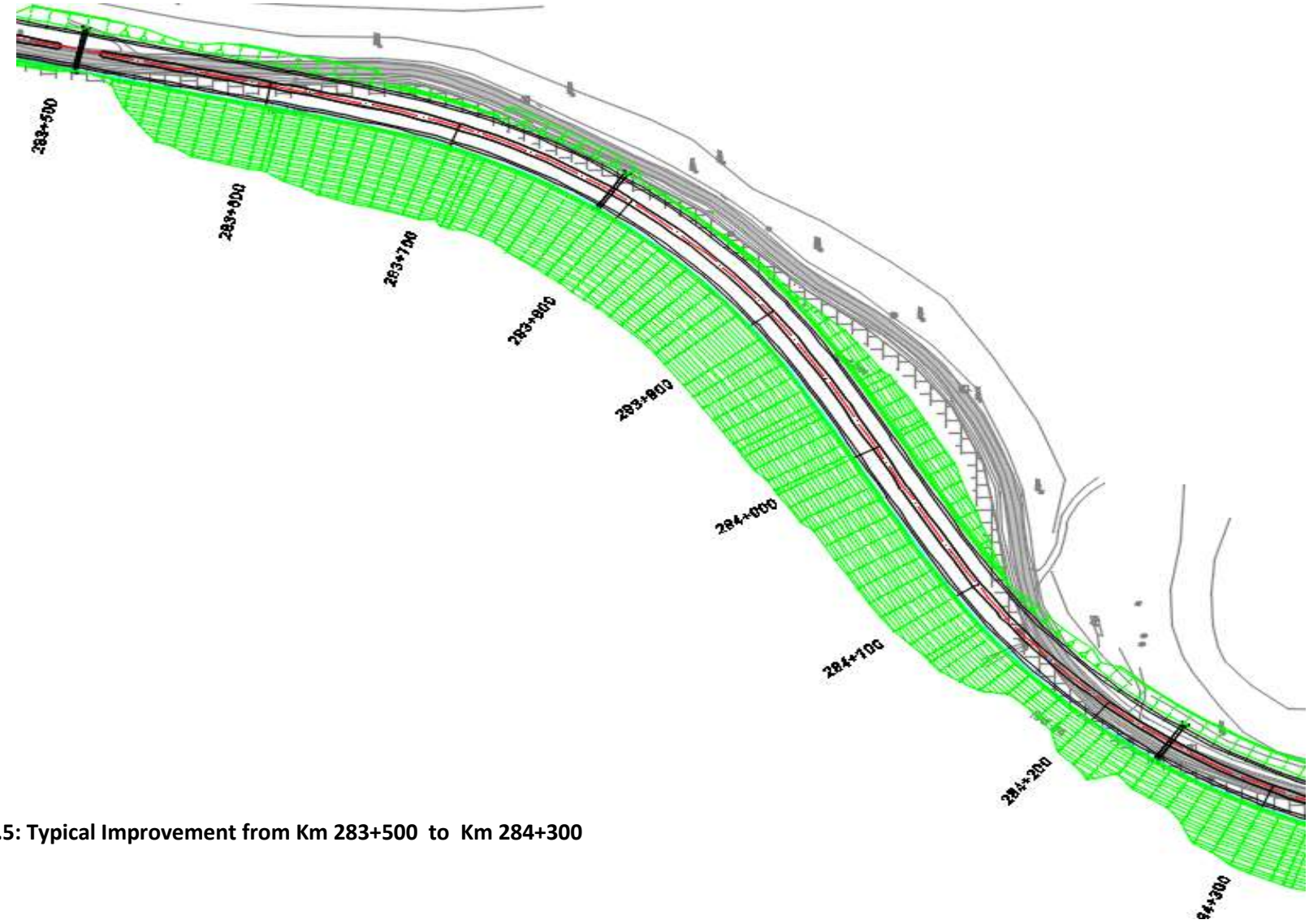


Figure 6.5: Typical Improvement from Km 283+500 to Km 284+300

Figure 6.6: Typical Improvement from Km 289+300 to Km 289+900

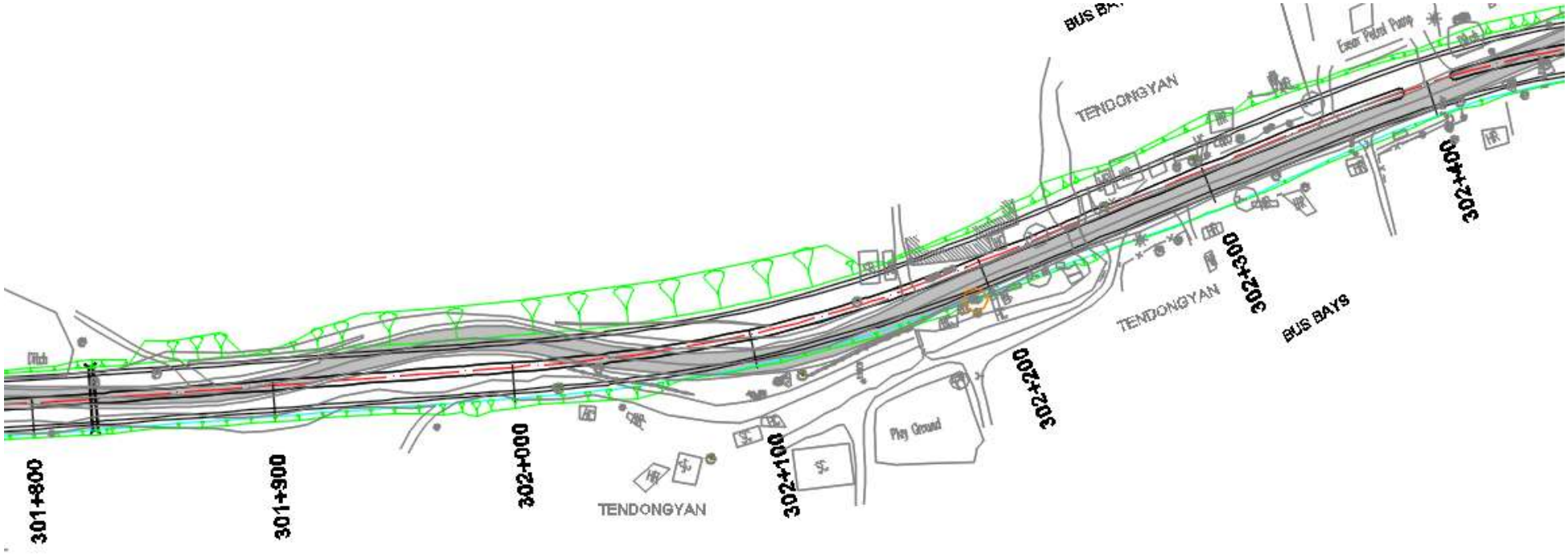


Figure 6.7: Typical Improvement from Km 301+800 to Km 302+400

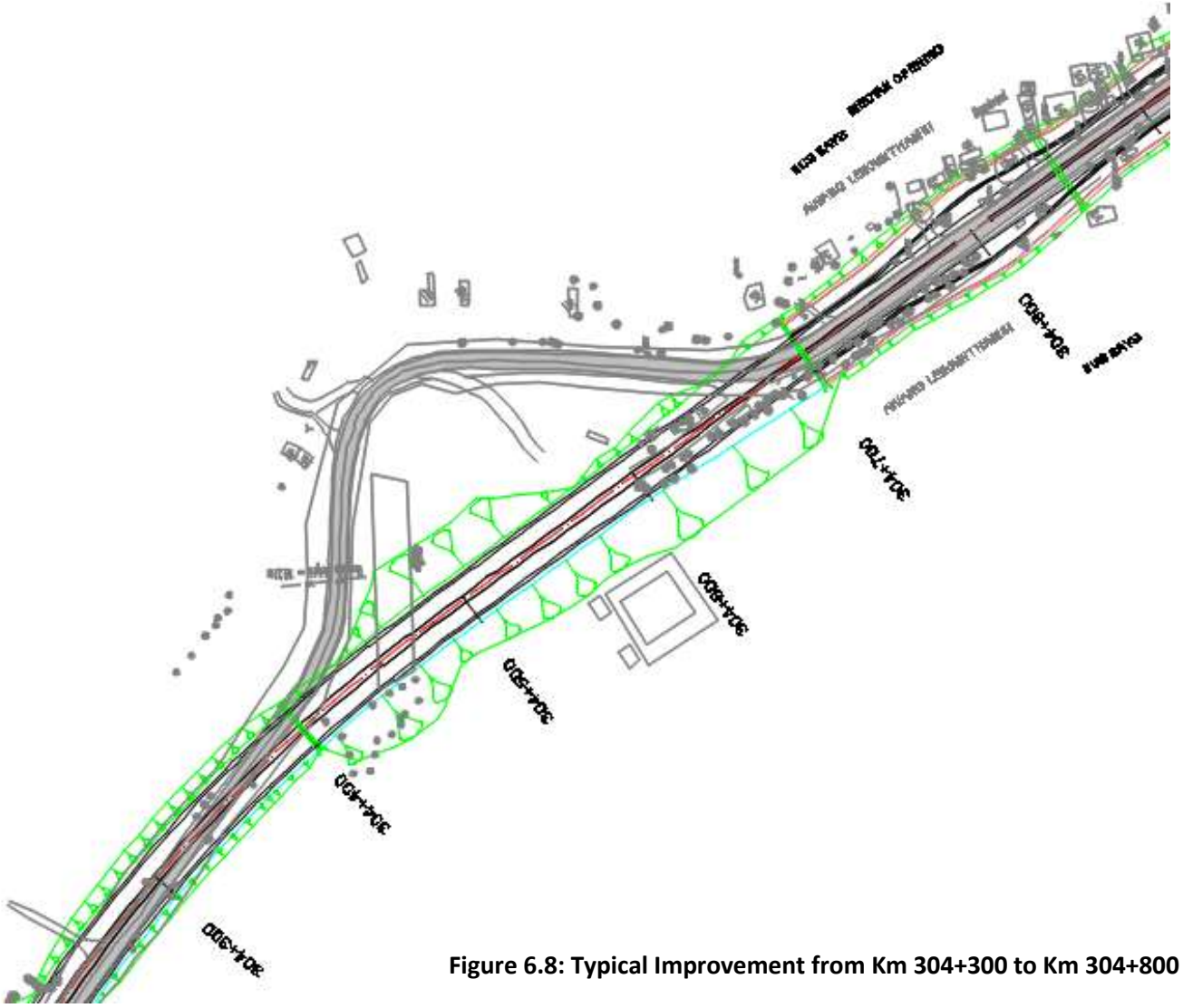


Figure 6.8: Typical Improvement from Km 304+300 to Km 304+800

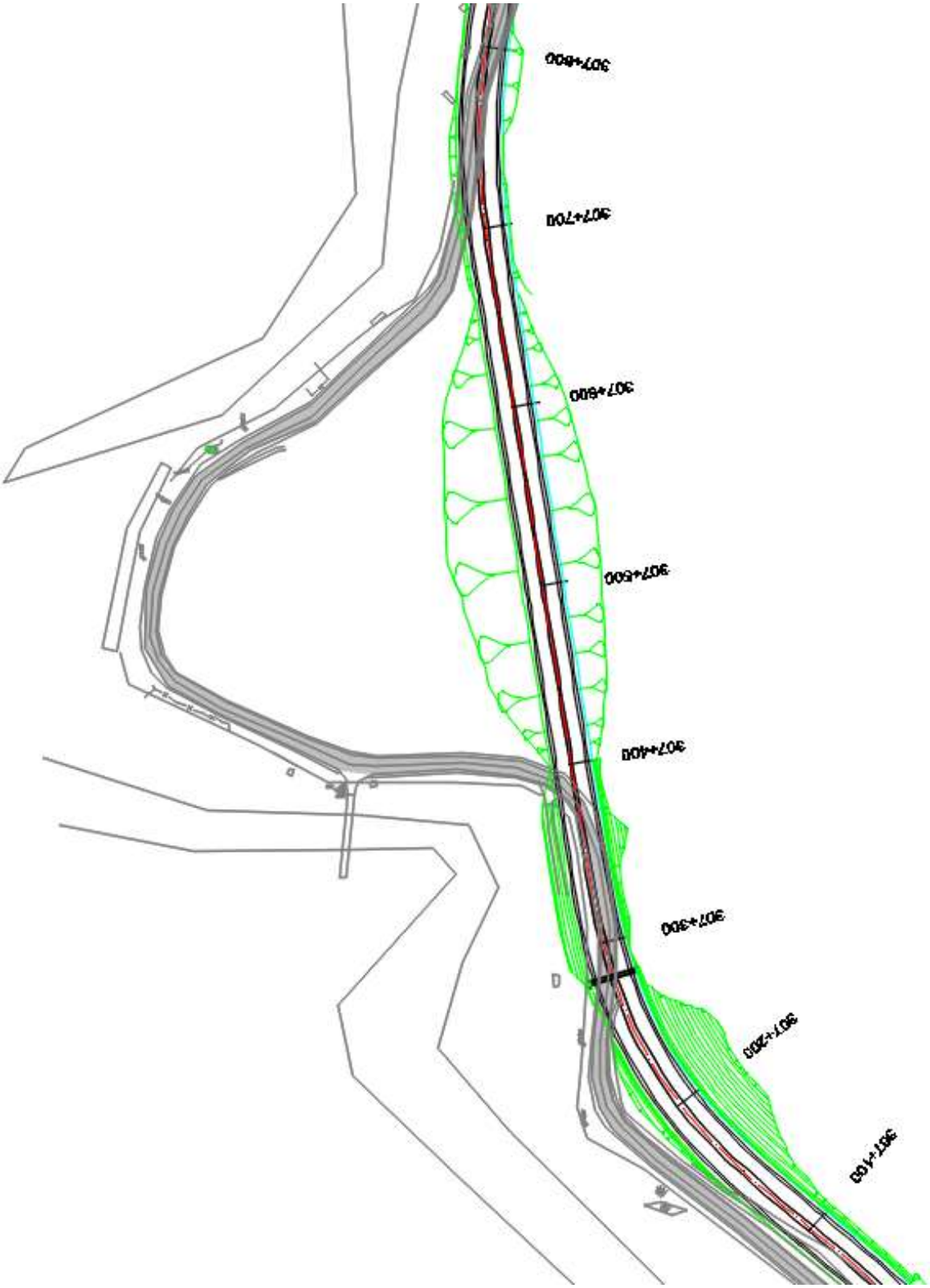


Figure 6.9: Typical Improvement from Km 307+100 to Km 307+800 (CUT & COVER LOCATION)

6.4.2. Vertical Geometrics

Vertical curves are necessary for effecting a smooth transition at the locations where grade changes. Vertical curves have been proposed at all such locations where grade changes along the finalised project highway alignment based on Stopping /intermediate sight distance.

As Senapati to Saparmeina section of project road is to be developed as four lane divided carriageway configuration, vertical curves as per Stopping /intermediate sight distance have been designed and valley curves are designed as per headlight sight distance. The structures, if any have been designed with single vertical curve to maintain design speed.

The improved vertical alignment for the Kohima-Imphal section of project highway has been designed on the ground profile generated from the ground surface modelling based on the detailed topographic surveys conducted along the existing alignment. Design has been carried out using MX Road software in unique way developing multiple profiles across the centre line and conducting evaluation thereof. The main criteria followed for fixing of the vertical control points of the alignment were, to avoid excessive cutting or filling, thus to minimise the protection, besides following ground profiles and co-ordinating surface drainage with natural channels. Efforts have been made to improve the vertical geometry i.e. to keep the longitudinal gradients within the permissible limits as per IRC by cutting the hill side or providing the retaining wall on the valley side.
At the locations where limiting gradient or steeper gradient exists, the summit points of such slopes have been depressed to the extent possible involving cutting and the effected gain thus made in lowering elevation of such summit have been used in improving the horizontal curves, if required. The horizontal and vertical alignments are thus properly coordinated to guard the safety of road users.

Proposed vertical gradient along the improved alignment thus has never exceeded the limiting gradient for plain and rolling terrain i.e., 3.3%. Efforts have been made to keep the longitudinal gradient upto rulling gradient i.e. 2.5% for the package 4 & 5. Minimum gradients have not been taken care of as most of the project road section passes through Plain or hilly terrain, therefore drainage will not develop any problem. Zero Gradients has been applied in major bridge locations.

During this process of detailed design of horizontal and vertical alignment, due care has also been taken to properly co-ordinate with the both horizontal & vertical geometry so as to ensure safety of improved utility and aesthetics of the highway. The summaries of improved Vertical Alignment details are presented in ***Table 6.14***.

Table 6.14: Summary of improved Vertical Alignment Details

Package No	Project Length (%) with Gradients		
	<=2.5%	**2.5%- 3.3%**	**>3.3%**
Package 4	78%	22%	-
Package 5	94%	6%	-

The Vertical alignment details of designed alignment are presented in ***Volume IX****: Drawing Volume.* A few typical cases of vertical geometry improvement has been shown from ***Figure 6.10*** to ***Figure 6.17***.

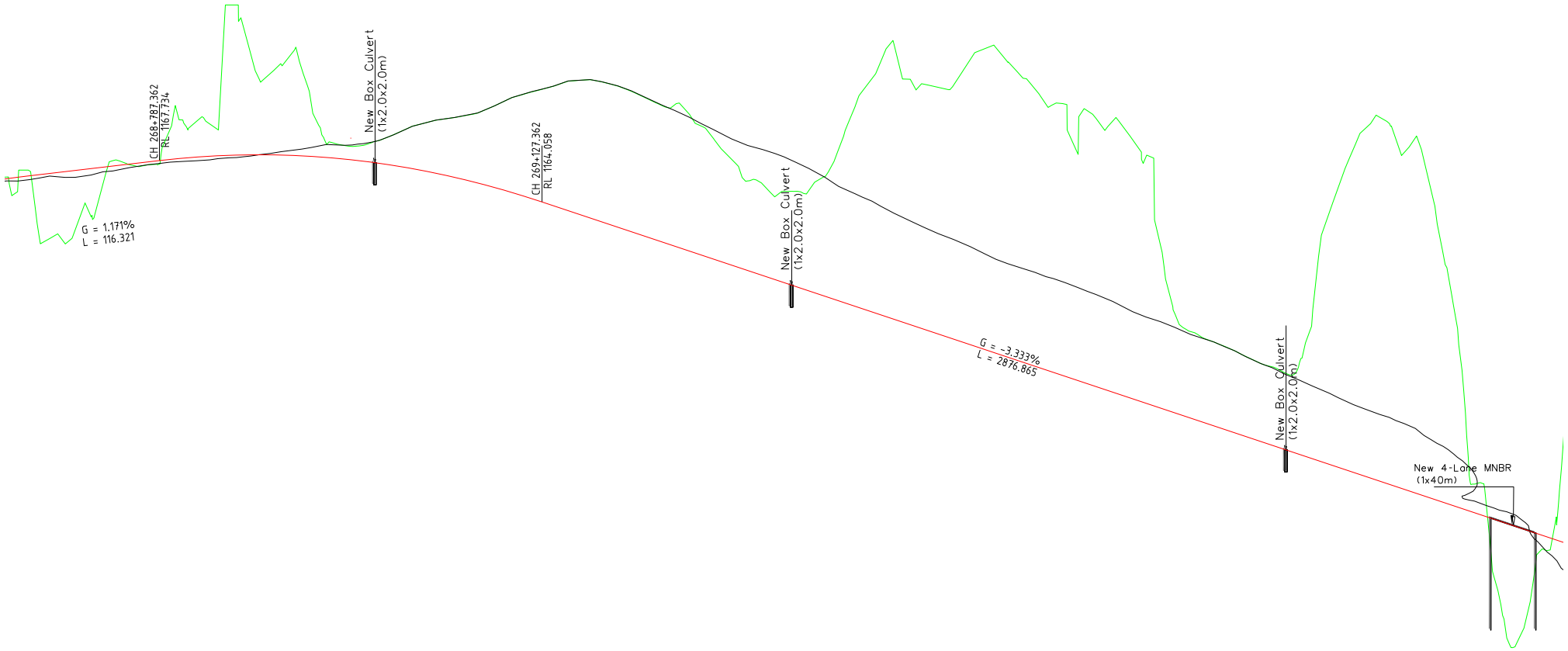


Figure 6.10: Longitudinal Profile Improvement from Km 268+700 to Km 270+000

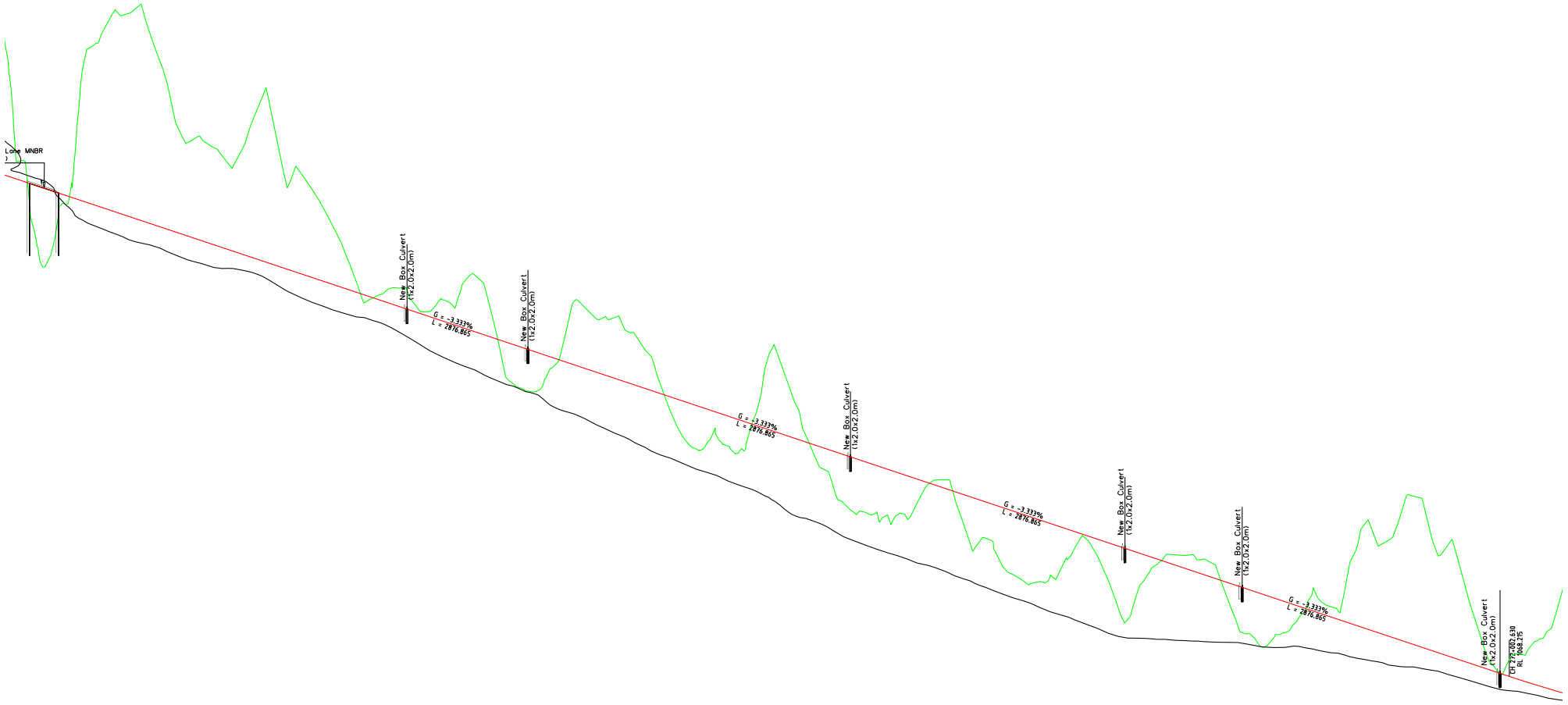


Figure 6.11: Longitudinal Profile Improvement from Km 269+900 to Km 272+000

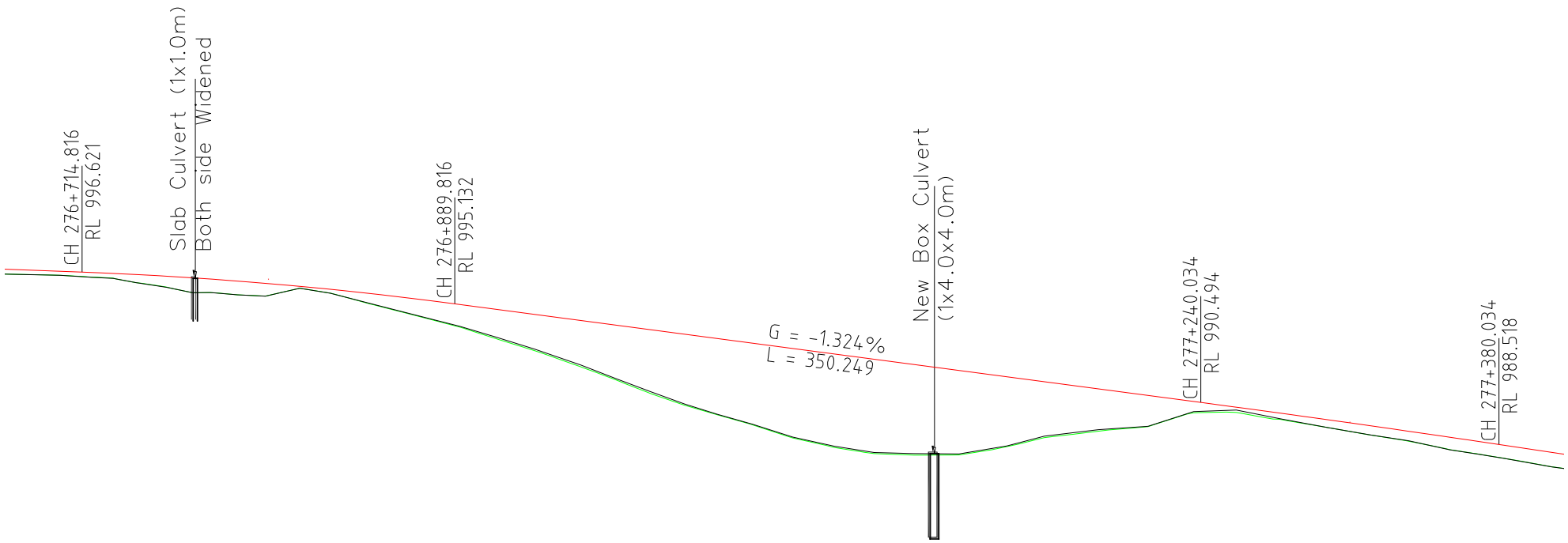


Figure 6.12: Longitudinal Profile Improvement from Km 276+700 to 277+380

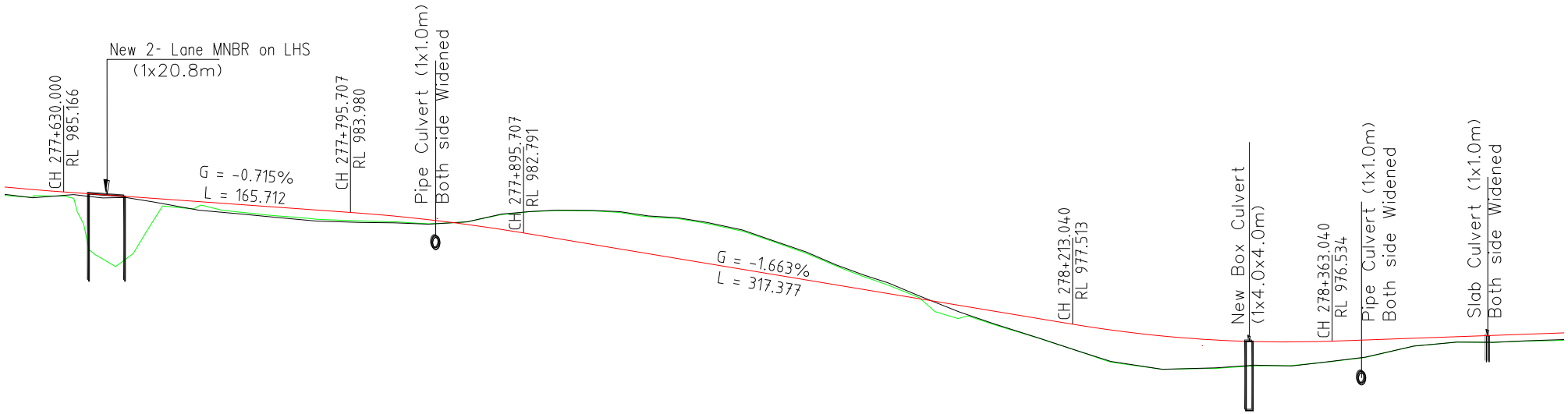


Figure 6.13: Longitudinal Profile Improvement from Km 277+600 to Km 278+500

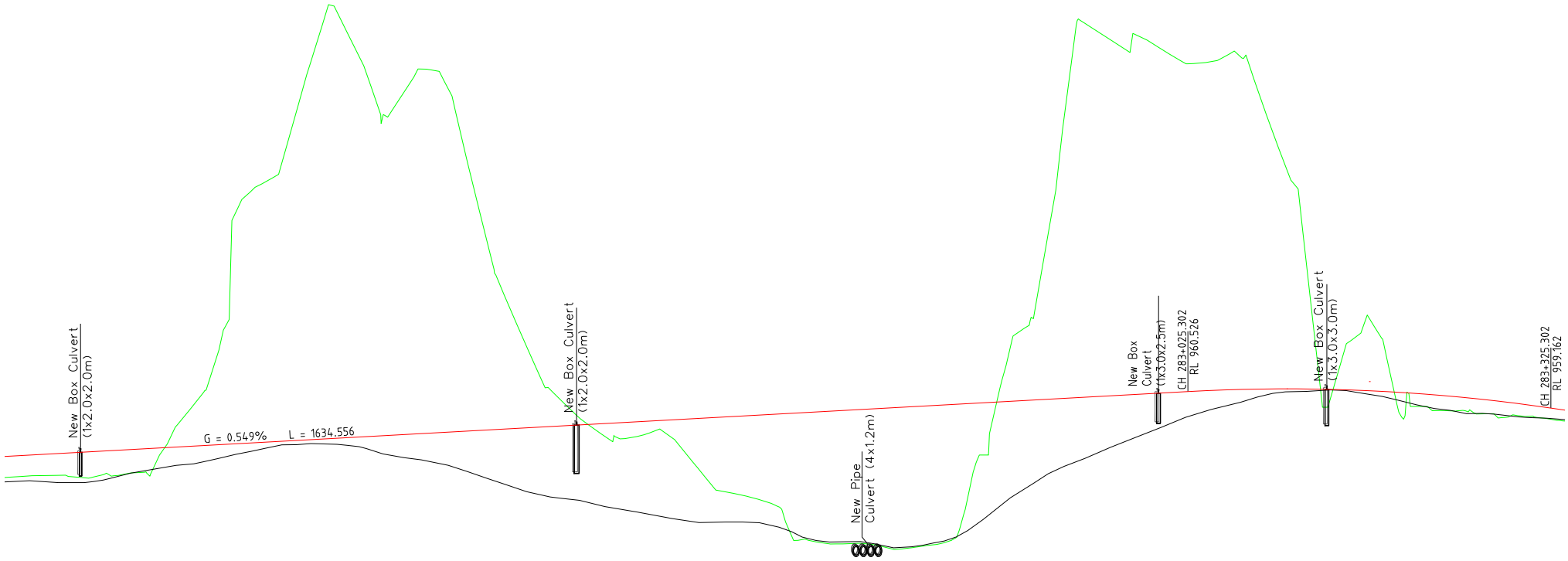


Figure 6.14: Longitudinal Profile Improvement from Km 282+100 to Km 283+300

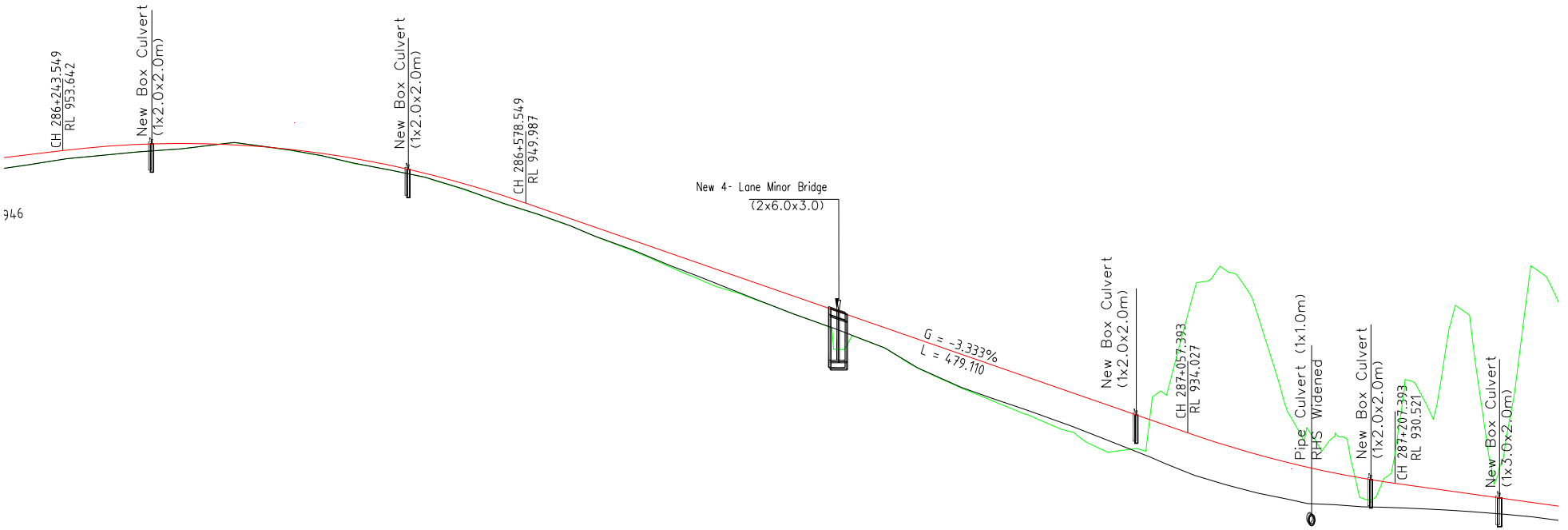


Figure 6.15: Longitudinal Profile Improvement from Km 286+200 to Km 287+300

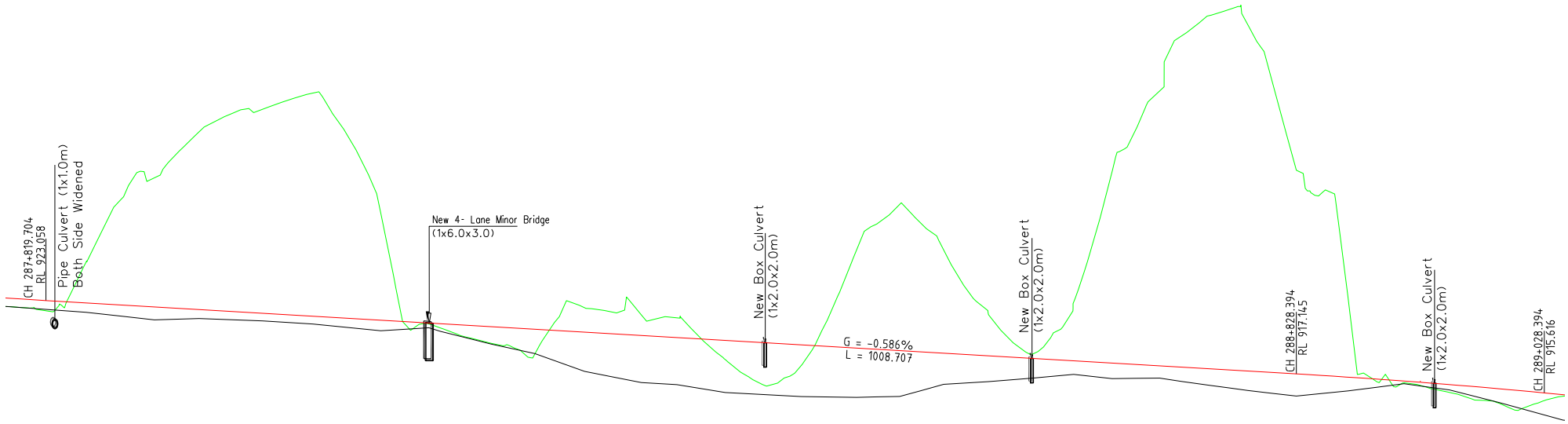


Figure 6.16: Longitudinal Profile Improvement from Km 287+800 to Km 289+000

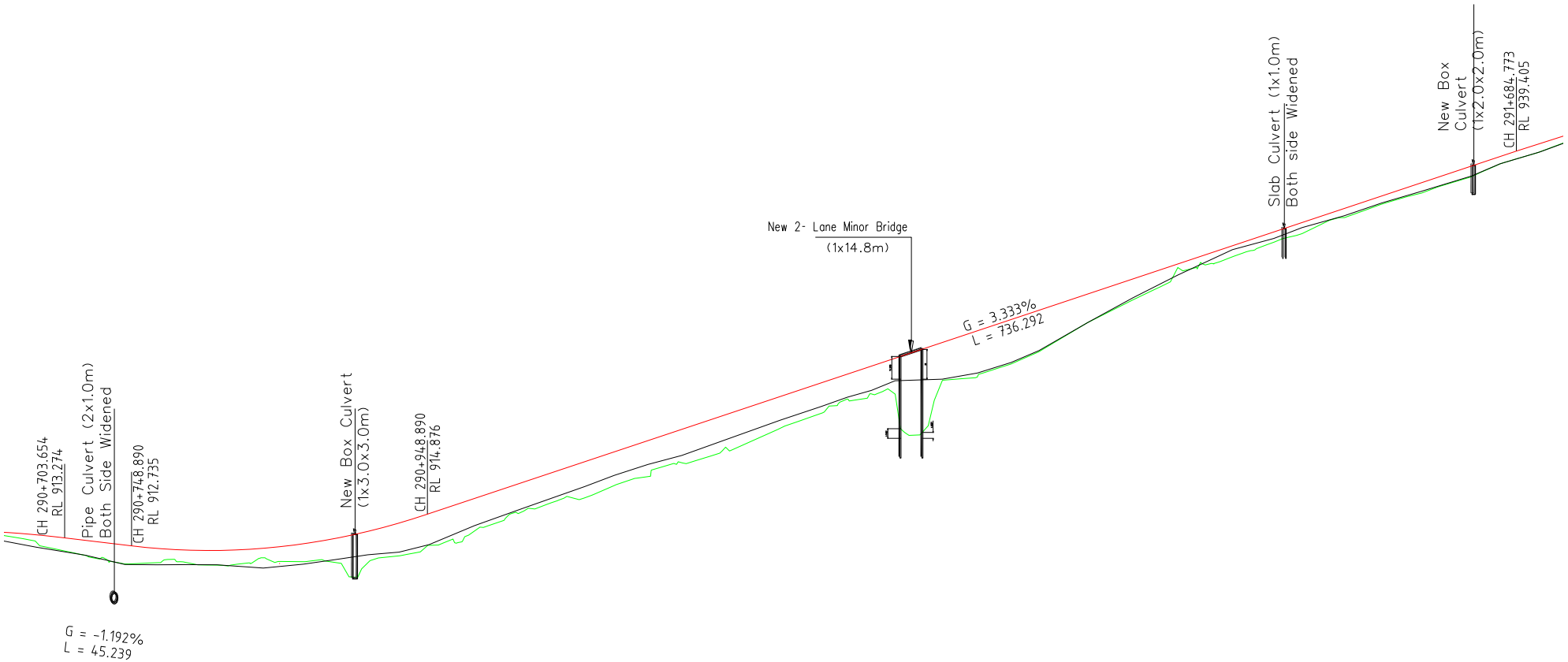


Figure 6.17: Longitudinal Profile Improvement from Km 290+700 to Km 291+700

6.5. TYPICAL CROSS SECTIONS (TCS)

The upgradation involves that the project road after improvement will have configuration of 4-lane divided carriageway with paved shoulder after Senapati town to Imphal from the current 2-lane configuration. These sections will be generally with treatment of reconstruction as well as new construction as described in the widening/improvement proposal. Road Cross sections have been designed considering the terrain type, built-up area and types of treatment envisaged (reconstruction, widening, and new construction). The various Typical Cross Sections (TCS) adopted for the project road have been presented in Appendex - 13 of this report.

The long side slope for soil have been provided with stepped cutting and presented in various TCS is 1H:2V (minimum). It is indicative only and variable based on the existing terrain and soil type at site.

The urban built up section with and without service roads have been proposed along the project corridor are presented in ***Table 6.15.***

Table 6.15: Urban Sections along the Project Road

S. No.	Design Chainage(Km)		Length (m)	TCS Type	Service Road Proposed
	From	To			
Package 4: Senapati to Saparmeina					
1	278+500	279+635	1135	9	No
2	279+652	279+730	78	9	
3	279+730	279+790	60	13	
4	279+790	280+150	360	9	
5	280+150	280+200	50	10	
6	285+820	285+910	90	10	
7	285+910	286+798	888	9	
8	286+810	286+900	90	9	
Package 5: Saparmeina to Imphal					
1	291+700	292+190	490	12	Yes
2	292+190	292+210	20	11	Yes
3	292+210	292+350	140	12	Yes
4	292+450	293+400	950	9	No
5	294+400	295+100	700	9	No
6	298+400	298+670	270	11	Yes
7	298+670	298+750	80	12	Yes
8	298+750	298+840	90	11	No
9	298+840	299+240	400	12	Yes
10	304+700	306+820	2120	9	No
11	306+820	306+940	120	10	No

The proposed Typical Cross Section Schedule along the project corridor is presented in ***Volume IX****: Drawing Volume.*

6.6. PAVEMENT

The existing 2-lane/intermediate lane carriageway configuration road from Kohima to Imphal is to be upgraded as two lanes with paved shoulders from Kohima to Senapati and balance section will be upgraded to 4-lane divided carriageway. As brought out earlier, the entire road is a candidate for reconstruction after improving the alignment causing reduction in steepness of vertical gradients in general. For design of 'New' pavement, the methodology as mentioned in Chapter 4: Detailed Methodology, has been followed concluding as below:

6.6.1. Pavement Type

The various pavement type options, which are studied, are as under:

- New Pavement for Reconstruction and realignment portion with
  - Flexible Pavement
  - Rigid Pavement

As per MoRT&H circular, DPR Consultant shall consider the rigid pavement for the new bypasses proposal and where the road section has eccentric widening for more the 3km length. But as per clause no 10.2.1 and 10.23.1 of IRC:SP:48-1998, the rigid pavement is not recommended for roads in the hilly region due to:

- Practical construction problems
- Unstable area
- Less working season
- Maintenance problems of concrete road

About 70% section of the project road passes through the Mountainous/Steep terrain which predominately involves only realignments due to geometric improvement, the length of which varies from 50m to 1km. Hence, the consultant has considered the flexible pavement type only for the entire project road.

6.6.2. Design Parameters for Flexible Pavements

- Sub-grade strength (CBR %)
- Design Traffic (msa)

6.6.3. Design Parameters

(a) Design Life

Asphalt Surfacing, Base and Sub base are designed for 15 years period.

(b) Design Traffic and Loading

i. Design Traffic

In order to determine the design traffic, classified volume count surveys were conducted for 24 hours continuously for 7 days along the Project Road. Traffic for pavement design purpose constitutes of commercial vehicles of greater than 3.0

tonnes gross vehicle weight. The base year traffic in different categories for various road sections is estimated and projected by adopted growth rates for the entire design period and presented in Traffic Survey and Analysis Chapter.

ii. Design Lane Traffic

Project Road is improved as 2-lanes with paved shoulder/4-lane divided carriageway facility. Therefore Design lane traffic is determined by application of:

- Directional Distribution factor of 0.5, and
- Lane Distribution factor
  - 50% of total number of commercial vehicle in both direction for 2 –Lanes
  - 75% of number of commercial vehicle in each direction- dual 2-lane

The above values are considered as per IRC 37-2012.

iii. Vehicle Damage Factor (VDF)

Based on the analysis of Axle-load survey data, the value of Vehicle damage factor (VDF) has been determined and presented in ***Table 6.16.***

Table 6.16: Adopted VDF Values

S. No.	Road Section	Length (km)	Trucks				Bus
			LCV	2-Axle	Tandem	MAV	
1	Kohima to Senapati	74.3	1.17	3.66	3.61	4.68	0.84
2	Senapati to Imphal	51	1.45	3.26	3.43	4.14	0.88

iv. Homogenous sections

As mentioned in Chapter 4: Detailed Methodology, following **Table 6.17** give details of the Traffic Homogeneous Sections.

Table 6.17: Traffic Homogeneous Sections

Sl. No.	From	To	Existing Chainages		Length (km)
			Start (km)	End (km)	
1	Kohima	Tadubi	185+540	219+600	34.06
2	Tadubi	Senapati	219+600	259.250	39.6
3	Senapati	Kangpokpi	259.250	275+700	16.5
4	Kangpokpi	Imphal	275+700	311+000	35.3

v. Design Traffic Loading

As per the homogenous sections stated above, Design Traffic loading computed for different sections are shown in Table 6.18 in Million Standard Axles (MSA).

Table 6.18: Design Traffic (MSA)

Sl. No.	From	To	Design Traffic (MSA)	Adopted Traffic (MSA)
1	Kohima	Tadubi	17.7	20
2	Tadubi	Senapati	17.6	20
3	Senapati	Kangpokpi	22.0	30
4	Kangpokpi	Imphal	31.6	30

(c) Subgrade Strength

Soil Properties along the project corridor is varying and hence design subgrades CBR of 6% to 8% are adopted for new subgrade both for widening and new construction. The barrow area soil CBR observed in Senapati to Imphal section is in the range of 8.5% to 10%.The adopted section wise CBR for the design of project highway corridor are given in ***Table 6.19***. Further, in mountainous region where rock cutting is involved, no subgrade would generally be required. After levelling with granular material (GSB), directly pavement layers shall be constructed.

Table 6.19: Adopted Design (Effective) Subgrade CBR

Sl. No.	From	To	Length (km)	Adopted design Subgrade CBR
1	Kohima	Tadubi	33.9	6%
2	Tadubi	Senapati	39.6	6%
3	Senapati	Kangpokpi	16.5	8%
4	Kangpokpi	Imphal	35.3	8%

6.6.4. Recommended Pavement Composition for New Construction

6.6.4.1 Recommended Pavement Composition for Main Carriageway (New Construction)

As per IRC: 37-2012 pavement compositions for each road section for the given input are listed in ***Table 6.20*** below:

Table 6.20: Proposed Pavement Crust Composition (mm)

Sections >>> / Pavement Composition	Kohima to Tadubi	Tadubi to Senapati	Senapati to Kangpokpi	Kangpokpi to Imphal
BC (mm)	40	40	40	40
DBM (mm)	90	90	100	100
WMM (mm)	250	250	250	250
GSB (mm)	260	260	200	200
Total Thickness (mm)	**640**	**640**	**590**	**590**

The thickness of Subgrade in each case is 500 mm except where rock cutting is involved. The bottom GSB layer will be extended till earthen shoulder to facilitate of proper drainage in the

pavement structure. The new pavement layers will be placed over an appropriate sub grade of 500 mm thickness compacted to minimum 97% MDD.

6.6.4.2 Recommended Pavement Composition for Service Roads

The minimum design traffic for Service road shall be 10MSA as per clause 5.5.5 of IRC:SP:84-2014. As per IRC: 37-2012, pavement crust compositions to be adopted for Service road considering 10 MSA and 8% CBR are presented in Table ***6.21*** below:

Table 6.21: Proposed Pavement Crust Composition for Service road (mm)

Description	Pavement Crust Composition (mm)			
	BC	DBM	WMM	GSB
Service Road	40	60	250	200

6.6.5. Justification for 'New' Pavement Construction

The consultants have analysed the existing pavement in the context of upgrading to 2-lane with paved shoulders/ 4-laning. The existing pavement is in such a state where salvaging it will be a herculean task with no guarantee for its extended life. Huge amount of investment will be at risk in this area. Besides, patches of different pavement layers will be frequently laid in short lengths, making the performance of road monitoring difficult for feedback.

Whereas in case of 'NEW' construction in its entire length is considered as safe investment resulting into meaningful pavement quality with tremendous economic advantages as it will throw open an opportunity to re-align the road geometrics to be much safe, effecting reduction in VOC, time saving, saving environment easy to negotiate and resulting in win-win situation. The project cost shall get offset by the huge accrual of economic benefits and area will get open to whole range of economic activities. This road being part of Great Asian Highway, is likely to invite investments both domestic and foreign in case its geometry and road condition are significantly improved which is possible only when new road condition are significantly improved which is possible only when 'New' road construction is taken up.

6.7. CROSS-DRAINAGE STRUCTURES

The inventory and condition survey of existing cross-drainage structures have been presented in Chapter –5: Engineering Survey and Investigations of Volume1: Main Report of Final Feasibility Report. The classification system for all structures has been evolved based on current practices. Adequacy and condition of existing structures have been examined on hydrological, hydraulic and visual considerations and standard designs have been evolved for different groups of spans for extension and reconstruction provisions. No non-destructive tests (NDT) have been performed for evaluation of hydraulic structures. The provision of proposed pipe and other culverts have been based on standard designs. The design details for culverts also includes invert levels, type and dimensions of head wall and wing wall, slope protection and bed protection works. The proposal also includes the reconstruction of existing culverts which have been found to be in unsatisfactory / damage condition. At certain locations additional culverts

have also been recommended for inclusion to improve drainage in the region. The culvert proposal is summarised in ***Table 6.22.***

Table 6.22: Proposals for Culverts

Package Nos.	New Box Culvert	Reconstruction by Box Culvert	Retained & Widened	
			Slab Culvert	Pipe Culvert
Package 4	22	49	17	8
Package 5	33	43	3	4

The details of proposed Cross Drainage Structures along the project corridor are presented in ***Appendix 1-4*** *of Volume I: Main Report.*

6.8. BUS BAYS & TRUCK LAY BYES

The 15m length bus bays with ghost Island and both side 100m taper length as per Figure 12.2 of IRC:SP:84-2014 have been proposed and locations are presented in ***Table 6.23***.

Table 6.23: Bus Bay Locations

S. No.	Design Chainage (Km)	Side	Town/Village Name
Package-4 : Senapati to Saparmeina			
1	264+050	Both	Hengbung
2	265+320	Both	Hengbung
3	267+400	Both	Thangal
4	268+710	RHS	Tumuyon Khullen
5	268+900	LHS	Tumuyon Khullen
6	272+630	Both	Starting Of Kangpokpi Bypass
7	274+750	Both	End of Kangpokpi Bypass
8	276+750	Both	Tumnoupokpi
9	277+950	Both	Kalapahar
10	278+850	Both	Keithelmanbi
11	286+110	Both	Surmeina
Package-5 : Saparmeina to Imphal			
1	288+710	Both	Takpakhul
2	290+910	Both	Pangmoul
3	292+000	Both	Motbung (Urban)
4	294+850	Both	Kanglatongbi
5	295+520	Both	Kanglatongbi
6	299+050	RHS	Sekmai (Urban)
7	299+100	LHS	Sekmai (Urban)
8	300+400	RHS	Maharabi
9	300+500	LHS	Maharabi

S. No.	Design Chainage (Km)	Side	Town/Village Name
10	302+300	Both	Tendongyan
11	303+850	Both	Tendongyan
12	304+810	Both	Khonghampat
13	305+700	LHS	Khonghampat
14	305+800	RHS	Khonghampat
15	308+100	Both	Imphal

Truck lay bye (100m length) with either side taper of 70m length as per Figure 12.1 of IRC:SP:84-2014 have been proposed at Km262+980.

6.9. MEDIAN OPENING & UTILITY DUCT

Median openings of 20m width are proposed and locations along the project road are presented in ***Table 6.24***.

Table 6.24: Location of Median Opening

S. No.	Design Chainage (Km)	Village / Town		S. No.	Design Chainage (Km)	Village / Town
Package-4 : Senapati to Saparmeina						
1	263+150	Near Truck Laybay		8	278+950	Keithelmanbi
2	265+450			9	279+900	Keithelmanbi (School Bulding)
3	267+050	Thangal		10	281+700	Bethel Veng
4	268+700	Tumnyon		11	284+750	Phoibih
5	270+800			12	285+900	Suparmeina
6	276+800	Tumnoupokpi		13	286+400	Suparmeina
7	277+750	Kalapahar				
Package-5 : Saparmeina to Imphal						
1	288+400			6	294+600	Vijaynagar
2	290+650	Pangmoul		7	295+600	Kanglatongbi
3	291+650	Motbong		8	298+100	Sekmai
4	292+100	Motbong		9	305+300	Awang Lekainthambi
5	293+200	Motbong		10	306+300	Awang Lekainthambi

As per clause 2.16 of IRC:SP:84-2014, 600mm diameter NP-4 Pipe along with inspection box/chamber have been recommended at one km interval in built-up area.

6.10. TOE/RETAINING & BREAST WALLS

The PCC/Stone Masonry Breast walls have been proposed on hill side along the roadway edge where cutting is required or cutting is more than available ROW.

Retaining walls are proposed to restrict the earth along the filling section where normal side slope crosses the available ROW. The PCC toe walls are adopted upto the height of 2m and RCC retaining wall where the required height of wall at site is more than 2m.

The lined drains have been proposed in hill cutting section to have speedy disposal of surface water. The summary of proposed Toe/Retaining walls and Breast walls are as below:

The proposed locations of Breast walls, Toe walls and Retaining walls along the package 4 & 5 are presented in ***Appendix 1-5, Appendix 1-6 and Appendix 1-7*** *of Volume I: Main Report* respectively and summary of these wall lengths are presented in ***Table 6.25***.

Table 6.25: Summary of Toe/Retaining and Breast wall Lengths

S. No.	Wall Type	Length (m)		Height (m)	
		LHS	RHS	LHS	RHS
Package 4: Senapati to Saparmeina					
1	PCC Toe wall	1630	700	0.93	0.78
2	Breast wall	945	2655	1.5	1.5
3	Breast wall	3360	6940	3	3
4	Retaining wall	2530	1568	3.04	4.51
Package 5: Saparmeina to Imphal					
1	PCC Toe wall	1294	265	0.75	1.04
2	Breast wall	400	850	1.5	1.5
3	Breast wall	370	1730	3	3
4	Retaining wall	859	36	2.45	1.73

6.11. W- Beam Metal Crash Barrier

The W-beam metal crash barriers are proposed where the embankment height is more than 3m.

The safety barriers are also recommended on both sides of curves where the horizontal curve radius are upto 450m as per clause 9.7.1 of IRC: SP: 84-2014.

The locations of package 4 & 5 where Metal crash barriers are recommended are presented in ***Appendix 1-8*** *of Volume I: Main Report* and proposed Metal crash barrier length summary are presented in ***Table 6.26***.

Table 6.26: Summary of Metal Crash Barrier Lengths

S. No.	Pkg No.	Embankment Height =3m or more		Horizontal Curve radius upto 450m
		LHS	RHS	
1	4	6948	1894	10777
2	5	3565	1229	9280

6.12. MAJOR & MINOR JUNCTIONS

The details of major junction for package 4 & 5 are presented in ***Table 6.27.***

Table 6.27: Details of Major Junctions

Sl. No.	Design Chainage (Km)	Type of Junction	Village /Town
Package 4: Senapati to Saparmeina			
1	272+536	Y	Kangpokpi Bypass Start
2	274+622	Y	Kangpokpi Bypass End
Package 5: Saparmeina to Imphal			
1	299+244	+	Sekmai
2	300+417	Y	Maharabi Mayai Lambi
3	302+582	Y	Tendongyan Realignment
4	303+286	Y	Pheidinga
5	303+671	Y	Pheidinga
6	308+294	+	Imphal

The details of proposed minor junctions for package 4 & 5 are presented in ***Table 6.28.***

Table 6.28: Location of Minor Junctions

S. No.	Design Chainage (Km)	Type of Junction	Side	Width (m)	Town /Village
Package-4 : Senapati to Saparmeina					
1	265+243	Y	LHS	2.7	Henjbung
2	266+997	T	RHS	4.3	Henjbung
3	267+262	T	RHS	2.2	Thangal
4	267+294	T	LHS	2.8	Thangal
5	267+425	T	LHS	2.8	Thangal
6	267+995	Y	LHS	3	Tumuyon khullen
7	268+298	Y	LHS	3.6	Tumuyon khullen
8	268+559	Y	LHS	2.7	Tumuyon khullen
9	268+776	Y	LHS	2.8	Tumuyon khullen
10	268+870	Y	LHS	2.6	Tumuyon khullen
11	269+084	T	LHS	3.2	Tumuyon khullen
12	276+675	T	RHS	2.5	Tumnoupokpi
13	277+056	Y	LHS	2.6	Tumnoupokpi
14	277+142	Y	RHS	2.6	Tumnoupokpi
15	278+700	T	RHS	5.4	Keithelmanbi
16	278+826	T	RHS	3.0	Keithelmanbi
17	278+896	T	RHS	2.8	Keithelmanbi
18	279+003	T	RHS	3.5	Keithelmanbi
19	279+685	Y	LHS	2.1	Keithelmanbi

S. No.	Design Chainage (Km)	Type of Junction	Side	Width (m)	Town /Village
20	279+693	Y	RHS	2.5	Keithelmanbi
21	279+801	Y	RHS	3.6	Keithelmanbi
22	279+823	T	LHS	3.7	Keithelmanbi
23	279+882	T	RHS	2.1	Keithelmanbi
24	280+452	T	RHS	2.9	Keithelmanbi
25	281+490	T	RHS	3.1	Keithelmanbi
26	282+013	Y	RHS	4.9	Bongmoul
27	284+581	Y	RHS	5.0	Phoibih
28	284+659	Y	RHS	2.5	Phoibih
29	285+465	T	RHS	2.7	Phoibih
30	285+952	T	RHS	2.3	Phoibih
31	286+022	Y	LHS	2.5	Saparmeina
32	286+058	Y	RHS	2.9	Saparmeina
33	286+146	T	LHS	2.7	Saparmeina
34	286+162	T	RHS	4.2	Saparmeina
35	286+765	Y	LHS	4.3	Saparmeina
36	286+820	Y	RHS	5.6	Saparmeina
Package 5 : Saparmeina to Imphal					
1	288+893	Y	RHS	4.2	Tokpa khul
2	290+386	Y	RHS	3.8	Tokpa khul
3	290+728	T	RHS	3.4	Pangmoul
4	290+775	T	RHS	2.9	Pangmoul
5	290+826	Y	RHS	3.0	Pangmoul
6	291+361	T	LHS	2.4	Pangmoul
7	291+507	T	LHS	2.3	Pangmoul
8	291+614	T	RHS	2.1	Motbung
9	291+730	T	RHS	2.5	Motbung
10	291+762	T	LHS	2.7	Motbung
11	291+860	T	RHS	3.0	Motbung
12	291+878	Y	LHS	3.9	Motbung
13	291+919	T	LHS	2.6	Motbung
14	291+920	T	RHS	3.6	Motbung
15	292+114	T	RHS	3.0	Motbung
16	292+202	T	LHS	2.3	Motbung
17	292+383	Y	LHS	2.5	Motbung
18	292+617	T	LHS	2.6	Motbung
19	292+835	T	RHS	3.3	Motbung
20	292+938	T	LHS	3.5	Motbung
21	293+274	T	LHS	2.6	Motbung
22	293+349	T	RHS	2.2	Motbung

S. No.	Design Chainage (Km)	Type of Junction	Side	Width (m)	Town /Village
23	293+567	Y	RHS	5.1	Kuraopokpi
24	294+394	T	RHS	5.2	Stantipur
25	294+553	T	LHS	3.3	Vijaynagar
26	294+900	T	RHS	3.3	Vijaynagar
27	294+932	T	LHS	4.3	Vijaynagar
28	294+960	T	RHS	1.7	Vijaynagar
29	295+062	T	LHS	3.7	Vijaynagar
30	295+350	T	LHS	4.2	Kanglatongbi
31	295+494	T	RHS	5.1	Kanglatongbi
32	295+547	T	RHS	4.8	Kanglatongbi
33	295+822	Y	RHS	4.3	Kanglatongbi
34	295+908	T	LHS	3.4	Kanglatongbi
35	297+211	Y	RHS	6.7	Kanglatongbi
36	297+874	Y	RHS	2.8	Kanglatongbi
37	298+175	Y	LHS	3.6	Seknai
38	298+492	T	LHS	3.0	Seknai
39	298+502	Y	RHS	3.7	Seknai
40	298+634	T	RHS	2.4	Seknai
41	298+898	Y	LHS	3.5	Seknai
42	298+978	Y	RHS	3.2	Seknai
43	299+009	Y	LHS	2.7	Seknai
44	299+116	Y	RHS	3.9	Seknai
45	299+188	T	RHS	2.3	Seknai
46	299+400	T	LHS	3.5	Tendongyan
47	302+256	Y	RHS	3.3	Tendongyan
48	302+368	T	RHS	2.6	Pheidinga
49	303+695	T	RHS	2.9	Pheidinga
50	304+572	T	LHS	5.6	Awang Leikainthambi
51	305+137	Y	RHS	3.3	Khoirentampak
52	305+930	Y	RHS	3.7	Khoirentampak
53	305+990	T	LHS	3.8	Khoirentampak
54	306+230	T	LHS	2.8	Khoirentampak
55	306+498	Y	RHS	2.7	Khoirentampak

6.13. SIDE SLOPE PROTECTION

6.13.1. Stone Pitching on Embankment

The Barak River runs parallel to the existing road and comes very close to existing road at some locations which affects the stability of embankment.

The stone pitching is proposed on side slope of embankment and locations are presented in ***Table 6.29***.

Table 6.29: Locations of Stone Pitching

Sl. No.	Design Chainage (Km)		Side	Length (m)	Avg. Height (m)
	From	To			
Package 4: Senapati to Saparmeina					
1	263+310	263+440	LHS	130	4.00
2	272+320	272+490	RHS	170	4.00
3	275+300	275+400	LHS	100	1.52
4	275+400	275+500	LHS	100	4.00
5	284+180	284+390	LHS	210	4.00
6	285+660	285+760	LHS	100	4.00
Package 5: Saparmeina to Imphal					
1	288+132	288+500	LHS	368	3.50
2	289+220	289+240	LHS	20	3.00
3	289+240	289+300	LHS	60	3.50
4	290+880	290+980	LHS	100	1.50

6.13.2. Surficial Protection and Erosion Control Measures

The hill side cut slope (5m height and 2m berm and so on - TCS-2) upto the height of 25m are found safe in the slope stability analysis. Hence, no specific treatments are proposed upto hill cut height upto 25m.

The project section where the hill side cut slope height is more than 20m, surficial protection and Erosion Control measures have been considered and details of typical measures for soil and rocky surfaces are described below:

1. **Hill side Toe Gabion wall for Localised Soil Strata-** Mechanically woven Double Twisted hexagonal shaped steel wire mesh gabion toe wall with minimum height 3.0 m shall be constructed for the locations wherever erodible strata is encountered after cutting. Gabion boxes shall be Zn+10% Al with PVC coated to ensure longer lifespan. Gabion toe wall shall be constructed having non-woven geotextile at the back side for filtration & separation.

2. **Surficial Protection for Rocky Strata -** Surficial protection with secured drapery system shall be done for full length and heights of cut slope wherever rocky strata are encountered. Surface protection shall be done by using high resistance double twisted hexagonal shaped wire mesh (Zn+5%Al coated) with top, bottom and surface anchors. Continuously threaded anchors shall be installed wherever rocky strata are encountered on the slope. Anchors shall have minimum length and minimum diameter of 3.0 m and 25 mm respectively. Top and bottom anchors shall be provided at a maximum spacing of 1.5 m and 3.0 m c/c in longitudinal direction respectively. Surface

anchors shall be provided with maximum spacing of 3 m c/c in longitudinal and vertical directions for total area. All rock anchors shall be fully grouted. Minimum yield strength of anchors shall be 500 MPa.

3. **Erosion Control Measures for Soil Surface -** Erosion control measures shall be adopted for cut slope wherever soil strata is encountered at the surface. Slope angle shall be limited to 45 degrees or flatter with horizontal after the excavation upto proposed right of way. Three dimensional reinforced synthetic geomat shall be used for erosion control measures along with hydraulically applied erosion control measures. Self Drilling Anchors shall be used for supporting geomat along with u-pins. Minimum length and outer diameter of self drilling anchors shall be 1 m and 32 mm respectively. Self drilling anchors shall be provided with maximum spacing of 3 m c/c in longitudinal and vertical directions. Self drilling anchors shall be installed wherever collapsible strata are encountered on the slope.

4. **Drainage Measures for Cut Slopes -** Drainage measures for internal seepage in the cut slope shall be adopted by installing PVC pipes inside the slope. PVC pipes for internal seepage shall be half perforated and lined with geotextile. PVC pipes shall be installed for minimum 4 m length at spacing of 4 m c/c in longitudinal direction in minimum 4 layers at the bottom of the cut slope. Open surface drains shall also be constructed on the berm wherever soil strata is encountered. Toe drain shall also be constructed at the toe of cut slope along with catch water drains at regular interval along the slope. In addition to the above mentioned drainage measures, suitable surface drainage measures shall be adopted as per the site condition.

The typical Surficial Protection and Erosion Control Measures for Cut Height of Side Slope > 20m are presented in **Figure 6.18**.

The slope stability analyses have been conducted for two cases:

- For 25m height as per TCS-2 i.e. 5m height and 2m berm and so on
- For Max height (assumed 52.2m) with Surficial Protection proposal i.e. 15m height and 1m berm

The Factor of Safety (FOS) achieved after slope stability analysis are presented in **Table 6.30.**

Table 6.30: Summary of FOS for Cut Slope (Global Stability)

Section	Case	Target FOS	Achieved FOS
Maximum height (52.2m)	Seismic Case	1.10	1.104
	Static Case	1.30	1.398
25m Height Section	Seismic Case	1.10	1.147
	Static Case	1.30	1.528

The detailed analysis of Global Stability are presented in ***Appendix 1-9*** *of Volume I: Main Report*.

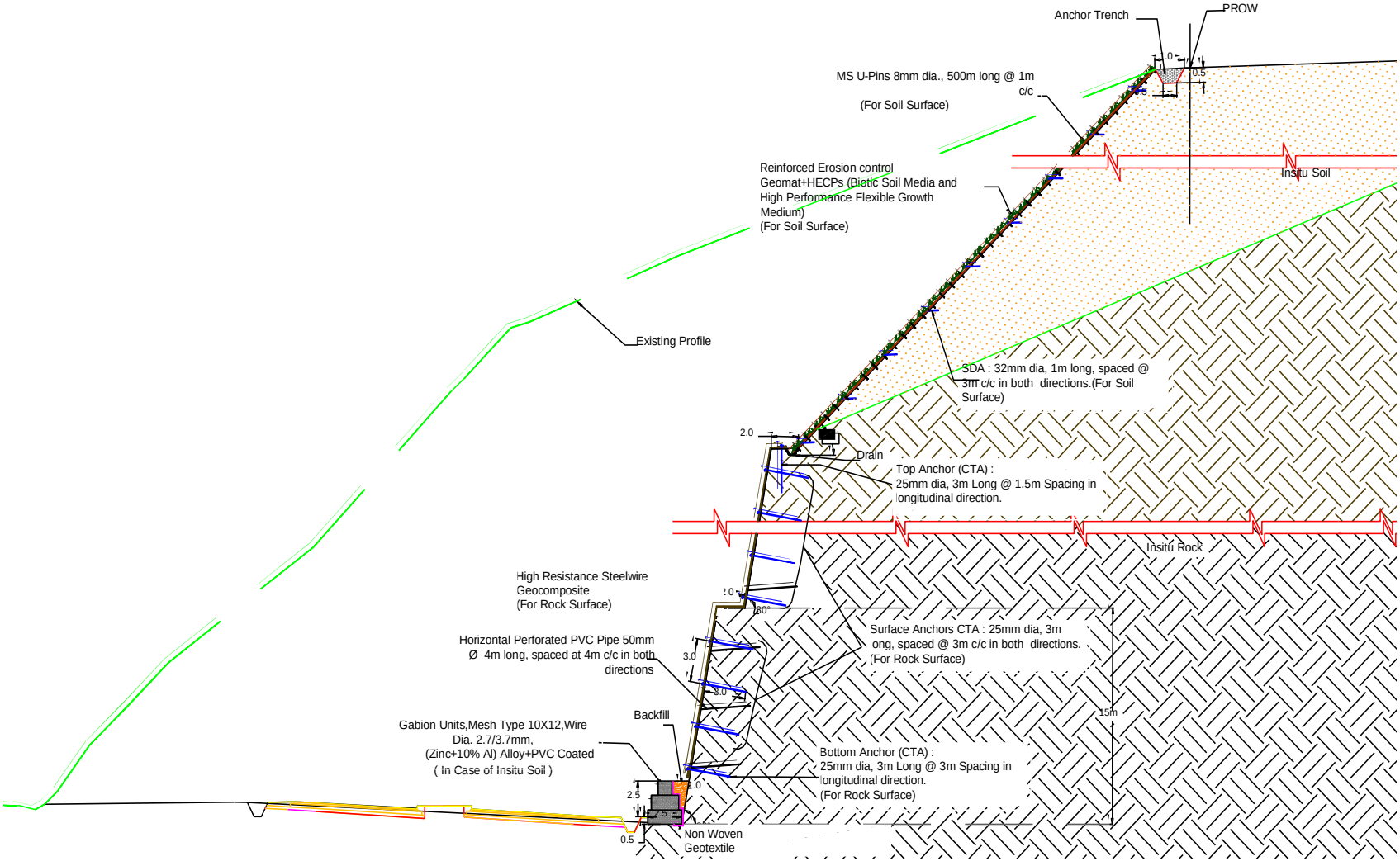


Figure 6.18: Typical Surficial Protection and Erosion Control Measures (Cut Height of Side Slope > 20m)

The package 4 & 5 locations where surficial treatments are considered are presented in ***Table 6.31.***

Table 6.31: Locations of Surficial Protection and Erosion Control

S No	Design Chainage (m)		Length (m)	Average Height (m)	Side
	From	To			
Package 4: Senapati to Saparmeina					
1	262+410	262+660	250	25.1	RHS
2	263+420	263+730	310	23.8	RHS
3	269+420	269+670	250	21.9	LHS
4	269+790	269+920	130	27.0	LHS
5	270+050	270+400	350	28.2	LHS
6	271+790	272+300	510	29.8	LHS
7	272+550	272+750	200	31.5	LHS
8	273+600	273+890	290	30.2	LHS
Package 5: Saparmeina to Imphal					
1	304+450	304+550	100	26.5	RHS
2	307+160	307+250	90	27.7	RHS

6.14. BRIDGES AND OTHER STRUCTURES

6.14.1. Inventory of Structures

During site inspection, inventory of major/minor bridges have been conducted. There are 25 nos. of Minor Bridges and 1 no. of Major Bridge along the project corridor from Kohima to Imphal section of NH-39.

This report is for package 4 & package 5 i.e. from Senapati to Imphal section of project highway.

The package 4 has 10 no. of minor bridges and 1 no. of light vehicular underpass. In package four, Bridges at Km269+990, Km273+077, Km273+551 and Km274+162 are configured with new four lane due to realignment and at Km285+450 & Km286+805 are configured with new four lane due to geometric improvement. Bridges at Km277+655, Km279+642, Km281+821 and Km284+607 are configured with new additional two lane as existing bridges at these locations are retained as condition of the existing bridges are considered good.

Package 5 have 1 no. of Major Bridge, 5 nos. of minor bridges and 1 no. of Tunnel of 260 m length. One minor bridge at Km288+129 is configured with new four lane due to geometric improvement and one Major bridge at Km302+800 is configured with new four lane due to realignment. Minor Bridges at Km291+276, Km295+148, Km296+209 and Km297+177 are configured with new two lane as existing bridges at these locations are retained as condition of the existing bridges are considered good.

The deck widths of proposed bridges are 11 m. The new 4-lane divided carriageway bridges are also of 11 m width deck for each carriageway.

The existing bridges which are retained, their conditions are fairly good except for some damaged in railings and poor wearing courses. Most of the bridges are across minor local streams and a few are across local small width rivers catering to local catchment areas. The

high flood level at each bridge location is fairly below the existing deck level without any signs of overflow/erosion/scour in bed and banks in the vicinity. The beds of the water way are mostly silty /sandy with vegetation at bed and banks. In a few cases the beds are with a mix of sand and gravel and in isolated cases the bed is with rock. There is no sign of erosion in the bed or bank. From these observations, it is reasonable to consider that the existing waterways are adequate for the expected maximum discharge end no unusual scour is expected at foundation location. The existing deck levels are also appropriate compared to expected maximum high flood level (HFL). Accordingly, all new bridges are planned close to the existing bridges maintaining same or slightly wider waterway and the deck level is also planned similar to the existing bridges or slightly higher.

For spans upto 10m- RCC Box, for spans 10m - 24m RCC T-beam and slab type superstructure are adopted and for individual spans more than 24m, pre-stressed concrete girders with cast-in-situ RCC deck type superstructures are proposed with cast in situ reinforced concrete solid abutments and RCC circular piers. The bed material is with mix of sand, gravel and boulder or with rock, RCC shallow open foundations are considered.

The bridges proposed to be taken up for 'new' construction on this project are listed in Table 6.32.

Table 6.32: Proposal for New Bridge Construction/Improvement from Senapati to Imphal Section

S No	Design Chainage (Km)	Existing Chainage	Struc. Type	Ext. Span Arrangement (m)	Ext. Outer Width (m)	Ext. Sup. Struc. Type	Prop. Span Arrangement (m)	Prop. Width (m)	Prop. Sup. Struc. Type	Remarks
Package-4: Senapati to Saparmeina (Km262+175 – Km287+000)										
1	269+990	-	MNBR	-	-	-	1 x 40	2 x 11.0	PSC Box	New 4L bridge is proposed.
2	273+080	-	MNBR	-	-	-	2 x 5.0 (Clear Span) x 2.5	2 x 11.0	RCC box	New 4L bridge is proposed.
3	273+551	-	MNBR	-	-	-	2 x 5.0 (Clear Span) x 2.5	2 x 11.0	RCC box	New 4L bridge is proposed.
4	273+940	-	LVUP	-	-	-	1x10.5x4.0	2 x 11.0	RCC box	New 4L LVUP is proposed.
5	274+160	-	MNBR	-	-	-	1 x 30.0	2 x 11.0	PSC I Girder with RCC Deck	New 4L bridge is proposed.

S No	Design Chainage (Km)	Existing Chainage	Struc. Type	Ext. Span Arrangement (m)	Ext. Outer Width (m)	Ext. Sup. Struc. Type	Prop. Span Arrangement (m)	Prop. Width (m)	Prop. Sup. Struc. Type	Remarks
6	277+655	279+357	MNBR	1 x 20.5	8.5	RCC-T Beam	1 x 20.8	11.0	RCC-T Beam	Existing bridge retained as same, new 2L bridge is proposed.
7	279+642	281+333	MNBR	1 x 17.0	10.5	RCC-T Beam	1 x 17.2	11.0	RCC-T Beam	Existing bridge retained as same, new 2L bridge is proposed.
8	281+824	283+525	MNBR	1 x 26.5	8.3	PSC I Beam with RCC Deck	1 x 26.6	11.0	PSC I Beam with RCC Deck	Existing bridge retained as same, new 2L bridge is proposed.
9	284+607	286+411	MNBR	1 x 6.7	12.0	Solid slab	1 x 6.0 (Clear span) x 3.5	11.0	RCC box	Existing bridge retained as same, new 2L bridge is proposed.
10	285+450	-	MNBR	-	-	-	1 x 14.8	2 x 11.0	RCC-T Beam	New 4L bridge is proposed.
11	286+805	-	MNBR	-	-	-	2 x 6 (Clear span) x 5.5	2 X 11.0	RCC box	New 4L bridge is proposed.
Package-5: Saparmeina to Imphal (Km287+000 – Km.308+460)										
1	288+129	289+968	MNBR	-	-	-	1 x 6.0 (Clear span) x 5.5	2 X 11.0	RCC box	New 4L bridge is proposed.
2	291+276	293+279	MNBR	-	-	RCC-T Beam	1 x 14.8	11.0	RCC-T Beam	Existing bridge to be dismantled, new 4L bridge is proposed.
3	295+148	297+007	MNBR	1 x 26.0	11.0	PSC I Beam with RCC Deck	1 x 26.0	11.0	PSC-I Beam with RCC Deck	Existing bridge retained as same, new 2L bridge is proposed.
4	296+209	297+1067	MNBR	1 x 11.5	11.2	RCC-T Beam	1 x 11.8	11.0	RCC-T Beam	Existing bridge retained as same, new 2L bridge is proposed.
5	297+177	299+015	MNBR	1 x 6.7	10.0	Solid Slab	1 x 6.0 (Clear span) x 3	11.0	RCC box	Existing bridge retained as same, new 2L bridge is proposed.

S No	Design Chainage (Km)	Existing Chainage	Struc. Type	Ext. Span Arrangement (m)	Ext. Outer Width (m)	Ext. Sup. Struc. Type	Prop. Span Arrangement (m)	Prop. Width (m)	Prop. Sup. Struc. Type	Remarks
6	302+800	-	MJBR	-	-	-	3 x 20.5	2 X 11.0	RCC-T Beam	New 4L bridge is proposed.
7	307+530	-	Tunnel (Cut & Cover)	-	-	-	2 x 10.5 x 5.5	-	RCC box	New 4L Tunnel is proposed.

MNBR – Minor Bridge; MJBR – Major Bridge

The Minor bridges retained along the package 4 & 5 of project corridor are presented in ***Table 6.33***.

Table 6.33: Retained Minor Bridges from Senapati to Imphal Section

S. No	Design Chainage	Struc. Type	Ext. Span arrangement (m)	Ext. Outer Width (m)	Ext. Sup.struc. Type	Remarks
Package-4: Senapati to Saparmeina (Km262+175 – Km287+000)						
1	277+655	MNBR	1 x 20.5	8.5	RCC-T Beam	Retained as same, no development proposal. General upkeep and maintenance
2	279+642	MNBR	1 x 17.0	10.5	RCC-T Beam	Retained as same, no development proposal. General upkeep and maintenance
3	281+824	MNBR	1 x 26.5	8.3	PSC I Beam with RCC Deck	Retained as same, no development proposal. General upkeep and maintenance
4	284+607	MNBR	1 x 6.7	12.3	Solid slab	Retained as same, no development proposal. General upkeep and maintenance
Package-5: Saparmeina to Imphal (Km287+000 – Km.308+460)						
5	295+148	MNBR	1 x 26.0	11.0	PSC I Beam with RCC Deck.	Retained as same, no development proposal. General upkeep and maintenance
6	296+209	MNBR	1 x 11.5	11.2	RCC-T Beam	Retained as same, no development proposal. General upkeep and maintenance
7	297+177	MNBR	1 x 6.7	10.0	Solid Slab	Retained as same, no development proposal. General upkeep and maintenance

CHAPTER-7 ENVIRONMENT AND SOCIAL IMPACT ASSESSMENT

7.1. BACKGROUND

The National Highways & Infrastructure Development Corporation Ltd. (NHIDCL), Ministry of Road Transport & Highway (MoRT&H) has decided to upgrade existing NH-39 (New NH-2) road section from Imphal to Kohima as two Lane with Paved Shoulder/4 laning in Manipur & Nagaland (126 Km) for execution on EPC Mode. The project road from Imphal to Kohima is a section of NH-39 which connects Myanmar. The existing road has generally two lanes with deficient geometry and pavement failures and sinking zone at certain locations.

The project road section is a part of proposed Great Asian Highway-2, presently designated as National Highway-2 in India (earlier NH-39), which connects Numaligarh - Golaghat - Dimapur - Kohima - Imphal – Moreh, and terminates near Mayanmar Border. The start point is approximately 6 km away from the heart of Kohima city, from the existing Km185+540, whereas, the termination point on Imphal side has been considered where the existing 4 laning (Km311+082 of NH-39)towards the city of Imphal at village Koirengei starts. Therefore, the starting point is considered at Km 185+540 located at Lerie colony Jn., Kohima city. The corridor terminates at Imphal and match with already existing 4 lane road at KM 311+082.

This Environmental Impact Assessment Report is prepared for Package no. 4 and 5 (total length of 46.28km) in order to identify the baseline environmental status of the proposed alignment, assessment of impacts due to the proposed widening of the road on various environmental parameters and preparation of environmental management plan to mitigate the negative impact on these parameters.

7.2. Scope of Environmental Impact Assessment

The present Environmental Impact Assessment Report prepared as part of the Detailed Project Report. The Environmental Impact Assessment Report is prepared for the present assignment in order to identify the baseline environmental status of the proposed alignment, assessment of impacts due to the proposed widening of the road on various environmental parameters and preparation of environmental management plan to mitigate the negative impact on these parameters. The report is structured to meet ToR and Government of India requirements for project screening based on feasibility study.

Basic idea is to minimize adverse environmental and social impacts with best possible engineering solutions at the optimal cost to make development environmentally sound and sustainable.

The objective of the present, EIA study is to identify potential environmental impacts of the proposed road improvement measures and formulate strategies to avoid / mitigate the same along project road section under Package no. 4 starts from design chainage at Km 262+175 to Km 287+000 (length 24.825km), and under Package no. 5 starts from Design chainage at Km 287+000 to Km 308+460 (length 21.460km). The scope of work to accomplish the above objective, comprise the following.

- understanding the baseline environmental conditions of the project area,
- identifying the potential environmental impacts of the project proposal,
- recommending appropriate mitigation measures to avoid / minimise the environmental impacts, and
- preparing an environmental management plan for implementation.

7.3. Main Environmental Features

The critical issues in the study area and the main findings of the environmental screening survey are summarized herewith. These issues are detailed out in this report.

- The project road sections are passing through rolling &hilly terrain with land use being mainly forest, agricultural and built-up intermittently. The topography of the project road areas is mixed type.
- The ROW is not marked on the ground nor boundary pillars available. The ROW is varying in range of 12-30 m and the Carriageway is mainly two lanes varying from 6m to 7.5m as per field measurements.
- The project road section (Package 4 & 5) length of 13.400km in small stretches passes through forest area including open scrub, unclassed, mixed & reserve forest.
- For widening proposal from two lanes to four-lane configuration and to improve curve approximately 138.58 hectare of additional land (approx. 78.611 hectare of non forest and approx. 59.969 hectare of forest land) is to be acquired.
- On the basis of analysis of alternatives for the road section of the project road alignment existing alignment is followed, keeping in view the minimum impacts and maximum benefits to the local people, the feasible alignment for project road sections has been worked out.
- The climate of the project area is sub-tropical. Rainfall is relatively abundant and widespread. The rainy season starts in June with the onset of the south-west monsoon and last upto September. Intermittent rains continue even upto October along with the retreat of the monsoon. The summer months are never oppressive with the average maximum temperature fluctuating from 32°C to 35°C during April-June, the mercury seldom going beyond 37°C. The monsoon season spreads from the month of June to September with average rainfall of 2000 mm.
- The baseline environmental parameter monitoring has been conducted along the project road sections by NABL accrediated laboratory. The quality of environmental parameters i.e. Air Quality, Water Quality and Noise levels are well within the permissible limits. The noise level at congested places like Senapati and Imphal is slightly on higher side. Air quality seems also well within the prescribed limits throughout the project road section and are monitored and reported in this EIA.
- The project road does not pass through any protected areas (national park, wild life sanctuary, protected forests). Road plantation is done with very thin vegetation cover in open and barren land use while thin vegetation covers in area with agricultural land use around the area with irrigated fields.

- The surface water bodies such as Marei and Barak River are crossing to project road sections. In addition to this, several numbers of springs (Jhora) are crossing the project road.
- Also, there are no locations/sites of any historical /cultural significance in the project areas.
- Roadside tree plantation has been done/grown along the existing road sections intermittently. In some sections of the project alignment few trees are planted on both side of the road specifically in agricultural fields.
- Total numbers of trees (approx. 5557) in all of various species exist along the project road. Most of the trees affected are of girth size G1 (30-60 cm), G2 (60-90cm) and G3 (90-120cm).
- There is one temple, fall near to the corridor of project RoW, may have direct impact i.e. loss or relocation will be required.
- There are several public utility resources exist within the corridor of impact, which include hand pumps, petrol pumps, transmission lines, water storage tanks etc.
- Drainage condition of the area is poor at some places along the project road.
- There is no Thermal Power Plant located within the 100km of the project road sections. Since no industries are located on the project road/area; hence there is no industrial effluent discharge.
- Power transmission & distribution line (including transformers) exist almost along project road alignment. High transmission line crosses the project corridor at places.

7.4. Anticipated Impacts and Mitigation Measures

7.4.1. Environmental Impact Associated with the Project Location

The environmental impacts associated with the location will not be significant because most of road will either follow the existing alignment or pass through uninhabited or open forest areas. None of the road sections pass through environmentally sensitive areas. The roads will be realigned to avoid impacts if feasible and carriageways are widened to the left or right to avoid the majority of sensitive receivers.

Where noise sensitive receivers remain close enough to the road alignment, measures at source, such as solid noise barriers and earth berms will be built to provide noise attenuation.

7.4.2. Environmental Impact Associated with Construction Activities

Construction impacts, particularly those activities due to earthwork and the use of mechanical equipment are potentially significant. To reduce noise impact, mitigation measures at source will be adopted in line with Government's noise standards, and portable noise barriers will be used. Proper maintenance and storage of the equipment will be done to minimize emission impacts and to facilitate dispersion. Materials during transporting and stockpiling will be covered to minimize dust. Rock crushers and batching plants will be installed only after receiving permissions from the State Pollution Control Board. Hot mix plants will be licensed and controlled in line with state pollution board requirements.

During construction of the various components of the project, muck is generated both from soil or slide material and from rock excavation. Total quantity of muck / debris, generated due to the project, shall be about 33.34 lakh cum (27.22 lac m3 for Pkg-4 and 6.12 lakh m3 for Package -5) of soil will be generated. A volume of 13.00 lac m3 out of total generated quantity will be utilized at site for various backfill and formation works. For remaining volume (20.33 lac m3) on land disposal, 27.71 hectare of land has been identified for muck disposal. Thirteen (13), muck dumping sites have been identified and details of muck disposal are given in much disposal plan.

Potential soil erosion will be controlled by minimizing cut-and-fill, and provision of slope drains, stone pitching and turfing. Aggregates and other quarried material will be obtained from licensed sites and new quarries or borrow pits will only be excavated after obtaining Government clearance and with prior permission from local/district authorities. Borrow pits will be rehabilitated after use. Cement batching and aggregate mixing plant shall be located away from settlements.

Construction works should not use the groundwater without prior permission from the local ground water board. The main concerns about surface water conditions are related to bridge construction works. The mitigation measures for these aspects, especially to prevent pollution of ground and surface water resources are comprehensively covered in the environmental management plan (EMP). Tree cutting will be minimized, but if unavoidable, the trees will be restored immediately, and compensatory planting will be applied as a statutory requirement. Specimen and religious trees will be retained. No worker camps, asphalt plants, mixing plants, or rock crushers will be allowed within inhabited / forest area.

7.4.3. Environmental Impacts Associated with Operation

Both generic and site specific mitigation and enhancement measures have been planned for identified adverse environmental impacts. The construction workers camp will be located at least 500m away from habitations. The construction yard, hot mix plants, crushers etc. will be located at 500m away from habitations and in downwind directions. Adequate cross drainage structures have been planned to maintain proper cross drainage.

In order to compensate negative impacts on flora due to cutting of trees the project plans compensatory plantation in the ratio of 1:10 i.e. for every tree to be cut, ten trees will be planted. The project shall also witness the plantation of trees for providing aesthetic beauty and shade. Approximately 5557 trees of various species have been identified along the proposed alignment for felling. A total of 55570 trees are to be planted to compensate the loss at a ratio of 1:10.

The plantation of trees shall be done subject to availability of space in the proposed ROW. The project will take an opportunity to provide environmental enhancement measures to improve aesthetics in the project area. The planned environmental enhancement measures include plantation in available clear space in ROW, enhancement of water bodies etc. In order to avoid contamination of water bodies during construction sedimentation chambers, oils and grease separators, oil interceptors at storage areas and at construction yard have been planned. An avenue plantation scheme has been prepared for the road sections with details of typical cross section for plantation implementation.

No long-term ecological impact anticipated; however, it is important to maintain trees planted along the roadside. Long-term tree planting will compensate the loss of trees due to road widening and target areas should include degraded forest areas.

7.4.4. EMP Cost Estimate

Project specific environmental management plan have been prepared for ensuring the implementation of the proposed measures during construction phase of the project, implementation and supervision responsibilities, sufficient allocation of funds, timeframes for anticipated activities etc. has been dealt with in this document, which will eventually form a part of the Contract documents between the NHIDCL and the Contractor. The cost of environmental management for both Packages 4 &5 is INR 8,38,78,500 (Indian Rupees approx. 8.40 Crores).

7.5. Conclusion

Based on the EIA study and surveys conducted for the Project, it can be safely concluded that associated potential adverse environmental impacts can be mitigated to an acceptable level by adequate implementation of the measures as stated in the EIA Report. Adequate provisions shall be made in the Project to cover the environmental mitigation and monitoring requirements, and their associated costs as suggested in environmental budget. The proposed project shall improve Road efficiency and bring economic growth. In terms of air and noise quality, the project shall bring considerable improvement to possible exposure levels to population.

7.6. SOCIO-ECONOMIC PROFILE OF THE INFLUENCE AREA

The social economic details are summarized as below:

Archaeological and Cultural Sites

There are no archaeologically important monuments, arts or cultural site on either side of the project road.

Industries

There is no major industrial activity along the project road.

Mining

Along the project road near Km290.5 of NH-39, the Stone aggregate mining activity is present in Bongmol village and sand quarry at Km300of NH-39 at Sekmai. Trucks transport Sand/Stones aggregates to other places in the N-E region.

7.6.1. Cultural Environment

The project road traverses through a number of settlements and is often dotted with religious and cultural properties, which though not of archaeological significance are nevertheless very significant to the community. Cultural properties along the project road were identified and documented based on site survey.

Primary occupation of the people living along the corridor is agriculture and mining.

7.6.2. Population Density

Population Distribution and Density along the project corridor is tabulated below.

Table 7.1: Population Distribution and Density in Tehsil along Project Corridor, 2011

State	Population		Density (per sq. km.)	
	2001	2011	2001	2011
Manipur	2293896	28855794	103	128
Nagaland	1990039	1978502	120	119

7.6.3. Sex Ratio and the Influence Area

As per the Census estimates (2011) number of Sex ratio (females/1000 male) of project influence area is 986. The highest sex ratio of 1029 registered in Imphal West district and the lowest in Senapati district along the project influence area.

District	Population (2011)		Sex Ratio
	Male	Female	
Kohima	138,998	128,990	928
Senapati	183,081	171,891	939
Imphal West	253,628	261,055	1029
Imphal East	225,130	227,531	1011
Project Influence Area	**800,837**	**789,467**	**986**

7.6.4. Literacy Rate

The literacy rate in the states is tabulated below as per 2011 census.

Table 7.2: Literacy Rate along the Project Corridor, 2011

State	Literacy Rate	
	2001	2011
Manipur	66.61	76.94
Nagaland	66.59	79.94

7.7. PUBLIC CONSULTATION

Community consultations were held with Project affected Persons (PAPs), other stakeholders and general public to determine their views about the proposed road and their suggestion while finalising the alignment.

The people were generally in favour of reconstruction of the project road, as it would reduce their fuel wastage, time saving due to increase in speed, comfortable & safe travel and improve their socio economic status of the area. On the basis of community consultations, following recommendations have been made:

- Compensatory plantation of tree, as per state forest department for each tree cut and removed in accordance with State guidelines.
- Adoption of Stringent control measures for 'Air', 'Water' and 'Noise' pollution during construction and operation particularly near settlements and junctions.
- Provision of adequate cross drainage structures
- Prevention of deterioration in Surface Water quality through sediment control
- Safety measures at work site through traffic management and provision of personal protective equipment for work force
- Protecting sensitive receptors like schools and hospitals close to ROW from high noise level
- Impacting minimum number of cultural properties such as temples/churches/ shrines coming close to ROW.
- Resettlement of people as per provisions of RAP.
- Realignment at certain locations for easing out gradients
- Compensation for loss of land under agricultural
- Compensation for loss of private structure, community and public
- Ensure employment of local labour in unskilled and semiskilled sector
- Setting up migrant worker camp at least 1km away from settlement
- Ensure sanitary measures at construction camp with Creech facility for children of construction Labour.

7.8. MAGNITUDE OF IMPACT ON STRUCTURE AND LAND

The upgradation of the project road will necessitate acquisition of structures and land in this section of NH-39. Social Screening Survey has revealed that some structures that are likely to be affected belong to category of private ownership followed by religious category.

Social screening survey of the project road was conducted within as per width of proposed ROW. The built-up properties likely to be affected due to the project road were enumerated at this stage by using a pre-structured questionnaire. These properties include residential structures, commercial structures, Govt. offices, religious places, and school and boundary walls.

7.9. IMPACT ON PROJECT AFFECTED PERSONS (PAPs)

Certain households owning private properties will be affected leading to impact on PAPs within proposed ROW. Result of social stratification of PAPs has revealed that a majority of households are likely to be affected belong to General category followed by Scheduled Tribes.

7.10. LA and R&R Impact Assessment

The additional land required for the project proposal was calculated. The Budget for additional land and R&R of affected structrues for Package 4 & 5 have been assessed and summarised below:

Pkg No.	Muck location Area (in Hectare)	Additional Land required (in Hectare)	LA Cost (Cr.)	R&R (Cr.)	Total (Cr.)
Package-4	6.999	96.863	27.06	43.18	70.24
Package-5	10.918	41.720	15.94	51.41	67.35
Total	**17.916**	**138.583**	**43.00**	**94.59**	**137.59**

CHAPTER-8 PRELIMINARY COST ESTIMATES

8.1. GENERAL

This Chapter deals with unit rate for various items of works, estimation of quantities and costs. The Consultants have taken due care of various construction, maintenance and operational activities expected to be accomplished till the designed life of the proposed project road.

In view of the fact that the project road has been proposed to be built under EPC mode, further attention has been accorded in working out the project costs to sufficient details to facilitate realistic commercial analysis and financing options. Special care has been taken to provide sufficient details clarifying all relevant data to ensure a rational bidding process.

8.2. ITEM OF WORKS

Site Clearance	Clearing and Grubbing Dismantling of Hutment, old culvert & Structures etc.
Earthwork	Earth excavation Construction of embankment Fill by borrowed earth for Subgrade
Rock Excavation	Improvement of alignment
Granular sub-Base, Base and Bituminous Courses	Earthen Shoulder Sub-base; Base Prime coat; Tack coat Dense bituminous macadam Bituminous concrete
Drainage Structures	Culverts, Minor & Major Bridges
Other Structures	Underpasses
Surface/sub-surface Drainage and Protective works	Roadside Surface drain RCC Retaining wall, Surficial Protection and Erosion Control Measures, Stone pitching,
Appurtenances	Krebs, Signage & Markings, Crash barrier, Street light, Busway , passenger shelter, Landscaping & EMP etc.
Junctions	Major and Minor Junction
Environmental Improvement	
Land acquisition	
Rehabilitation and Social Impact	
Relocation of services	Cross Roads, Hutments, Other Utility services

8.3. SPECIFICATIONS

The detailed specifications for various items of work will be finalised at the Bid document stage. However, for arriving at unit rates for major items of works, Technical Specification has been prepared conforming to the stipulations made in "**Specifications for Road and Bridge Works (5th Edition – August 2013)**" of MoRT&H.

8.4. UNIT RATES

8.4.1. General Approach

Inputs required for Unit rates of major items of works, like labour and machinery etc. have been considered from available latest ***Manipur Schedule of Rates for National Highways-Works, 2018*** of Public Works Department, Manipur.

The consultants have considered mechanised construction methods for the analysis of unit rates to have high qualitative standard of the facility. The "Standard Data Book (June 2003) for Analysis of Rates" of Ministry of Road Transport & Highways, 5th revision, has been followed by the consultants while preparing the rate analysis for this project. Methodology for lead calculations and finalisation of rate for major items are as follows:

8.4.2. Lead

It has been proposed to install Hot Mix Plant at mid of each package. Depending on the location of the quarries, the following average lead of materials for the each package were worked out and considered in the rate analysis. The detailed calculation of lead is presented in Rate Analysis.

Material	Source of Material	Average Lead (km)				Remarks
		Plain		Hill		
		Pac-4	Pac-5	Pac-4	Pac-5	
Bitumen VG-40	Barauni	1064	1087	189	189	IOCL Plant
Bitumen/Emulsion/PMB	Haldia	1388	1411	189	189	IOCL Plant
Steel	Guwahati	262	285	189	189	SAIL Outlet
Cement	Adhunik	139	116	255	255	East Jayantia Hills

The Stone boulder/ Metal chips are available at following locations:

- Stone Boulder/Aggregate-Km290.5 of NH-39 (Bongmol village)+ 2km for approach
- Sand- Km300 of NH-39 (Sekmai village)+2km for approach

8.4.3. Basic Rates

Rate for Major Items like Bitumen have been considered as prevailing current market rates of 16th August 2019 for package 4&5 obtained from IOCL Website and Steel rates are market rate of May 2019 for package 4&5 obtained from SAIL Website. Cement rates are M/s Adhunik

factory rate based on local enquiry. Basic rates including leads for these materials are given below.

Particulars	Unit	Ex Plant bulk Rate (Rs)	Rate for Pkg 4 incl lead (Rs)	Rate for Pkg 5 incl lead (Rs)
Cement	Tonne	5,403	9,562	9,139
Steel (TMT)	Tonne	50642	55,046	54,827
Bitumen (Bulk) VG-40 grade	Tonne	33,650	43,856	42,872
CRMB 55 grade	Tonne	33,900	46,569	45,261

The cost of materials like boulder and aggregates includes the basic cost at source from Quarry, Royalty transportation charges to work site and loading and unloading charges. While estimating lead of materials, the consultants assumed that:

- Borrow earth, boulders, filler materials, and granular materials for embankment protection works and granular sub-base would be directly transported to the construction site, and
- Crushed stone aggregate, bitumen, cement etc. would be transported to the Hot Mix and Batching Plant site and mixed material then be carried to the work site.

8.4.4. Overhead Charges and Contractors Profit

The overhead charges include the following elements:

- Site accommodation, setting up plant, access road, water supply, electricity and general site arrangements.
- Office furniture, equipment and communications
- Expenditure on
  - Corporate office of contractor
  - Site supervision
  - Documentation and “as built” drawings
- Mobilisation /de-mobilisation of resources
- Labour camps with minimum amenities and transportation to work sites.
- Light vehicles for site supervision including administrative and Managerial requirements.
- Laboratory equipment and quality control including field and laboratory testing
- Minor T & P and survey instruments and setting out works, including verification of line, dimensions, trial pits and bore holes, where required.
- Watch and ward
- Traffic management during construction, Expenditure on safeguarding environment.
- Sundries
- Financing Expenditure
- Sales/Turn over tax, Work Insurance/compensation

The GST (Goods and Service Tax) has been introduced from July 2017. No taxes have been considered during the rate analysis and 12% of GST has been considered on civil construction cost of the civil contract package. Accordingly, no taxes were considered in the rate analysis conducted by Standard Data Book. It is assumed that about 4% taxes were inbuilt in the overheads considered in Standard Data Book which will be now not applicable due to GST; therefore this 4% is deducted from the proposed overheads in MOST data book for Road & Bridge works. Contractor's profit has been taken uniformly as 10 %, over the cost of items. The details of overhead & contractor's profit adopted for the project are given as under:

	Over-heads	Contractors Profit
Road Works	4%	10%
Bridge Works	16%	10%
Bridge Works (Rehabilitation)	26%	10%

8.5. Project Costing

The work has to be completed in thirty six months with construction phasing annually of 20%, 40% and 40% respectively.

As suggested in MoRT&H's circular number RW-NH-33044/10/2019-S&R(P&B) dated 7th March 2019, while arriving the total cost of construction for work under EPC mode, the agency charges etc. adopted are as follows:

a) Civil Cost
b) GST-12% of (a)
c) Contingencies-2.8% of (a)
d) Supervision charges-3% of (a)
e) Agency charges-3% of (a)

The BOQ and Cost estimate have been done for package 4 and package 5 separately. The summary of Cost Estimate is presented below:

Package No.	Design Chainage (Km)		Design Length (km)	Project Proposal	Civil Cost (Cr/km)
	From	To			
4	262+175	287+000	24.825	4L Divided Carriageway	**16.54**
5	287+000	308+460	21.460	4L Divided Carriageway	**15.26**

The details of package wise cost are presented in ***Table 8.1*** *to* ***Table 8.2***.

Table 8.1- Cost Estimate Summary - Package 4: Senapati to Saparmeina		
S. No.	**Item Description**	**Total Cost (Rs.)**
A	BILL NO: 1 - SITE CLEARANCE	1,10,11,194
	BILL NO: 2 - EARTHWORKS	79,88,89,361
	BILL NO: 3 - SUB-BASE AND BASE COURSES	69,83,64,762
	BILL NO: 4 - BITUMINOUS WORKS	63,70,49,296
	BILL NO: 5 - CULVERTS	49,51,20,649
	BILL NO: 6 - BRIDGES	18,35,49,066
	BILL NO: 7 - DRAINAGE AND PROTECTION WORKS	1,07,48,13,104
	BILL NO: 8 – ROAD JUNCTIONS	4,49,13,842
	BILL NO: 9 - TRAFFIC SIGNS, MARKINGS AND APPURTENANCES	3,62,18,624
	BILL NO: 10 – MISCELLANEOUS	5,44,35,040
	BILL NO: 11 – ROAD SAFETY APPURTENANCES	7,18,44,309
	Civil Construction Cost (A)	**4,10,62,09,248**
B	GST for Works Contracts @ 12% of A	49,27,45,110
	Contingencies @ 2.8% of A	11,49,73,859
	Supervision Charges @ 3% of A	12,31,86,277.43
	Agency Charges @ 3%of A	12,31,86,277.43
	Sub Total (B)	**85,40,91,524**
C	Utility Shifting	1,37,00,000
	Environmental Mitigation Cost	4,68,84,000
	Land Acquisition & R&R Cost	70,24,00,000
	Sub Total (C))	**76,29,84,000**
	Total Project Cost (A+B+C)	**5,72,32,84,771**
	Length of Package-4 (km)	24.83
	Civil Construction Cost (Crore per km)	**16.54**
	Total Project Cost (Crore per km)	**23.05**

Table 8.2: Cost Estimate Summary -Package 5: Saparmeina to Imphal

S. No.	Item Description	Total Cost (Rs.)
A	BILL NO: 1 - SITE CLEARANCE	70,09,415
	BILL NO: 2 - EARTHWORKS	26,59,08,134
	BILL NO: 3 - SUB-BASE AND BASE COURSES	69,83,52,247
	BILL NO: 4 - BITUMINOUS WORKS	58,32,12,147
	BILL NO: 5 - CULVERTS	47,00,15,405
	BILL NO: 6 - BRIDGES	74,19,26,998
	BILL NO: 7 - DRAINAGE AND PROTECTION WORKS	28,09,92,602
	BILL NO: 8 – ROAD JUNCTIONS	8,81,33,658
	BILL NO: 9 - TRAFFIC SIGNS, MARKINGS AND APPURTENANCES	3,74,13,818
	BILL NO: 10 – MISCELLANEOUS	5,08,88,591
	BILL NO: 11 – ROAD SAFETY APPURTENANCES	5,15,39,028
	Civil Construction Cost (A)	**3,27,53,92,043**
B	GST for Works Contracts @ 12% of A	39,30,47,045
	Contingencies @ 2.8% of A	9,17,10,977
	Supervision Charges @ 3% of A	9,82,61,761
	Agency Charges @ 3%of A	9,82,61,761
	Sub Total (B)	**68,12,81,545**
C	Utility Shifting	2,92,00,000
	Environmental Mitigation Cost	3,69,94,500
	Land Acquisition & R&R Cost	67,35,00,000
	Sub Total (C)	**73,96,94,500**
	Total Project Cost (A+B+C)	**4,69,63,68,087**
	Length of Package-5 (km)	**21.46**
	Civil Construction Cost (Crore per km)	**15.26**
	Total Project Cost (Crore per km)	**21.88**

CHAPTER-9 ECONOMIC AND FINANCIAL ANALYSIS

9.1. General

An infrastructure project is subjected to economic/ financial viability analysis to ensure that the investment proposed would yield appropriate return to the National Economy/ investor. Therefore, economic/ commercial appraisal has been carried out for a section of NH-39 (New Number is NH-02) from Kohima to Imphal in Meghalaya & Nagaland States, which is proposed to be upgraded as 2-lane with paved shoulders from Kohima to Senapati and after Senapati to Imphal as 4-lane divided carriageway in accordance with the prevailing National Highway Standards. In the report, now NH-39 will be refered as NH-02.

9.2. Methodology for Economic Appraisal

9.2.1. With and Without Project

The appraisal has been carried out within the framework of 'with' and without' the project situations. 'Without' the project situation is the one in which the projected traffic would continue to move on the existing road network that will require certain minimum routine and periodic maintenance for upkeep of the facility. In the case of 'with' project situation, the traffic would divert from existing network to use the new facility, which is planned as 2-lane with paved shoulder/4-lane carriageway/bypass facility.

The benefits due to improvements are the savings in vehicle operation cost, saving in time and other caused benefits. The cost of the project is subtracted from benefits accruing year wise and discounted to work out the Economic Internal Rate of Return. In the economic appraisal, all the financial estimates of costs and benefits are converted to economic costs by applying necessary factors.

9.2.2. Cost and Benefit Stream

The cost stream comprises of:

- Capital cost of construction of the project road and related works
- Annual repair and maintenance cost
- Recurring costs of Highway Operation

The Benefit Stream will comprise the cost saving in operation and maintenance of the road network between "Do-nothing" (Base Alternate) and 'Project' options (Improvement-Reconstruction, condition responsive maintenance and routine maintenance).

As the economic analysis indicates the impact of the project on the economy, all the financial costs and benefits of the project are adjusted to reflect the economic costs. The economic cost is derived by removing taxes and duties from financial cost so as to reflect the resource cost.

On the benefit stream also, the financial cost is converted into economic cost using appropriate factors. The vehicle operation cost consists of, inter alia, cost of fuel, vehicle depreciation, crew wages, tyres, repairs etc. that will have to be converted to appropriate economic cost by excluding taxes and duties.

9.3. Input data for Economic Analysis

9.3.1. Link Characteristics

The project road length, about 125.5 Km, has been divided into sections are given below:

Table 9.1: Homogeneous Sections for Economic Analysis

S No.	Existing Chainage (Km)		Length (km)	Ex. Carriageway width	Terrain	Traffic Section	Project Proposal
	From	To					
1	185.540	212.334	26.8	6m-9m	Hilly	HS-1	2 lanes carriageway with Paved Shoulder (2L+PS)
2	212.334	242.150	29.8	6m-6.5m	Hilly	HS-2	
3	242.150	254.400	12.3	6m-6.5m			
4	254.400	259.300	4.9	6.5m	Hilly		2 L+PS, Senapati Bypass (13.525km)
5	259.300	259.600	0.3	6.5m	Hilly	HS-3	
6	259.600	260.000	0.4	20m	Hilly		
7	260.000	264.300	4.3	7.5m	Hilly		
8	264.300	274.800	10.5	6.5m-7.5m	Rolling/ Hilly		4 Lanes divided Carriageway
9	274.800	275.700	0.9	7.0m	Rolling/ Hilly		4L, Kongpokpi Bypass (2.075 km)
10	275.700	276.050	0.4	6.5m-7m	Rolling/ Hilly	HS-4	
11	276.050	288.815	12.8	6.5m-7m	Rolling/ Hilly		4 Lanes divided Carriageway
12	288.815	304.000	15.2	6.2m-8m	Rolling/ Hilly		
13	304.000	311.082	7.1	7.5m, 2 Lanes+ Paved Sholder	Rolling/ Hilly		
Total Ex. length (km)			***125.5***				

Physical characteristics data of each section pertains to altitude /rainfall, traffic volume, existing road geometry, pavement (structure, strength and condition) subgrade strength and construction/maintenance features and derived from field survey and investigations/ design carried out for the project.

Senapati and Kangpokpi bypasses have been proposed to reduce the traffic congestion and reduce the travel time. The design length of the project highway is 124.15km i.e. reduction in length around 0.4km.

9.3.2. Construction Options and Costs

Project costs have been worked out and given in Chapter – 8 of this report. A conversion factor of 0.85 has been used to convert financial costs to economic costs. For economic evaluation, base costs have been taken as factor costs of civil works and other costs related to land acquisition, social, environmental and utility relocations.

Cost of civil works for improvement of existing road as 2-lane with paved shoulder /4-lane configurations considering respective length is estimated for the purpose of economic analysis. Thus, Civil cost of construction for economic appraisal is worked out as:

Table 9.2: Construction Costs (2018-19 prices), Rs. Crore

Package No.	Length (Km)	Civil Cost + GST (Cr.)	LA + Utility + EIA + Social Cost (Cr.)	Total Project Cost *(Cr.)	Reference
1	26.17	455.74	38.17	493.91	PPR
2	27.38	441.15	47.58	488.73	
3	24.32	366.05	73.97	440.02	
4	24.82	459.90	76.30	536.19	Draft DPR
5	21.46	366.84	73.97	440.81	
Total	124.15	2089.68	309.99	2399.67	
			Economic Cost, Total	***2039.71***	

** Including Land Acquisition, Relocation of Utilities, Environmental Improvement & Rehabilitation/ Social*

A construction period of 3 years (2020-22) has been envisaged with a phasing of 20%, 40% and 40% respectively.

9.3.3. Maintenance Standards and Unit Costs

Unit costs of various maintenance operations are derived from the rates of individual item of works, discussed in the section dealing with project costs. Maintenance Standards for the existing road and routine maintenance costs are worked out based on latest Manipur Schedule of Rates for National Highway-Work, 2018, Public Works Department, Manipur, Government of Manipur. For the proposed highway facility, renewal has been made condition responsive. The Maintenance Standards proposed for the project road is discussed below:

SL No.	*Maintenance Standard*	*Remarks*	*Year of Application*
1	Routine Maintenance once in a year for the existing road	For existing roads Without project (Base Alternate= "Do Nothing")	On all Sections From 2020
	• Repair of Pavement Edges		
	• Repair of Surface distress and potholes		
	• Repair of Shoulders etc.		

SL No.	*Maintenance Standard*	*Remarks*	*Year of Application*
	• Routine Maintenance		
2	• Surface renewal, 40mm AC at IRI> 4.5 m/km • Repair of Pavement Edges • Repair of Surface distress and potholes	For Project Facility	On all Sections From 2023
3	• Routine Maintenance	For Project Facility	Minimum Routine Maintenance on Section 3, 4, 5, 6, 8, and 9 from 2021

Financial costs of various maintenance works are taken as

- Patching of pothole Rs. 563.00 per sq. m
- Sealing of cracks and damages Rs. 200.00 per sq. m
- Edge repair Rs. 450.00 per sq. m
- Surface renewal, 40mm AC Rs. 562.00 per sq. m

Routine maintenance work involves other activities, not related to pavement distresses.

Based on the prevailing rates for routine maintenance cost for the analysis is taken as:

- Rs. 2,00,000 per km per year- for 2-lane road
- Rs. 3,00,000 per km per year for 4-lane road

9.3.4. General Vehicle Fleet Characteristics and Vehicle Damage Factors

HDM Vehicle Category

Significant traffic categories of fast moving vehicles are 2/3-wheeler, car & utility (Mini LCVs such TATA Magic etc), Mini bus, Bus, LCV, 2-axle Truck, 3-axle Truck, Articulated Truck (4-axle) and Agricultural Tractor with/without Trailer. HDM-4 does not include the traffic categories of 3-wheeler and Agricultural tractor at its current version. Based on average cost of vehicle, space equivalency, mobility and resource consumption level an equivalent "Small Car" Category has been created to represent 3-wheeler as 1 small car = 1 nos. 3-wheelers. Agricultural tractor with trailer is considered equivalent to 1 LCV. With this arrangement, the summary of traffic volume with Vehicle Category, Composition in Terms of Numbers and Percentage, traffic growth rate and vehicle damage factor for project road is given below:

Traffic Details with Vehicle Category, Composition in Terms of Numbers and Percentage.

Table 9.3: Details of Motorised Vehicle

Vehicle Type	HS-1	%	HS-2	%	HS-3	%	HS-4	%
Car/ Jeep/ Three Wheeler	929	*52*	882	*53*	3076	*66*	3632	*48*
Two Wheeler	49	*3*	37	*2*	300	*6*	1977	*26*
State/ Private/ Tourist Bus	64	*4*	48	*3*	102	*2*	93	*1*
Mini Bus	94	*5*	14	*1*	23	*1*	158	*2*
Light Truck	158	*9*	81	*5*	230	*5*	121	*2*
Midium Truck/LCV/Tempo	30	*2*	13	*1*	10	*0*	237	*3*
Heavy Truck/2-Axle Trucks	303	*17*	361	*22*	532	*11*	1182	*15*
Multi-Axle Truck	175	*10*	234	*14*	403	*9*	228	*3*
Total (MT)	1801	100.0	1669	100	4677	100	7626	100

Table 9.4: Details of Non-Motorised Vehicle

Vehicle Type	HS-1	%	HS-2	%	HS-3	%	HS-4	%
Cycle	94	97	75	97	119	76	117	19
Tri-Cycle/ Van	3	3	2	3	37	24	486	81
Total (NMT)	97	100	77	100	156	100	603	100

Table 9.5: Traffic Growth Rate

Period	2 Wheelers	3 Wheelers	Cars/ Jeeps	Buses	Trucks			
					2 Axle	3 Axle	M Axle	LCV and Mini LCV
Up to 2020	10.7	4.0	10.1	8.9	5.5	7.0	7.0	5.5
2021 – 2025	8.9	3.8	8.9	7.7	5.1	6.5	6.5	5.1
2026 – 2030	7.1	3.5	7.7	6.6	4.9	5.9	5.9	4.9
2031 – 2035	5.4	3.0	7.1	5.4	4.5	5.4	5.4	4.5
2036 - 2040	5.4	3.0	7.1	5.4	4.5	5.4	5.4	4.5
Beyond 2041	5.4	3.0	7.1	5.4	4.5	5.4	5.4	4.5

Table 9.6: VDF Adopted for Project Corridor

S. No.	Road Section	Length (km)	Trucks				Bus
			LCV	2-Axle	Tandem	MAV	
1	Kohima to Senapati	74.5	1.17	3.66	3.61	4.68	0.84
2	Senapati to Imphal	51.0	1.45	3.26	3.43	4.14	0.88

Vehicle Characteristic Data

Vehicle fleet data related to axle configuration and load distribution have been derived directly from axle load survey carried out by the Consultant. All other data on fleet characteristics are based on calibration to the Indian condition carried out for the "Maintenance Planning Study for Gujarat Roads" in 1994-95 under World Bank Funding.

9.3.5. Vehicle Fleet Unit Costs

Vehicle and Tyre

Economic Costs of vehicle and tyre are derived from that suggested in IRC: SP:30-2009 (with due escalation to the changes in price index in the respective category) supplemented by the market survey of the prevailing costs. Elements of taxes and duties applicable have been removed on a representative basis to arrive at the economic costs. Summary of derived economic costs for each vehicle category is given below:

Category	*Two Wheeler*	*Medium Car*	*Mini Bus*	*Bus*	*Light Truck*	*Medium Truck*	*Heavy Truck*	*Artic Truck*
Vehicle	44,930	5,40,725	6,79,334	12,86,762	5,66,112	10,22,267	13,89,350	18,06,155
Tyre	880	3,080	4,576	7,920	4,576	8,140	8,140	10,582

Maintenance Labour and Crew Costs

Based on the market survey and inquiries from the various organisations in Manipur & Nagaland, the maintenance labour cost/hr and wages/hour has been evaluated. The crew salary for LCV (Driver and Conductor), Heavy Trucks (Driver and cleaner) and Passenger Bus (Driver and Conductor) are found to be around Rs. 12,400/-, Rs.15500/- and Rs.23250/- per month respectively based on 300 hours of working per month. Per day wages for Driver/ Welder/ Plumber/ Electrician/ Fitter/Painter as per latest Manipur Schedule of Rates for National Highway-Work, 2015, Public Works Department, Manipur, Government of Manipur is Rs. 354 per day. Keeping this in view the cost Rs. /hr. has been calculated for the different categories of crew. Rates have been compared with that adopted for the recent studies before arriving at reasonable values. Adopted values are:

(Cost in Rs. per hour)

Category	*Two Wheeler*	*Medium Car*	*Mini Bus*	*Bus*	*Light Truck*	*Medium Truck*	*Heavy Truck*	*Artic Truck*
Maint. Labour	30	39	45	49	45	49	62	629
Crew Wage	0	0	97	123	68	86	103	103

Passenger Time-delay Costs

Value of travel time saving of passengers was first quantified in "Road User Cost Study (RUCS)" carried out in India in 1982 on the basis of wage rate approach. The results so obtained were updated to 1990 values using wage index and subsequently validated by limited primary survey carried out on various secondary and trunk routes in the "Study for Updating Road User Cost Data", 1992. Passenger time-delay cost for the project road has been derived from the same

corresponding to leisure trips @ 25% of the value of non-leisure trips (recommended by RUCS, 1992) as given below:

Travel Time Value of Passengers (Rs./hour) *(Based on average wage/income for both work and non-work trips)*

Mode of Travel	*Travel time Value*		*Derived from WPI*		*Non-work Time*
	RUCS-1980	*RUCS-1990*	*2004*	*2012*	
Car/ Taxi	10	24.3	55.9	95.3	23.8
Bus/ Minibus	7	19.7	49.3	84.0	21.0

Overhead

Annual overhead cost per vehicle is derived by the consultants as per the recommendations of the "Study for Updating Road User Cost Data", and resulting IRC: SP:30- 2010 as given below:

(*Cost in Rs.)*

Two Wheeler	*Medium Car*	*Mini Bus*	*Bus*	*Light Truck*	*Medium Truck*	*Heavy Truck*	*Artic Truck*
0	0	0	86085	192801	86085	182861	201241

Interest

An economic interest rate of 12% has been adopted based on opportunity cost of capital.

Fuel and Lubricants

Market price of petrol, diesel is quite variable at this stage due to unstable international market prices. Domestic market prices are based on anticipation of downward stabilisation of border price of crude oil. Therefore, economic cost of fuel is based on an international crude price of US $ 60 per barrel (1st April 2017, Pricing Charged to Dealers before VAT) as given below:

Item	*Unit*	*Total Cost*
Petrol	Rs. /litre	48.43
Diesel	Rs. /litre	47.74

Economic cost of Engine oil, lubricants and grease is estimated to vary in the range of Rs. 180 per litre, to Rs. 240 per litre. Rs. 210/litre has been adopted as average cost of lubricant.

Cargo Time-delay Costs

Average value of commodity is based on the "Study for Updating Road User Cost Data", 1992. A value of Rs. 20,000/- per ton was worked out from a detailed survey carried out in 1990. Equivalent cost of commodity in 2017 is determined using the WPI ratio as Rs. 90,000/-. However, commodity survey on the project road corridor does not justify such high value. For the present analysis, therefore, 50% cost is considered, i.e. Rs. 45,000 per ton. Average payload for each category of freight vehicles is based on axle load survey. Time-delay cost, is estimated with an economic interest rate of 11% and economic conversion factor of 0.85.

Vehicle Category	***Average Payload***	***Average Running Time***	***Time-delay Cost***
	(ton)	*(hour/ year)*	*(Rs. /hr.)*
Light Truck	5	1027	22.35
Medium Truck	9	2160	19.13
Heavy truck	15	2533	27.18
Artic Truck	21	2533	38.05

Fleet Utilisation

Data pertaining to annual utilization, hours driven per year, service life and passenger occupancy per vehicle are adopted from detailed findings in "Maintenance Planning Study for Gujarat Roads (1994-95)," substantiated by the OD surveys and field inquiries. Adopted values are given as:

Particulars	***Two Wheeler***	***Small Car***	***Medium Car***	***Mini Bus***	***Bus***	***Light Truck***	***Medium Truck***	***Heavy Truck***	***Artic Truck***
Km Driven	10000	33300	33300	40000	80000	40000	60000	60000	60000
Life, yr	12	16	16	12	12	12	12	12	12
Working h	400	925	925	1025	2010	1025	2155	2535	2535
Passenger			2	20	50				

9.4. Deterioration Factors and Model Calibration

HDM-4 is equipped with a wide range of calibration options to suit to individual project conditions in global respect. Not much work so far done on adaptation and calibration of the same on Indian scenario. Under such situation, attempts have been made to calibrate the model to arrive at likely prediction of road deterioration and work effects based on Consultants' vast experience on similar projects as well as calibration of HDM-III model for Indian conditions.

9.5. Results of Economic Appraisal

The consultants carried out the economic appraisal using the appraisal methodology and economic costs and benefits described in the preceding paragraphs of this report.

9.5.1. Economic Internal Rate of Return

The project road corridor is located in Semi-arid sub-tropical hot climate. The yearly rain fall is of the order of about 1620 mm. The project road declared as Asian Highway and is the lifeline of Manipur. The Commercial and Industrial centers are now coming up in North East region. Government of India is now giving more emphasis on development of North East region. Between 2004-05 and 2015-16, Gross State Domestic Product (GSDP) expanded at a compound annual growth rate (CAGR) of 9.74 per cent to US$ 4.17 billion whereas the Net State Domestic Product (NSDP) expanded at a CAGR of 9.17 per cent to US$ 3.41 billion. At a CAGR of 16.13 per cent, the secondary sector was the fastest growing among the three sectors during 2004-05 to 2015-16. Growth has been driven by manufacturing, construction, electricity, gas & water supply. As a result, majority of the trips are constituted of business/ service purposes. Car category of vehicles constitutes nearly 29-30% of the total traffic which is an average proportion. Manipur and Nagaland have shown good economic growth over the past years and

expected to grow in future too. Therefore, it is appropriate that passenger time is included in the analysis in order to arrive at a fairly representative life-cycle cost for the proposed road.

The summary of economic analysis for project section and for the project with relevant details is given in Table 9.07.

9.5.2. Sensitivity Analysis

Two critical factors could affect the viability of the project and these are the Capital Cost and traffic level. The capital cost can increase or the expected traffic growth could not materialise or both factors could occur simultaneously sensitivity check using the following parameters has been carried out:

Sensitivity Option S1	Increase in base costs by 15%
Sensitivity Option S2	Decrease in base benefits by 15%
Sensitivity Option S3	Increase in base costs by 15% and decrease in base benefits by 15%

The details of the economic analysis are given in Table 9.8, Table 9.9, Table 9.10 and Table 9.9. The EIRR for each section along with combined project road is subjected to sensitivity analysis and results are as follows:

Table 9.07: Summary of Economic Analysis

Project Road	***Economic Internal Rate of Return***			
Kohima –Imphal (NH-39)	***Normal***	***Sensitivity S1***	***Sensitivity S2***	***Sensitivity S3***
With Project including taking Passenger Time	18.20%	15.74%	15.36%	13.14%

The economic returns for base case are above 18.2% which justifies the need for investment on the corridor. However, investment is very healthy with passenger time cost, which is normally not taken into account for developing economy and where cost of leisure time is yet to be appreciated. The economics were tested against sensitivity, the economic return is 13.14% in case of worst combination of increase in cost and decrease in traffic (Case S3). However, improvement of existing road is very much justified to promote the overall economy with very tight economic returns.

Table 9.8 **Economic evaluation: Cost-Benefit Streams**

Kohima Imphal Project, NH-39

All Sections Combined - For the Project

(Costs in Rupees million)

Year	Increase in Road Agency Costs			Decrease in Road User Costs			Net Benefit Stream
	Capital Cost	Recurrent Cost	Total Transport Cost	MT VOC Cost	MT Time Cost	Total Transport Cost	
2020	4079.439	0.000	4079.439	0.000	0.000	0.000	-4079.439
2021	8158.878	1.693	8160.571	10.770	0.193	10.770	-8149.802
2022	8158.878	-3.489	8155.389	32.350	0.460	32.350	-8123.039
2023	0.000	-2.937	-2.937	4280.406	762.927	4280.406	4283.343
2024	0.000	2.005	2.005	4982.689	1039.320	4982.689	4980.685
2025	0.000	8.685	8.685	4814.634	1001.007	4814.634	4805.949
2026	0.000	12.293	12.293	4666.132	967.137	4666.132	4653.839
2027	0.000	14.259	14.259	4515.632	933.418	4515.632	4501.373
2028	0.000	17.311	17.311	4396.203	907.247	4396.203	4378.893
2029	0.000	22.824	22.824	4320.280	896.959	4320.280	4297.456
2030	0.000	24.790	24.790	4263.868	891.661	4263.868	4239.078
2031	0.000	26.618	26.618	4211.555	884.184	4211.555	4184.937
2032	0.000	28.540	28.540	4158.071	870.694	4158.071	4129.531
2033	0.000	30.227	30.227	4068.668	845.740	4068.668	4038.441
2034	0.000	32.007	32.007	3928.407	808.785	3928.407	3896.400
2035	0.000	33.793	33.793	3774.720	769.552	3774.720	3740.927
2036	0.000	35.565	35.565	3621.158	731.979	3621.158	3585.593
2037	0.000	37.340	37.340	3477.157	698.963	3477.157	3439.817
2038	0.000	39.113	39.113	3326.357	667.377	3326.357	3287.244
2039	0.000	40.861	40.861	3162.584	633.972	3162.584	3121.723
2040	0.000	42.630	42.630	3003.327	601.385	3003.327	2960.697
2041	0.000	44.424	44.424	2853.161	570.626	2853.161	2808.738
2042	0.000	46.233	46.233	2713.130	541.995	2713.130	2666.898
2043	0.000	48.055	48.055	2578.004	514.086	2578.004	2529.949
2044	0.000	49.889	49.889	2448.237	487.179	2448.237	2398.348
2045	0.000	51.724	51.724	2326.910	462.139	2326.910	2275.186
2046	0.000	53.577	53.577	2212.380	438.524	2212.380	2158.802
2047	0.000	55.450	55.450	2106.219	416.852	2106.219	2050.769
2048	-63.240	57.335	-5.905	2004.446	395.917	2004.446	2010.350
Total Economic Costs, Discount Rate= 0.0%							
	20,333.96	850.81	21,184.77	92,257.46	18,740.28	92,257.46	
Total Economic Costs, Discount Rate= 12.0%							
	14,242.44	99.22	14,341.66	20,951.33	4,254.43	20,951.33	
				Net Present Value (NPV)			
					Discount Rate= 0.0%		**71,073**
					Discount Rate= 12.0%		**6,610**
				Economic Internal Rate of Return(%)			**18.20%**

Table 9.9 **Economic evaluation: Cost-Benefit Streams**

Kohima Imphal Project, NH-39

All Sections Combined - For the Project

Sensitivity Option S1: 15% increase in Base Costs and Base Benefits

(Costs in Rupees million)

Year	Increase in Road Agency Costs			Decrease in Road User Costs			Net Benefit Stream
	Capital Cost	Recurrent Cost	Total Transport Cost	MT VOC Cost	MT Time Cost	Total Transport Cost	
2018	4691.355	0.000	4691.355	0.000	0.000	0.000	-4691.355
2019	9382.710	1.947	9384.657	10.770	0.193	10.770	-9373.887
2020	9382.710	-4.012	9378.698	32.350	0.460	32.350	-9346.348
2021	0.000	-3.378	-3.378	4280.406	762.927	4280.406	4283.784
2022	0.000	2.305	2.305	4982.689	1039.320	4982.689	4980.384
2023	0.000	9.988	9.988	4814.634	1001.007	4814.634	4804.646
2024	0.000	14.136	14.136	4666.132	967.137	4666.132	4651.996
2025	0.000	16.397	16.397	4515.632	933.418	4515.632	4499.235
2026	0.000	19.907	19.907	4396.203	907.247	4396.203	4376.296
2027	0.000	26.247	26.247	4320.280	896.959	4320.280	4294.032
2028	0.000	28.509	28.509	4263.868	891.661	4263.868	4235.360
2029	0.000	30.610	30.610	4211.555	884.184	4211.555	4180.945
2030	0.000	32.821	32.821	4158.071	870.694	4158.071	4125.250
2031	0.000	34.761	34.761	4068.668	845.740	4068.668	4033.907
2032	0.000	36.809	36.809	3928.407	808.785	3928.407	3891.599
2033	0.000	38.862	38.862	3774.720	769.552	3774.720	3735.858
2034	0.000	40.900	40.900	3621.158	731.979	3621.158	3580.259
2035	0.000	42.942	42.942	3477.157	698.963	3477.157	3434.216
2036	0.000	44.980	44.980	3326.357	667.377	3326.357	3281.377
2037	0.000	46.990	46.990	3162.584	633.972	3162.584	3115.594
2038	0.000	49.024	49.024	3003.327	601.385	3003.327	2954.303
2039	0.000	51.087	51.087	2853.161	570.626	2853.161	2802.074
2040	0.000	53.167	53.167	2713.130	541.995	2713.130	2659.963
2041	0.000	55.263	55.263	2578.004	514.086	2578.004	2522.741
2042	0.000	57.372	57.372	2448.237	487.179	2448.237	2390.865
2043	0.000	59.483	59.483	2326.910	462.139	2326.910	2267.427
2044	0.000	61.614	61.614	2212.380	438.524	2212.380	2150.766
2045	0.000	63.768	63.768	2106.219	416.852	2106.219	2042.451
2046	-72.726	65.936	-6.790	2004.446	395.917	2004.446	2011.236
Total Economic Costs, Discount Rate= 0.0%							
	23,384.05	978.44	24,362.48	92,257.46	18,740.28	92,257.46	
Total Economic Costs, Discount Rate= 12.0%							
	16,378.80	114.10	16,492.91	20,951.33	4,254.43	20,951.33	

Net Present Value (NPV)	
Discount Rate= 0.0%	**67,894.97**
Discount Rate= 12.0%	**4,458.42**
Economic Internal Rate of Return(%)	**15.74%**

Table 9.10 **Economic evaluation: Cost-Benefit Streams**

Kohima Imphal Project, NH-39

All Sections Combined - For the Project

Sensitivity Option S2: Base Costs and 15% decrease in Base Benefits

(Costs in Rupees million)

Year	Increase in Road Agency Costs			Decrease in Road User Costs			Net Benefit Stream
	Capital Cost	Recurrent Cost	Total Transport Cost	MT VOC Cost	MT Time Cost	Total Transport Cost	
2020	4079.439	0.000	4079.439	0.000	0.000	0.000	-4079.439
2021	8158.878	1.693	8160.571	9.154	0.164	9.154	-8151.417
2022	8158.878	-3.489	8155.389	27.498	0.391	27.498	-8127.892
2023	0.000	-2.937	-2.937	3638.345	648.488	3638.345	3641.282
2024	0.000	2.005	2.005	4235.286	883.422	4235.286	4233.281
2025	0.000	8.685	8.685	4092.439	850.856	4092.439	4083.754
2026	0.000	12.293	12.293	3966.212	822.066	3966.212	3953.920
2027	0.000	14.259	14.259	3838.287	793.405	3838.287	3824.029
2028	0.000	17.311	17.311	3736.773	771.160	3736.773	3719.462
2029	0.000	22.824	22.824	3672.238	762.415	3672.238	3649.414
2030	0.000	24.790	24.790	3624.288	757.912	3624.288	3599.498
2031	0.000	26.618	26.618	3579.822	751.557	3579.822	3553.204
2032	0.000	28.540	28.540	3534.360	740.090	3534.360	3505.820
2033	0.000	30.227	30.227	3458.368	718.879	3458.368	3428.141
2034	0.000	32.007	32.007	3339.146	687.468	3339.146	3307.139
2035	0.000	33.793	33.793	3208.512	654.119	3208.512	3174.719
2036	0.000	35.565	35.565	3077.985	622.183	3077.985	3042.420
2037	0.000	37.340	37.340	2955.584	594.118	2955.584	2918.243
2038	0.000	39.113	39.113	2827.404	567.270	2827.404	2788.291
2039	0.000	40.861	40.861	2688.196	538.877	2688.196	2647.336
2040	0.000	42.630	42.630	2552.828	511.177	2552.828	2510.198
2041	0.000	44.424	44.424	2425.187	485.032	2425.187	2380.764
2042	0.000	46.233	46.233	2306.161	460.696	2306.161	2259.928
2043	0.000	48.055	48.055	2191.303	436.973	2191.303	2143.249
2044	0.000	49.889	49.889	2081.001	414.102	2081.001	2031.112
2045	0.000	51.724	51.724	1977.874	392.818	1977.874	1926.149
2046	0.000	53.577	53.577	1880.523	372.745	1880.523	1826.945
2047	0.000	55.450	55.450	1790.286	354.325	1790.286	1734.836
2048	-63.240	57.335	-5.905	1703.779	336.530	1703.779	1709.683
Total Economic Costs, Discount Rate= 0.0%							
	20,333.96	850.81	21,184.77	78,418.84	15,929.24	78,418.84	57,234.07
Total Economic Costs, Discount Rate= 12.0%							
	14,242.44	99.22	14,341.66	17,808.63	3,616.26	17,808.63	3,466.97

Net Present Value (NPV)	
Discount Rate= 0.0%	**57,234.07**
Discount Rate= 12.0%	**3,466.97**
Economic Internal Rate of Return(%)	**15.36%**

Table 9.11 **Economic evaluation: Cost-Benefit Streams**

Kohima Imphal Project, NH-39

All Sections Combined - For the Project

Sensitivity Option S3: 15% increase in Base Costs and 15% decrease in Base Benefits

Year	Increase in Road Agency Costs			Decrease in Road User Costs			Net Benefit Stream
	Capital Cost	Recurrent Cost	Total Transport Cost	MT VOC Cost	MT Time Cost	Total Transport Cost	
2020	4691.355	0.000	4691.355	0.000	0.000	0.000	-4691.355
2021	9382.710	1.947	9384.657	9.154	0.164	9.154	-9375.503
2022	9382.710	-4.012	9378.698	27.498	0.391	27.498	-9351.200
2023	0.000	-3.378	-3.378	3638.345	648.488	3638.345	3641.723
2024	0.000	2.305	2.305	4235.286	883.422	4235.286	4232.981
2025	0.000	9.988	9.988	4092.439	850.856	4092.439	4082.451
2026	0.000	14.136	14.136	3966.212	822.066	3966.212	3952.076
2027	0.000	16.397	16.397	3838.287	793.405	3838.287	3821.890
2028	0.000	19.907	19.907	3736.773	771.160	3736.773	3716.865
2029	0.000	26.247	26.247	3672.238	762.415	3672.238	3645.990
2030	0.000	28.509	28.509	3624.288	757.912	3624.288	3595.779
2031	0.000	30.610	30.610	3579.822	751.557	3579.822	3549.212
2032	0.000	32.821	32.821	3534.360	740.090	3534.360	3501.539
2033	0.000	34.761	34.761	3458.368	718.879	3458.368	3423.607
2034	0.000	36.809	36.809	3339.146	687.468	3339.146	3302.338
2035	0.000	38.862	38.862	3208.512	654.119	3208.512	3169.650
2036	0.000	40.900	40.900	3077.985	622.183	3077.985	3037.085
2037	0.000	42.942	42.942	2955.584	594.118	2955.584	2912.642
2038	0.000	44.980	44.980	2827.404	567.270	2827.404	2782.424
2039	0.000	46.990	46.990	2688.196	538.877	2688.196	2641.207
2040	0.000	49.024	49.024	2552.828	511.177	2552.828	2503.804
2041	0.000	51.087	51.087	2425.187	485.032	2425.187	2374.100
2042	0.000	53.167	53.167	2306.161	460.696	2306.161	2252.993
2043	0.000	55.263	55.263	2191.303	436.973	2191.303	2136.040
2044	0.000	57.372	57.372	2081.001	414.102	2081.001	2023.629
2045	0.000	59.483	59.483	1977.874	392.818	1977.874	1918.391
2046	0.000	61.614	61.614	1880.523	372.745	1880.523	1818.909
2047	0.000	63.768	63.768	1790.286	354.325	1790.286	1726.518
2048	-72.726	65.936	-6.790	1703.779	336.530	1703.779	1710.569
Total Economic Costs, Discount Rate= 0.0%							
	23,384.05	978.44	24,362.48	78,418.84	15,929.24	78,418.84	54,056.35
Total Economic Costs, Discount Rate= 12.0%							
	16,378.80	114.10	16,492.91	17,808.63	3,616.26	17,808.63	1,315.72

Net Present Value (NPV)	
Discount Rate= 0.0%	**54,056.35**
Discount Rate= 12.0%	**1,315.72**
Economic Internal Rate of Return(%)	**13.14%**

9.6. Financial Analysis

9.6.1. Approach to Financial Evaluation

The main objective of financial analysis is to examine the viability of implementing the project on a BOT and if it is not possible on BOT then on any other way of financing the project. In this case, the other alternative may be on ANNUITY basis. The analysis attempts to ascertain the extent to which the investment can be recovered through toll revenue and if any gap remains that can be funded through funding from Government of India in the form of Grant (VGF). 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 with debt equity ratio of 70:30.

The FIRR should have a value above the discount rate (Opportunity Cost). Cash flow (Liquidity) situation should be satisfactory in each year of concession period. In other words, the cash balance at the end of every year should be positive.

9.6.2. Capital Cost

9.6.2.1 Project Cost Assumptions

The total cost of the project includes cost of civil works involved in the upgradation of the roads. The estimated project cost is considered excluding shifting of utilities, land acquisition, acquisition of structures, rehabilitation and resettlement and environmental mitigation measures. The total cost of the Project has been computed based on the 2017 prices. The annual phasing of capital cost is made as per the work schedule. Construction cost is phased over a 3 years period from 2020 to 2022 as 20%, 40% and 40% respectively.

The cost of the civil works of the project includes the improvement of the existing carriageway and the cost of Toll Plaza is given in ***Table 9.7.***

Table 9.7: Base Civil Cost

S. No.	Description	Cost in Crores
1	Project Civil cost	**2399**

9.6.2.2 Cost Escalation

The escalation cost during construction which is on the cost of funding incurred on the project.

9.6.2.3 Interest during Construction

The interest during construction, which is on the cost of funding incurred on the project, has been included in the Total Project Cost.

9.6.2.4 Landed Project Cost

The total landed project cost at the end of the construction period has been estimated by adding Contingencies, IC and Pre-operative Cost, Escalation and Interest during construction. The total project cost at the time of commissioning is thus estimated and is given in ***Table 9.8.***

Table 9.8: Project Cost Summary of Concessionaire Cost (with 40% Grant)

S. No	Description	Total Project
1	Total Civil Construction cost for the Project	2399
2	Contingencies/QC @ 2.8% Civil Cost	67.172
	Total EPC Cost	*2466*
3	IC & Pre-operative expenses @1.5% of EPC	37
4	Financing Cost @2% Debt at 70:30 DER	35
5	Esclation @ 5% Per Anum	123
6	Interest During Construction @11.75% pa on Debt (at 70:30 DER) (Term Loan)	365.1
	TOTAL PROJECT COST *	3,026

9.6.2.5 Operation and Maintenance Cost

The maintenance costs, both routine and periodic have been discussed in the Preliminary Cost Estimate Chapter. Routine maintenance costs comprise of maintenance of the pavement, collection of litter, lighting, traffic management (policing), accident repairs 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 5th years.

Routine maintenance/ Periodic maintenance costs have been considered as per the MORT&H guidelines 1997 prices. The details of the maintenance costs and administration charges are given in ***Table 9.9.***

Table 9.9: Routine & Periodic Maintenance

Sl.No	Description	Amount (Million/km)
1	Routine maintenance in every year cost per km for the two lanes with paved shoulder. 2011-12 Prices	0.210
2	Periodic maintenance in every 5^{th} year cost per km for the two lanes with paved shoulder. 2011-12 Prices	2.10
3	Toll Collection Expenses	5.29/Annum
4	Insurance 0.15% of the Civil Cost	3.85/ Annum
5	Patrolling Expenses Rs.37500/ Km	3.52/ Annum
6	Electricity Expenses Rs.37500/Km	3.52/ Annum
7	Office Expenses	15.00/ Annum

9.7. Project Revenue

9.7.1. Toll Revenue

The Toll revenue has been calculated by multiplying the toll rate of the concerned category of vehicle by its projected number for that particular year. However, the revenue has been calculated by taking the traffic of the section which has the maximum tollable traffic and the same has been multiplied by 50% of the road length. This has been done to optimize the revenue collection at the same time giving due care to the road user. The indexing of the Toll has been done as per the Toll policy of 2008 and rounding up in multiples of nearest five rupee.

9.7.2. Toll Rates

The project investment would be recovered by imposing user fee on vehicles using the Roads. In general the toll rates for the project should have a direct relation with the benefits that the road user would gain from its improvements. The benefits to road user are likely to be in terms of fuel savings, saving in travel time and good riding quality.

As per amendment made in December 2010 in the Toll Policy of 2008, the toll rates for the analysis are as given in Table 9.10.

Table 9.10: Toll Rates in the year 2007-2008 for 2-lane & 4-lane devided road

Toll Rates	Two Lane (Rs. /km)
Car	0.39
LCV/ Mini Bus	0.63
Bus/ 2 Axle Trucks	1.32
Trucks 3 Axle	1.44
Trucks 4 to 7 Axle	2.07
Trucks more than 7 Axle	2.52

The increase in the Toll as per the Toll policy of 2008 has been adopted i.e. 3% Non Compounding of the base rate and 40% of WPI will be added to the toll of the previous year toll. In the future years where WPI is not available in those years WPI will be taken at 5% p.a. The base toll rates for the year 2016-17 are given in ***Table 9.11***.

Table 9.11: Toll Rates in the year 2016-2017

Toll Rates	Rs. / KM.
Car	0.63
LCV/ Mini Bus	1.01
Bus/ 2 Axle Trucks	2.13
Trucks 3 Axle	2.32
Trucks 4 to 7 Axle	3.33
Trucks more than 7 Axle	4.06

9.7.3. Toll Plaza Locations:

The proposed Toll Plaza Locations and their effective lengths are given in ***Table 9.12.***

Table 9.12: Proposed Toll Plaza Locations

S.No.	Toll Plaza Location	Tollable Length (km)
1	km250	65
2	Km276	60

9.7.4. Traffic Detail

The details of tollable traffic and growth scenario are presented in the Traffic Survey and Analysis chapter.

9.7.5. Financial Model Input and Analysis

The methods adopted to ascertain the Financial Viability of the Project has been outlined in this section. The first stage in ascertaining the financial viability is to identify the revenue and expenditure stream. In this project only Toll revenue is considered. No revenue from advertisement is being considered.

9.7.6. Proposed Source of Finance

In general the developer shall crystallize the source of Finance by optimizing his equity returns keeping in view the project cash flow and terms of all the financing options available. At the same time market standing and the financial strength of the developer is the key criteria to determine the terms on which the funds are available from all the financial institutions.

For the purpose of study following source of finance has been taken.

- Equity: To be provided by the developer.
- Grant: To be provided by the Client.
- Debt: To be arranged by the developer.

9.7.7. Resource Mobilization Schedule

In general, the duration of construction for similar size road projects ranges between 25-30 months. Since the proposed Project may be implemented on a BOT format, the developer has an incentive in early completion of the project in order to expedite toll collection. Hence, the Project implementation period has been taken as 36 months. Based on the implementation period, the project cost has been phased as given in ***Table 9.13***.

Table 9.13: Project Cost Phasing

Description	1st year	2nd year	3rdyear
Percentage of total cost incurred	20%	40%	40%

9.7.8. Minimum Return Criteria

The minimum return criteria for the B.O.T project is considered as follows: -

The return on project investment (FIRR) should be in the range of 15% to 17% and the return on equity (Equity IRR) should range from 14% - 16%. The minimum average DSCR is taken as 1.5 and the pay pack period shall be 15 -16 years.

9.7.9. Tax Calculation Module

The tax rate adopted for this study is 33.22% following the deduction of depreciation and amortization. Even the Minimum Alternate Tax (MAT) of 19.93% has been taken into account for the total concession period.

9.8. Financial Viability

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.

The following assumptions are taken into consideration for the financial analysis: -

- Debt – Equity ratio :- 70:30
- Subsidy – 40%
- Concession period (Including 36 months construction period) – 25 years.
- Escalation – 5%
- Interest on Debt – 11.75%
- Project Phasing: First year – 20%, Second year – 40%, Third year – 40%.
- Loan Repayment period – 10 years
- Moratorium – 1 year
- Depreciation by Straight line method - 100%
- Depreciation by Written down value method – 10%

9.9. Result and Analysis

Based on the project structure, study of all possible sources of revenue, 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 operation. FIRR for the Returns on Investment and Returns on Equity for the years from 2018 and 2041 (concession period 25 years including three years construction period) is giving no result.

9.10. Recommendation

The project is not viable. The main reason for non-viability is very less traffic in terms of Trucks and high cost of constructions and overhead, that is about Rs. 25.64 Billion. At the end of 2041 the number of trucks are coming 4584. As a result, toll collection is very nominal of the order of Rs. 421 Million.