



**NATIONAL HIGHWAYS AND INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED
(MINISTRY OF ROAD TRANSPORT & HIGHWAYS)
GOVT. OF INDIA**

**Consultancy Services for Preparation of DPR for Development of
Economic Corridors, Inter Corridors and Feeder Routes to Improve
the Efficiency of Freight Movement in India under Bharatmala
Pariyojana**



**Lot-1 : Package-II
(251.8 KM)**

**Section-6+7(combined): Km
113+830 – Km 145+712**



**Final
Detailed Project Report**

**Volume - I
Main Report**

Revision –R2

August 2021



Voyants Solutions Pvt. Ltd

Corporate Office:

403, 4th Floor, Park Centra, Sector-30, NH-8, Gurugram-122001, Haryana, India
CIN- U74140HR2004PTC046918
Ph: 0124-4598200, Fax: 0124-4019051, E-mail: info@voyants.in, www.voyants.in

Regional Office:

Jindal Towers, Block-A, 4th Floor, 21/1A/3, Darga Road,
Kolkata – 700 017
Tele: 033- 40519300/ 40063240/ 300070350

CONTENTS

LIST OF VOLUMES (DETAILEDPROJECT REPORT)

Volume-I	-	Main Report
Volume-IA	-	Appendices to Main Report
Volume-II	-	Design Report
Volume-III	-	Material Report
Volume-IV	-	Environmental Assessment Report
Volume-V	-	Technical Specification
Volume-VI	-	Rate Analysis
Volume-VII	-	Cost Estimates
Volume-VIII	-	Bill of Quantities
Volume-IX	-	Drawings (Road Works and Structure Works)

VOLUME-I

0.0 EXECUTIVE SUMMARY

0.1	Project Background
0.2	Project Road Description
0.3	Existing Characteristics of the Project Road
0.4	Traffic
0.5	Surveys and Investigations
0.6	Development Proposals
0.7	Proposed ROW and Land Acquisition
0.8	Summary of Environmental Screening and Issues
0.9	Summary of Social Screening and Issues
0.10	Cost Estimates
0.11	Economic Analysis
0.12	Financial Analysis
0.13	Conclusion and Recommendation

1.0 INTRODUCTION

1.1	Project Background
1.2	Project Road Description
1.3	Other Information Relevant to the Project Road
1.4	Improvement Objective
1.5	Objective of Consultancy Services
1.6	Scope of Work
1.7	Stages of Submission
1.8	Structure of Detailed Project Report

2.0 EXISTING CHARACTERISTICS OF THE PROJECT ROAD

- 2.1 General
- 2.2 Terminal Points including Important Cardinal Points
- 2.3 GPS Co-ordinates
- 2.4 Status of Existing km Stones
- 2.5 Important Settlements along the Project Road
- 2.6 Connectivity
- 2.7 Terrain and Land Use
- 2.8 Existing Right of Way (ROW)
- 2.9 Existing Cross Sectional Elements
- 2.10 Geometry
- 2.11 Pavement
- 2.12 Road Intersections/Cross Roads
- 2.13 ROB/Railway Level Crossing
- 2.14 Bridges and Culverts
- 2.15 Other Facilities
- 2.16 Existing Utilities
- 2.17 Project Road Deficiencies
- 2.18 Critical Areas Needing Attention
- 2.19 Field Photographs

3.0 SOCIO ECONOMIC PROFILE

- 3.1 Introduction
- 3.2 Project Influence Area
- 3.3 The State of Assam at a Glance
- 3.4 District Profile :Hojai
 - 3.4.1 Climate
 - 3.4.2 Demography
 - 3.4.3 Working Profile
 - 3.4.4 Economy
- 3.5 District Profile :East KarbiAnglong
 - 3.5.1 Climate
 - 3.5.2 Demography
 - 3.5.3 Economy

4.0 ENGINEERING SURVEYS AND INVESTIGATIONS

- 4.1 Introduction
- 4.2 Reconnaissance Survey
- 4.3 Road Inventory
- 4.4 Pavement Condition Survey

4.5	Inventory and Condition Survey of Existing Bridges, Culverts and Other Structures
4.6	Alternative Alignment Study of Major Realignments
4.7	Topographical Survey
4.8	Traffic Survey
4.9	Axle Load Survey
4.10	Falling Weight Deflectometer (FWD) Survey
4.10.1	TOR Requirements
4.10.2	Falling Weight Deflectometer (FWD)
4.10.3	Data Verification
4.10.4	Identification of Homogeneous Sub-sections
4.10.5	Work Procedure
4.11	Roughness Survey
4.12	Subgrade Investigation
4.12.1	Sub-grade Investigation Methodology (Test Pits)
4.12.2	Large Pits (1.0m x 1.0m x 1.0m)
4.12.3	Existing Pavement Composition
4.12.4	Laboratory Properties of Sub Grade Soil
4.12.5	Grain Size
4.12.6	Atterberg Limit
4.12.7	Moisture Content vs. Dry Unit Weight Relationship (Heavy Compaction)
4.12.8	CBR of Existing Sub Grade Soil
4.12.9	Field Dry Density
4.12.10	Laboratory Properties of Sub-Grade Soil
4.13	Material Investigation
4.13.1	Borrow Area Material Survey
4.13.2	Quarry Material Survey
4.13.3	Manufactured Materials
4.14	Lead Charts
4.15	Hydrological and Hydraulic Study
4.16	Secondary Data Collection

5.0 TRAFFIC SURVEY AND ANALYSIS

5.1	Introduction
5.2	Road Connectivity
5.3	Traffic Homogeneous Sections
5.4	Traffic Survey Schedule
5.5	Methodology of Traffic Survey
5.5.1	Classified Traffic Volume Counts
5.5.2	Origin-Destination Survey
5.5.3	Speed and Delay Survey
5.5.4	Turning Movement Survey
5.5.5	Axle Load Survey

5.6	Data Analysis
5.6.1	Traffic Volume Count
5.6.2	Analysis of OD Survey Data
5.6.3	Analysis of Turning Movement Count Survey
5.6.4	Analysis of Speed and Delay Survey
5.6.5	Analysis of Axle Load Survey
5.7	Traffic Forecast
5.7.1	Past Vehicle Registration Details
5.7.2	Past Growth of the Economy
5.7.3	Transport Demand Elasticity
5.7.4	Description of Regression Analysis
5.7.5	Traffic Forecasting Methodology
5.7.6	Traffic Growth Rates
5.7.7	Diverted Traffic
5.7.8	Generated Traffic
5.7.9	Total Traffic
5.7.10	Traffic Projection
5.8	Capacity Analysis
5.9	Recommendation
6.0	DEVELOPMENT PROPOSALS
6.1	General
6.2	Geometric Improvement
6.2.1	Codes and Guidelines
6.2.2	Design Concept
6.2.3	Geometric Design Standards
6.2.4	Widening Proposal
6.2.5	Cross-section for Improved Facility
6.2.6	Cross-section for Bridges, Culverts and Other Structures
6.2.7	Horizontal Alignment
6.2.8	Vertical Alignment
6.2.9	Proposal for Built-Up Areas
6.2.10	Proposal for Forest Areas
6.2.11	Realignments
6.3	Drainage
6.4	Bridges, Culverts and Other Structures
6.4.1	Major Bridges
6.4.2	Minor Bridges
6.4.3	Culverts
6.4.4	Underpasses
6.4.5	Rail Over Bridges (ROB)
6.4.6	Flyovers

6.4.7	Interchanges
6.5	Intersection Improvement Proposals
6.6	Pavement Design
6.6.1	General
6.6.2	Methodology of Pavement Design
6.6.3	Design of New Flexible Pavement
6.6.4	Overlay Design
6.7	Protection Works
6.8	Other Highway Facilities
6.8.1	Bus Bays
6.8.2	Truck Laybys
6.8.3	Toll Plazas
6.8.4	Wayside Amenities
6.8.5	Illumination
6.8.6	Miscellaneous Provisions for Traffic Guidance and Safety
6.9	Landscaping and Arboriculture
6.10	Proposed ROW and Land Acquisition
7.0	ENVIRONMENTAL SCREENING
7.1	Introduction
7.1.1	Scope of Environmental Screening
7.2	Methodology and Work Plan
7.2.1	Approach to Screening and Scoping
7.2.2	Project Work Plan
7.3	Project Description
7.3.1	Widening Proposal
7.3.2	Geometric Design Standards
7.3.3	Project Proponent
7.3.4	Need of the Project and Benefits Associated
7.3.5	Proposed Features of the Road
7.4	Legislative Framework
7.4.1	Introduction
7.4.2	Environment Legislation – India
7.4.3	International Agreements
7.4.4	Environment and Social Safeguard Policies
7.5	Environment Screening
7.5.1	Introduction
7.5.2	Study Area
7.5.3	Data Collection
7.5.4	Location
7.5.5	Climatology
7.5.6	Drainage Pattern

7.5.7	Surface Water Resources in the Project Area
7.5.8	Air Quality
7.5.9	Noise Level
7.5.10	Forest and Biodiversity
7.5.11	Reserved Forest and Eco Sensitive Locations along the Project Road
7.5.12	Wild Life Corridor along the Project Road
7.5.13	Social and Cultural Feature
7.5.14	Historical/Archaeological Sites
7.5.15	Educational Facilities
7.5.16	Medical Facilities
7.5.17	Religious and Cultural Structures
7.6	Stakeholder Consultation
7.6.1	Process and Methodology
7.7	Screening of Potential Environmental and Social Impacts
7.7.1	Analysis of Data and Environmental & Social Screening
7.7.2	Identification of Critical Sections
7.7.3	Potential Environmental Impacts and Mitigation Measures
7.8	Environmental Management Plan
7.9	Structure of EIA & EMP Report
7.10	Photographs of Environment Screening Field Visits
8.0	PRELIMINARY SOCIAL IMPACT ASSESSMENT
8.1	Introduction
8.2	Social Screening
8.3	Existing Road Width
8.4	Existing Right of Way (ROW)
8.5	Terrain and Landuse
8.6	Built up Areas
8.7	Project Impacts
8.7.1	Impacts on Land
8.7.2	Impacts on Structures
8.7.3	Impacts on Community Structures
8.8	Community Perceptions about the Project
8.9	Further Detailed Social & Resettlement Assessment
8.10	Resettlement and Rehabilitation Budget
8.11	Conclusions/Recommendations
9.0	PRELIMINARY COST ESTIMATES
9.1	General
9.2	Methodology
9.2.1	Estimation of Quantities

- 9.2.2 Unit Rates of Civil Works
- 9.2.3 Civil Cost and TPC
- 9.2.4 Other Costs

10.0 ECONOMIC ANALYSIS

- 10.1 Introduction
- 10.2 Measures of Project Analysis
- 10.3 Decision Criteria
- 10.4 Price Elasticity of Demand and Traffic Forecasting
- 10.5 Road User Costs (RUC) Components
- 10.6 Inputs to the HDM-4 Model
- 10.7 Capital Cost of the Project
- 10.8 Routine and Periodic Maintenance Cost
- 10.9 Project Benefits
- 10.10 Economic Viability
- 10.11 Sensitivity Analysis
- 10.12 Conclusions

11.0 FINANCIAL ANALYSIS

- 11.1 Background
- 11.2 Approach to Financial Evaluation
- 11.3 Cost of the Project
- 11.4 Cost Escalation and Total Project Cost
- 11.5 Toll Rates
- 11.6 Traffic
- 11.7 Toll Revenue
- 11.8 Tax Calculation Module
- 11.9 Proposed Sources of Finance
- 11.10 Methodology
- 11.11 Expenses
- 11.12 Operation and Maintenance Cost
- 11.13 Resource Mobilization
- 11.14 Resource Mobilization Schedule
- 11.15 Minimum Return Criteria
- 11.16 Financial Viability
- 11.17 Results and Analysis
- 11.18 Conclusions and Recommendations

12.0 ROAD SAFETY AUDIT

- 12.1 Introduction

-
- 12.2 Stages of Road Safety Audit (RSA)
 - 12.3 Aspects to be Checked

13.0 CONCLUSIONS AND RECOMMENDATIONS

- 13.1 Conclusions
- 13.2 Recommendations

Executive Summary

EXECUTIVE SUMMARY

0.1 Project Background

The National Highways & Infrastructure Development Corporation Limited has been constituted through an Act of Parliament for faster, economical and quality Road Construction work throughout India. The National Highways & Infrastructure Development Corporation Limited (NHIDCL) has been entrusted with the assignment of preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojana.

In view of the above work NHIDCL has appointed M/s Voyants Solutions Pvt. Ltd. to carry out the Feasibility Studies and Detailed Project Report including field investigations, road inventory, structure inventory, FWD test, road crust sample (trial pits), material investigation, secondary data collection and traffic survey (classified traffic volume count, O-D, intersection counts, axle load survey, animal/pedestrian crossing counts and speed-delay survey). The letter of invitation (LOI) has been issued vide memo no. NHIDCL/Bharatmala/DPR/Phase-I /Lot-1/2017, dated October 30, 2017, whereas, the letter of acceptance (LOA) has been issued vide letter no. NHIDCL/Bharatmala/DPR/Phase-I /Lot-1/Package II/2017/27, dated February 02, 2018. Letter of commencement (LOC) for the consultancy services was issued vide letter no. NHIDCL/Bharatmala/DPR/Phase-I /Lot-1/Package II/2017/80, dated April 13, 2018.

0.2 Project Road Description

The project road comprises 5 stretches as mentioned in the RFP as mentioned below in **Table 0.1**.

Table 0.1 : Details of Major Road Segments

Stretches	Description
Strech-1	Daboka – Manja (NH-29)
Strech-2	Manja- Lahorijan (NH-29)
Strech-3	Lahorijan – Khatkhathi (NH-129)
Strech-4	Numaligar- Khatkhathi (NH 129)
Strech-5	Khatkhathi – Chumukademia (Dimapur Bypass)

Project location on state and district maps are presented on **Figure 1.1** and **1.2** respectively.

Different road segments are schematically presented in **Figure 1.3**.

This report includes the road section as mentioned below from the Stretch -1 and 2 in the above table:

Section-6+7 (combined): **From Km 113+830(near Manja)to Km 145+712 (near Dillai)**

0.3 Existing Characteristics of the Project Road

The salient features of the existing project road are given in **Table 0.2**.

Table 0.2: Salient Features of the Existing Project Road

Sl No.	Items	Details
		Stretch I: Daboka to Lahorijan (NH 29)
1	Length as per RFP	128.8 KM
2	Districts Enroute	Hojai, KarbiAnglong
3	Important Settlements	Haludihadi, Langpi, Dokmoka, Langhin, Pholoni, Uttarbarbil, Bokalia, Manja, Dilai
4	Terrain	62% Plain, 38% Rolling
5	Landuse	Agricultural-48%, Open/Barren-7%, Forest-28%, Residential/Commercial-17%
6	National Park	Nil
7	Existing ROW	18m – 45m (as measured at site)
8	Forest Stretches	Around 33km (Daboka RF, Sildharampur RF, Longhit RF)
9	Present Road Condition	Fair to Poor (2-Lane c/w)
10	Bypass/Realignment to be Involved	Around 37%
11	Built Up Stretches	About 28km
12	Carriageway Width	6.0m – 10.0m
13	Average Journey Speed	40-50kmph,
14	Requirement of Bypasses	At Dokmoka, Bokalia and Manja
15	Horizontal Geometry	Fair-Good (In Rolling terrain, Poor-Fair)
16	Vertical Geometry	A few curves with inadequate sight distance mainly near Bridge Approaches, otherwise good
17	No. of Existing Structures	248 (MJB-2, MNB-42, Culvert-204)
18	No. of Level Crossings	Nil
19	No. of Intersections	Major-9, Minor-71
20	Roadside Trees	Approx. 6,000
21	Major Rivers	Jamuna and Shiloni
22	Water Logging Area	-
23	Roadside Utility	HT/LT lines, OFCs, transmission towers, tube wells, wells
24	Road Safety	Sub-standard and Negligible

0.4 Traffic

The summary of Annual Average Daily Traffic (AADT) is shown in **Table 0.3**.

Table 0.3: Average Daily Traffic on Project Road at Km 62 of NH-29, Km 127 of NH-29 and Km 138+450 of NH-29 (in Numbers)

Vehicle Type	At km 62 of NH-29	At km 127 of NH-29
Car	1533	1657
Taxi	32	34
2 Wheeler	2274	2455
3 Wheeler	852	921
Mini Bus	46	49
Standard Bus	240	259
LCV	445	483
2 Axle	164	182
3 Axle	74	83
MAV	65	72
Tractor	7	7
Tractor with Trailer	5	5
Cycle	984	1063
Cycle Rickshaw	4	4
Animal Drawn	11	11
Others	2	2
Total (numbers)	6739	7288
Total (PCU)	6627	7184

Source: Consultant's analysis

The projected combined traffic on the project road sections from start of Daboka to Hatikhuli is presented in **Table 0.4**.

Table 0.4: Projected Total Traffic AADT

Year	2018	2020	2023	2030	2035	2040
Total Traffic (PCU)	7184	8515	11032	19628	28433	41385

0.5 Survey and Investigations

The following engineering survey and investigations were conducted at this stage of project preparation:

- Reconnaissance Survey: to assess the quality and quantity of features along the alignment, the data was used to finalize the most preferred alignment.
- Road Inventory: to assess the characteristics of existing road, this was used to finalize plan and profile drawings as well as extent of widening required.

- c) Road Condition Survey: to assess condition of existing pavement, the data has helped to assess the usability of existing pavement along with extent of repair work needed.
- d) Inventory and Condition Survey of Existing Bridges, Culverts and Other Structures: to check the dimensions and conditions of existing structures, the information obtained has guided to finalize the improvement proposals of existing structures.
- e) Topographic Survey: to exactly identify locations of all existing features along the alignment, this survey will dictate the final plan & profile drawings, BOQ etc. This survey will be conducted at the next stage of project preparation.
- f) Traffic Survey: To assess possible traffic intensity along the proposed road along with its future projection, this survey is the basic of the entire study. The data has been used to finalize lane configuration, tolling strategy and the viability of the project.
- g) Axle Load Survey: to assess possible loading over proposed pavement. The data was used to determine the VDF which ultimately guided the pavement design.
- h) FWD Survey: to assess the existing pavement composition from deflection point of view, the data was used to finalize overlay thickness. As the road sections are under construction, the survey could not be conducted for these stretches.
- i) Pavement Investigation: to assess characteristics of existing pavement, the data was used for pavement design.
- j) Material Investigation: to assess possible sources of construction materials and their suitability, distance of sources from project road was used to calculate the lead distance which is ultimately used for rate analysis.

0.6 Development Proposals

The salient proposals for up-gradation and improvement of the project road are classified into the following engineering aspects:

Where Proposed Alignment Overlaps with Existing Roads

- In general, in this section of proposed stretch follows existing Daboka – Lahorijan Road (NH 29).
 - Widening of the project road based on traffic capacity/requirement.
 - Improving the horizontal geometry of the existing road based on the design standards as per IRC: SP: 84-2019
 - Design of new pavement for widening and realignment of the existing road.
 - Provision of overlay at strengthening stretches.
 - Improvement of all major and minor intersections.
 - Rehabilitation and widening of the existing structures including bridges, culverts etc. and design of new ones as per requirement.
 - Provision of new structures including bridges, culverts, underpasses etc.
 - Provision of comprehensive road furniture for complete road safety measures.
 - Provision of protective measures on high embankment slopes.
- Mitigation measures for environmental and social issues w.r.t.to screening report.

The general design standards for improvement are enumerated in **Table 0.5**.

Table 0.5 : Geometric Design Standards for Road Works (Plain/Rolling Terrain)

Sl No.	Attributes	Geometric Design Standards
1	Design Speed	
	Plain and Rolling Terrain (Cross slope of the ground upto 25 per cent)	Ruling: 100 kmph Minimum: 80 kmph
2	Carriageway Width	For four lane: 2 x 7.0m with 0.5 m Kerb shyness at either side
3	Width of Shoulder	
	a) Paved Shoulder	2 x 2.5 m
	b) Earthen Shoulder	1.5 m
4	Footpath width at built-up areas	2 x 1.5 m drain cum footpath
5	Camber	
	a) Carriageway	2.5%
	b) Shoulder	3.0%
6	Maximum and Minimum Super-elevation	Maximum limited to 7.0% (for Radius less than Desirable minimum) Minimum limited to 5% (for Radius more than Desirable minimum)
7	Minimum Radius of Horizontal Curves	
	a) Plain and rolling Terrain	Desirable Minimum: 400m Absolute Minimum: 250m
8	Sight Distances for Various Speeds	180m – 360m
9	Longitudinal Gradient	
	a) Plain and Rolling Terrain	Ruling: 2.5%, Limiting: 3.3%
10	Extra Width of Pavement	
	Radius of Curve	Extra Width
	75-100m	0.9m
	101-300m	0.6m

Total 9 nos. typical cross sections are envisaged for the project as mentioned below:

TYPE –1	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN IN RURAL AREA (CONCENTRIC WIDENING)
TYPE –1A	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN IN BYPASS/REALIGNMENT STRETCHES
TYPE –2	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN IN RURAL AREA (ECCENTRIC WIDENING)
TYPE –3	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN AND WITH SERVICE ROAD ON BOTH SIDES IN BUILT UP AREA.
Type-4	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN IN FOREST AREA (CONCENTRIC WIDENING).

Type-4A	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN INFOREST AREA (ECCENCENTRIC WIDENING).
Type-5	TYPICAL CROSS SECTION OF APPROACHES OF ELEPHANT UNDERPASSES (FOREST AREA).
Type-6	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN IN FOREST AREA (NEW CONSTRUCTION).
Type-7	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY AT GRADE SEPARATOR APPROACHES WITH SERVICE ROAD AND RE WALL ON BOTH SIDES
Type-8	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN (NEW CONSTRUCTION) IN CUT SECTION ONE SIDE (MOUNTAINOUS TERRAIN ONE SIDE - HILL AND ONE SIDE - VALLEY)
Type-8A	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN (NEW CONSTRUCTION) IN CUT SECTION ONE SIDE(MOUNTAINOUS TERRAIN ONE SIDE - HILL AND ONE SIDE - VALLEY)
Type-9	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN(NEW CONSTRUCTION) IN CUT SECTION BOTH SIDE

Details of Cross Sections are presented in Chapter 6 of this Report.

The improvement proposals for the sections are presented below:

Structures proposed for cross drainage purpose and safe movement of road users as summarized in **Table 0.6**.

Table 0.6 : Summary of Structures

Structure Type	Total	Remarks
Section-6		
Major Bridge	2	New construction (4- lane new structure)
Minor Bridge	14	<ul style="list-style-type: none"> Widening of Existing + New 2-Lane – 6 Nos. New 4-lane structure- 6nos Retain & Repair of Existing + New 2-Lane – 1No. Reconstruction-1 no.
ROB	NIL	-
Flyover	NIL	-
Interchange	NIL	-
VUP/ LVUP/ CUP/VOP	1	1 nos. VOP
Hume Pipe Culvert	97	<ul style="list-style-type: none"> Retain & Repair of Existing + New 2-Lane – 34 Nos. Reconstruction– 29 Nos. New construction- 34 Nos.
Box Culvert	NIL	-
Total	114	

- (i) *Intersections:*
 - a. Provision of 35 nos. minor intersections in Section-6+7
 - b. Provision of 3 nos. major intersections in Section-6+7
- (ii) Provision of 11 nos. bus bay.(both side total) in Section-6+7
- (iii) Provision of 4 nos. truck lay bye in Section-6+7.
- (iv) Flexible pavement has been proposed. Proposed pavement compositions (in mm) are stated below:
 - Flexible Pavement (for 20 msa) - 30 BC, 90 DBM, 250 WMM, 200 GSB, 500 SG
- (v) Provision of traffic guidance, regulation, control and safety measures like traffic signs, road markings, road studs, pedestrian guard rails, guardposts etc.
- (vi) Provision of pedestrian facilities like footpaths, pedestrian crossings etc.
- (vii) Provision of speed breakers
- (viii) Provision of illumination
- (ix) Provision of landscaping and arboriculture including tree plantation

0.7 Proposed ROW and Land Acquisition

Various proposed ROW options were considered for accommodating codal provisions with minimum land acquisition under this stage as mentioned below:

• Existing Rural Stretches (Non-Forest)	-	42.0m
• Existing Rural Stretches (Forest)	-	35.5m
• Existing Rural Stretches approach of EUP (Forest)	-	42.5m
• Built-Up Stretches	-	47.0m (Min. Requirement)
• Realignment in non-forest area	-	42.0m
• Realignment in forest area	-	35.5m
• Bypass	-	60.0m
• Grade Separator Approaches	-	60.0m
• One side cut section	-	42.0m
• Both side cut section	-	42.0m

As per assessment at this stage tentative land acquisition is assessed as below:

- ***For Section 6+7(combined): 84.20 Ha***

0.8 Summary Environmental Screening and Issues

Environmental Protection Act, Forest Conservation Act, Wild Life Protection Act, Water (prevention and control of pollution) Act, The Air (prevention and control of pollution) Act, Noise Pollution Rules, EIA Notification, Fly Ash Notification, National Highway Act, Right to Fair Compensation in Transparency in Land Acquisition and Rehabilitation and Resettlement Act, E waste management Rule, Construction & Demolition Rule, Hazardous & Other Wastes

Rules, Solid Waste Management Rules, Plastic Waste Management Rules are considered for Environmental Assessment of the Project.

Climate

Assam has a Tropical Monsoon Rainforest Climate. The average annual rainfall is 2818mm. The monsoon starts late in June and generally lasts up-to September. 90% of the rainfall received from July to September.

Water Resources and Drainage System

The State of Assam comprised of two valleys namely the Brahmaputra and Barak Valley and it is situated in between 90° to 96° North Latitude and 24° to 28° East Longitude. The geographical area of Assam is 78,438.00 Sq. Km out of which 56,194.00 Sq. Km and 22,244.00 Sq. Km fall under the Brahmaputra and Barak Valley including 2 (Two) hill districts respectively. The flood prone area of the state is 31,500.00 Sq Km as assessed by the Rastriya BarhAyog which is about 39.58 % of the total land area of Assam. This is about 9.40% of total flood prone area of the whole country. The flood prone area of the country as a whole stand at about 10.2 % of the total area of the country, but flood prone area of Assam is 39.58 % of the area of the state. It signifies that the flood prone area of Assam is four times the national mark of the flood prone area of the country. Records show that average annual area affected by flood is 9.31 Lakh Hectares. The flood protected area of the state is 16500.00 Sq. Km till date.

The severity of flood problem of the state has been further aggravated by the acuteness of erosion on both banks of river Brahmaputra and its tributaries. Study reveals that an area of 4.27 Lakh Hectare of the state has been eroded by the rivers since 1950, which is 7.40 % of area of the state. The average annual rate of erosion is 8000.00 Ha. The world's largest river island Majuli is also under the grip of erosion by river Brahmaputra and about 60 % of its original area has already been engulfed by the river.

0.9 Summary of Social Screening and Issues

One of the most crucial and difficult works in implementing a road project is land/property acquisition and resettlement of households thereof, particularly in towns and semi-urban areas. Anticipating this problem, the Consultant has started identifying various social issues all along the project road. During the field visit no ROW (Right-of-Way) pillars were observed or else road boundaries are appreciated along the project road stretches. However, the Consultant has collected the same details from the concerned offices.

At this junction, social issues gathered from the site are rather approximate but will help in taking tentative decisions on various aspects related to improvement. During field visits social issues (types of land, affected buildings etc.) are collected with an idea of proposed widening schemes which are also generally guided by the presence of roadside utilities and

residential/commercial structures in semi-urban/urban areas.

0.10 Cost Estimates

Summary Civil cost and TPC is provided in **Table 0.7**.

Table 0.7 : Summary of Civil Cost and TPC

Section No.		Sec-6+7
Civil Cost	(Rs.)	3,53,57,50,594
Total cost including GST, Contingency, Administration, Supervision, Maintenance etc.	(Rs.)	2,78,28,65,295
Cost for LA, R&R, Utility and Environment Mitigation	(Rs.)	18,64,61,937
Total Project Cost (Rs.)		6,31,86,15,889
Cost per km (Rs. Crore)		19.82

Abstract of cost is provided in **Table 0.8**.

Table 0.8 :Abstract of Cost

Item	Bill Description	Rate (Rs.)	Amount(Rs)
BILL# 01	Site Clearance & Dismantaling	Rs.	6,576,533
BILL# 02	Earthwork	Rs.	301,628,743
BILL# 03	Base & Sub Base	Rs.	643,699,514
BILL# 04	Pavement (Flexible)	Rs.	781,807,863
BILL# 05	Drainage & Protection	Rs.	348,142,758
BILL# 06	Landscaping	Rs.	30,426,007
BILL# 07	Junction	Rs.	83,165,606
BILL# 08	Bus Bay	Rs.	16,660,528
BILL# 09	Truck Lay Bye	Rs.	9,806,517
BILL# 10	Illumination	Rs.	3,611,368
BILL# 11	Road Furniture	Rs.	208,250,102
A.	Civil Cost for Highways	Rs.	2,433,775,539
	Culvert	Rs.	32,435,128
	Bridge (Major)	Rs.	320,885,332
	Bridge (Minor)	Rs.	289,113,215
	VOP	Rs.	60,741,266
B.	Civil Cost for Structures	Rs.	703,174,941
C.	Total Civil Cost (A+B)	Rs.	3,136,950,480
D.	Area weightage @10% of civil cost		313,695,048
E.	Total Civil Cost including area weightage (D+E)		3,450,645,528
	Civil cost per Km (in Cr.)		10.82
F.	GST @ 12% of civil cost	Rs.	414,077,463
G.	Contingency Charges @ 2.8% of civil cost	Rs.	96,618,075
H.	Supervision Charges @ 3% of civil cost	Rs.	103,519,366
I.	Administrative charges @3% of civil cost	Rs.	103,519,366

Item	Bill Description	Rate (Rs.)	Amount(Rs)
J.	Maintenance charge @ 2.5% of Civil cost	Rs.	86,266,138
K.	Escalation cost @5% per annum of Civil cost during construction period	Rs.	86,266,138
L.	Total Cost (E+F+G+H+I+J)		4,340,912,074
M.	Electrical Utility -HT/LT Line and Crossings		
	Civil items cost (Civil Works)-Electrical	Rs.	62,799,897
	GST @ 18% of civil works cost	Rs.	11,303,981
	Supervision Charges @ 15% of civil works cost	Rs.	9,419,985
	Contingency Charges @ 3% of civil works cost	Rs.	1,883,997
	Total Cost of Electrical including GST and supervision etc.	Rs.	85,407,860
N.	Water Pipeline Utility -Water pipe line (PHE)		
	Civil items cost (Civil Works)-Water pipeline (Urban)	Rs.	21,239,356
	Addition of GST @ 18%	Rs.	3,823,084
	Sub total	Rs.	25,062,440
	Addition of Supervision Charges @ 10%	Rs.	2,506,244
	Total Cost of water pipeline (Urban) including GST and supervision etc.	Rs.	27,568,684
	Civil items cost (Civil Works)-Water pipeline (Rural)	Rs.	1,065,814
	Addition of 1% contingency and 5% Supervision charge	Rs.	63,949
	Sub total	Rs.	1,129,763
	Addition 12% GST	Rs.	135,572
	Total Cost of waterpipeline (Rural) including GST and supervision etc.	Rs.	1,265,334
	Total Civil item Cost (Road, Structure and Utility- Electric & Water pipe line)	Rs.	3,535,750,594
	Total Cost including GST, supervision etc. (Road, Structure and Utility)	Rs.	4,455,153,952
O.	Cost for Pre Construction Activities		
1	Cost of Land Acquisition	Rs	1,427,735,297
2	Cost of Assets (Structure, Zeerat, horticulture, fishery etc)	Rs	295,726,640
A.	Total Cost of LA &Cost of Assets	Rs	1,723,461,937
3	Tree Cutting Cost and Afforestation Cost	Rs	140,000,000
P.	Total Project Cost	Rs	6,318,615,889
	Total project cost per Km (in Cr.)		19.82

0.11 Economic Analysis

The project road is being developed to improve the connectivity of the surrounding area and connectivity is the guiding factor for developing this section. The road stretches from Daboka to Lahorijan via Dokmoka, Bakolia, and Manja will be improved manifold if the project road is developed.

0.12 Conclusions and Recommendations

Conclusions

- (i) One toll plaza is proposed in Section 3 .
- (ii) Concession period of the road project is 30 years including 36 months construction period.
- (iii) All the traffic moving on the project road is through traffic.
- (iv) The project road is being developed to improve the connectivity of the surrounding area and connectivity is the guiding factor for developing this section. The road stretches from Daboka to Lahorijan via Dokmoka, Bakolia, and Manja will be improved manifold if the project road is developed.

Recommendations

The proposed project road being developed as four lane carriageway configuration for 15.007 Km is not recommended under BOT mode.

The proposed project can, however, be considered under other options as under

- EPC Construction

Recommendation for Immediate Development

Road Segment	Homogeneous Section	Existing Chainage	Recommendation	Remarks
NH-29	HS1	Km 39.5 to Km 85.4	4-Lane with paved shoulder	<ul style="list-style-type: none"> Major connectivity from Nagaland, Manipur with Guwahati. Traffic of 9438 PCU in the year of opening (2022) is close to 10000 PCU i.e. Design Service Volume Standards for four lane facility.
	HS2	Km 85.4 to Km 128.3		
	HS3	Km 128.3 to Km 157.4		

Chapter 1 : Introduction

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

1.1 Project Background

The National Highways & Infrastructure Development Corporation Limited has been constituted through an Act of Parliament for faster, economical and quality Road Construction work throughout India. The National Highways & Infrastructure Development Corporation Limited (NHIDCL) has been entrusted with the assignment of preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojana.

In view of the above work NHIDCL has appointed M/s Voyants Solutions Pvt. Ltd. to carry out the Feasibility Studies and Detailed Project Report including field investigations, road inventory, structure inventory, FWD test, road crust sample (trial pits), material investigation, secondary data collection and traffic survey (classified traffic volume count, O-D, intersection counts, axle load survey, animal/pedestrian crossing counts and speed-delay survey). The letter of invitation (LOI) has been issued vide memo no. NHIDCL/Bharatmala/DPR/Phase-I /Lot-1/2017, dated October 30, 2017, whereas, the letter of acceptance (LOA) has been issued vide letter no. NHIDCL/Bharatmala/DPR/Phase-I /Lot-1/Package II/2017/27, dated February 02, 2018. Letter of commencement (LOC) for the consultancy services was issued vide letter no. NHIDCL/Bharatmala/DPR/Phase-I /Lot-1/Package II/2017/80, dated April 13, 2018.

1.2 Project Road Description

The project road comprises 5 stretches as mentioned in the RFP as mentioned below in **Table 1.1**

Table 1.1: List of Road Segments as per RFP

Stretches	Description
Strech-1	Daboka – Manja (NH-29)
Strech-2	Manja- Lahorijan (NH-29)
Strech-3	Lahorijan – Khatkhathi (NH-129)
Strech-4	Numaligar- Khatkhathi (NH 129)
Strech-5	Khatkhathi – Chumukademia (Dimapur Bypass)

Project location on state and district maps are presented on **Figure 1.1** and **1.2** respectively.

Different road segments are schematically presented in **Figure 1.3**.

Segment wise variation of lengths from RFP document is provided in **Table 1.2**.

Table 1.2 : Variation in Lengths of Different Segments from RFP Document

Stretches as per RFP	Node Reference	Description	RFP Length (km)	Ground Length (Km)	Remarks
1	A-B	Daboka - Manja	90	88.8	-
2	B-C	Manja - Lahorijan	38.8	29.3	Variation due to relocation of project end point from Dimapur Town to Start of Dimapur Bypass at Lahorijan
3	C-D	Lahorijan - Khatkhati	1	N/A *	Stretch already included in Dimapur Bypass (Under Construction)
4	E-D	Numaligarh – Khatkhati (NH-129)	99	99	Project road length considered along proposed Bypass of Nambor Wild Life Sanctuary
5	D-F	Khatkhati – Chumukedeima (Dimapur Bypass)	23	N/A *	Stretch already included in Dimapur Bypass (Under Construction)
Total			251.8	217.1	

As mentioned in the above section, the project road has 5 (Five) stretches. However after ground verification two road segments had been deleted as mentioned in **Table 1.2**. The details of three road segments are mentioned as below:

- i) The Daboka – Manja stretch under Nagaon – Dimapur Economic Corridor starts at Daboka – Sutargaon More (26°6'56.85"N, 92°52'28.97"E) which is a junction of the project road i.e. NH-29 (Old NH-36) and Nagaon - Lumding/ Silchar road. The chainage of the start point is Km 39+500 of NH-29. The stretch runs along South-East direction and ends at the junction (Manja Market) of the Project Road with Manja – Diphu – Lumding Road at existing Km 128+300 of NH-29 (25°58'14.79"N, 93°26'14.79"E). The Length of the stretch is about 88.8 Km.
- ii) The Manja – Lahorijan stretch under Nagaon – Dimapur Economic Corridor starts at existing Km 128+300 (25°58'14.79"N, 93°26'14.79"E) and ends at Lahorijan (25°55'15.60"N, 93°43'49.75"E), the outskirts of Dimapur. The end point is about 2 Km towards North from the City Tower (Junction of NH-29 and NH-129). The stretch passes mainly forest stretches and partly through the vicinity of Marat Wild Life Sanctuary. The Length of the stretch is about 40.1 Km.

- iii) The Numaligarh – Khatkhathi stretch under Numaligarh – Dimapur Economic Corridor starts at the Junction ($26^{\circ}37'51.90''\text{N}$, $93^{\circ}43'38.58''\text{E}$) of NH-129 and NH-37 at Numaligarh and ends at Khatkhathi ($25^{\circ}57'19.36''\text{N}$, $93^{\circ}44'8.86''\text{E}$) about 7 Km towards North from the City Tower in Dimapur. The Length of the stretch is about 102 Km.

This report includes the road section as mentioned below from the **Stretch -1 in Table 1.2**

Section-6+7: From Km 113+830 (near Kwaram Taro Village) to Km 145+712 (near Dilai)

1.3 Other Information Relevant to the Project Road

The project road stretch comprises of the following Road Divisions:-

- i) PWD, NH Bakulia Division at Diphu – The jurisdiction of the division is from Daboka to Lahorijan stretch of NH-29

The project road stretch comprises of the following Forest Divisions:-

- i) DFO, Hojai Forest Division – The jurisdiction of the division is from Daboka to Dokmoka along NH-29
ii) DFO, Karbi Anglong west Forest Division – The jurisdiction of the division is from Bokulia to Lahorijan on right of existing project road Nh-29

The project road stretch comprises of the following Land Revenue Authorities:-

- i) Land Revenue Department under Karbi Anglong Autonomous Council (from Dokmoka to Lahorijan via Manja)
ii) Land Revenue Department under DC, Hojai (from Daboka to Dokmoka)

1.4 Improvement Objective

The objective of the scheme presented in this report is to create a 4-lane partially access controlled facility with provision of at grade intersections, grade separators with/without ramps etc. as appropriate/necessary, within the stipulated Right-of-Way by improving the existing single/two lane road and/or developing a new 4-lane road in case of locations with poor geometry and dense settlements to a standard 4-lane road with paved shoulder. To this end, land to the extent necessary will be acquired. Further, the development cost may be recouped, to the extent practicable, from collection of tolls from users of the improved facility. As such, the improvement schemes for the project road should be as economical as possible consistent with the functional requirements and amenable for quick implementation without much gestation delays.

1.5 Objectives of Consultancy Services

The main objective of the consultancy services is to establish the technical, economical and financial viability of the project and prepare detailed project reports for development of economic corridors, inter-corridors and feeder routes, as the case may be. These corridors are proposed for development to at least 4-lane access controlled (fully access control for Economic Corridors). The Consultant has already consulted State/Central Governments, authorities, Corporations and bodies dealing with works related to freight movement to assess the project requirement.

The viability of the project shall be established taking into account the requirements with regard to rehabilitation, upgrading and improvement based on highway design, pavement design, provision of service roads wherever necessary, type of intersections, rehabilitation and widening of existing and/or construction of new bridges and structures, road safety features, quantities of various items of works, cost estimates and economic analysis within the given time frame.

The Detailed Project Report (DPR) would inter-alia include detailed highway design, design of pavement and overlay with options for flexible or rigid pavements, design of bridges and cross drainage structures and grade separated structures, solutions for congestions/bottlenecks in highway/routes including bypass alignment & design, if needed, safety aspects, design of service roads, quantities of various items, detailed working drawings, detailed cost estimates, economic and financial viability analyses, environmental and social feasibility, social and environmental action plans as appropriate and documents required for tendering the project on commercial basis for international / local competitive bidding.

Other major objectives of consultancy services are preparation of DPR incorporating aspects of value engineering, quality audit and safety audit requirement, carry out Road Safety Audit at various stages as per TOR. Besides, viability analysis (both economic and financial), assessment of preferred mode of implementation on which the civil works for the stretches are to be taken up and cost estimates are also in the list.

1.6 Scope of Work

General scope of services shall cover but shall not be limited to the following major tasks:

General

- i) Review of all available reports and published information about the project road and project influence area;
- ii) Environmental and social impact assessment, including such as related to cultural properties, natural habitats, involuntary resettlement etc.;
- iiia) Public consultation including consultation with communities located along the road, NGOs working in the area, other stake holders and relevant Govt. departments at all The different stages of assignment (such as inception stage, feasibility stage,

- preliminary design stage and once final designs are concretized);
- iii) Detailed reconnaissance;
 - iv) Identification of possible improvements in the existing alignment and bypassing congested locations with alternatives, evaluation of different alternatives with comparison on techno-economic and other considerations and recommendations regarding the most appropriate option;
 - v) Traffic studies including traffic surveys, axle load surveys and demand forecasting for next thirty years;
 - vi) Inventory and condition surveys for road;
 - vii) Inventory and condition surveys for bridges, cross drainage structures, other structures, river bank training/protection works and drainage provisions;
 - viii) Detailed topographic surveys using LiDAR equipped with minimum engineering grade system or any other better technology having output accuracy not less than (a) specified in IRC SP 19 (b) Total Station (c) GPS/ DGPS. The use of conventional high precision instruments i.e Total Station or equivalent can be used at locations such as major bypasses, water bodies etc. where it may not be possible to survey using LiDAR. Use of mobile / Aerial LiDAR survey is preferable;
 - ix) Pavement investigations;
 - x) Sub-grade characteristics and strength : investigation for required sub-grade and sub-soil characteristics and strength for road and embankment design and sub-soil investigation;
 - xi) Identification for source of construction material;
 - xii) Detailed design for road, its x-sections, horizontal and vertical alignment and design of embankment for height more than 6.0m and also in poor soil conditions and where density consideration require, even lesser height embankment. Detailed design for structures, preparation of GAD and construction drawing and cross-drainage structures and underpasses etc.;
 - xiii) Identification of type and the design of intersections;
 - xiv) Design of complete drainage system and disposal point for storm water;
 - xv) Value analysis/value engineering and project costing;
 - xvi) Economic and financial analysis;
 - xvii) Contract packaging and implementation schedule;
 - xviii) Strip plan indicating the scheme for carriageway widening, location of all existing utility services (both over and underground) and the scheme for their relocation, trees to be felled, transplanted and planted and land acquisition requirements including schedule for LA : reports, documents and drawings arrangement of estimates for cutting/ transplanting of trees and shifting of utilities from the concerned department;
 - xix) Develop 3D engineered models of terrain and elevation, as-is project highway, proposed and project highway along with all features, current and proposed structures, current and proposed utilities and land acquisition plans;
 - xx) To find out financial viability of project for implementation and suggest the preferred mode on which the project is to be taken up;
 - xxi) Preparation of Detailed Project Report, cost estimate, approved for construction drawings, rate analysis, detailed bill of quantities, bid documents for execution for civil work through budgeting resources;

- xxii) Design for toll plaza, identification for their numbers and location and office cum residential complex including working drawings;
- xxiii) Design of weighing stations, parking areas and rest areas;
- xxiv) Any other user oriented facility en-route toll facility;
- xxv) Tie-in of ongoing/sanctioned works of MoRTH/NHIDCL/other agencies;
- xxvi) Preparation of social plans for the project affected people as per policy of the lending agencies/Govt. of India R&R policy;

The above points can be further discussed for refinement, prevalent practice and practicability in details, if and as required, with NHIDCL during the course of project preparation.

1.7 Stages of Project Submission

Project preparation activities will be split into three stages as mentioned below.

Stage-1	:	Inception Report (IR) and Quality Assurance Plan (QAP)
Stage-2	:	Alignment Option Report and Feasibility Report (FR)
Stage-3	:	LA and Clearance Report-I including Strip Plans and Utility Shifting Proposal
Stage-4	:	Draft Detailed Project Report (DPR)
Stage-5	:	Bid Documents and Technical Schedules
Stage-6	:	LA & Clearances II Report
Stage-7	:	Award Determination Report (LA-III)
Stage-8	:	Land Possession Report (LA-IV)

The stages will generally follow a sequence though stages are inter-related and inter-dependent on one another. This report is under Stage-4 activity.

1.8 Structure of Detailed Project Report

The Detailed Project Report has been prepared in following four volumes:

Volume-I	-	Main Report
Volume-IA	-	Appendices to Main Report
Volume-II	-	Design Report
Volume-III	-	Material Report
Volume-IV	-	Environmental Assessment Report
Volume-V	-	Technical Specification
Volume-VI	-	Rate Analysis
Volume-VII	-	Cost Estimates
Volume-VIII	-	Bill of Quantities
Volume-IX	-	Drawings (Road Works and Structure Works)

This Main Report has been presented in the following structural format:

Chapter-0	:	Executive Summary
Chapter-1	:	Introduction
Chapter-2	:	Existing Characteristics of the Project Road
Chapter-3	:	Socio-Economic Profile
Chapter-4	:	Engineering Surveys and Investigations
Chapter-5	:	Traffic Surveys and Analysis
Chapter-6	:	Development Proposals
Chapter-7	:	Environmental Impact Assessment (EIA) Report and Environmental Management Plan (EMP)
Chapter-8	:	Social Impact Assessment
Chapter-9	:	Cost Estimates
Chapter-10	:	Economic Analysis
Chapter-11	:	Financial Analysis
Chapter-12	:	Road Safety Audit
Chapter-13	:	Conclusions and Recommendations

Chapter 2 : Existing Characteristics of the
Project Road

CHAPTER 2

EXISTING CHARACTERISTICS OF THE PROJECT ROAD

2.0 Existing Characteristics of the Project Road

2.1 General

As mentioned in Chapter-1, the project road in this report comprises Section 6+7 as mentioned in **Table 2.1**.

Table 2.1 : List of Road Sections

Section	Description	Type	Length (km)	Remarks
6	Km 113+300 to Km 145+712	Economic Corridor	31+230	NH 29

This section starts at km 113+300 near Kwaram Taro village (25°59'40.70"N, 93° 20'59.99"E). The project road runs across Karbianglong district and terminates at Km 146+230 near Dilai (25°57'15.42"N, 93°35'15.25"E). The total length is 31.882 km.

Key plan of the project road is provided in **Figure 1.1** whereas the index map is provided in **Figure 1.3**.

2.2 Terminal Points including Important Cardinal Points

The project road has following cardinal points including terminal points.

1. Start point of section-6+7 at km 113+300 of NH-29–Node A
2. End point of section-6+7 at Km 146+230 of NH-29– Node-B

2.3 GPS Co-ordinates

Consultants have captured co-ordinates (latitude and longitude) of various features like major structures, major junctions etc. during reconnaissance survey through hand held GPS for various cross referencing. A list of such co-ordinates is presented in **Annexure 2.1**.

2.4 Status of Existing km Stones

- ❖ Most of the Km Stones are present along the project road

2.5 Important Settlements along the Project Road

- The important settlements in section-6 are Kwaram taro, Manja , Dilai etc.

In addition, few lower order settlements were also found at many locations along the project road in scattered manner.

2.6 Connectivity

The project connects the settlements directly. Besides, it connects the following major towns:

- Guwahati through Nh-29 and Nh-129
- Jorhat, Shivasagar, Digboi, Tinsukhia and Dibrugarh through NH-129 and NH-37
- Silchar through NH-29 and NH-54
- Dimapur, Kohima and Imphal through NH-29 and NH-129

2.7 Terrain and Landuse

The project road is passing mainly through plain & rolling terrain. Around 33% of the project road is passing through settlement areas with residential and commercial activities. Forest stretch are found at few locations which covers about 37%. Landuse pattern for the balance stretch is either agricultural or a mixture of agricultural, open and residential/commercial. Residential and commercial structures along with shops abut only at the settlement areas mentioned above. Along the project road, schools, health centers, temples and mosques are present.

Percentage of different abutting landuse is given in **Table 2.2**.

Table 2.2: Abutting Landuse Pattern

Daboka_Manja-Stretch-I	
Landuse Pattern	Percentage
Agricultural/open	30%
Forest	37%
Residential/Commercial	33%

2.8 Existing Right of way (ROW)

As per relevant information from respective PWD, NH Division and revenue maps, the existing total ROW at built up area and forest area are found to vary between 10.0m-45.0m in total as mentioned in **Table 2.3**.

Table 2.3 : Existing Right of Way (ROW) Details

Stretch	Road Segment	Existing Ch.		Existing Average ROW (m)
		From	To	
Section 6+7				
1	NH-29	113+300	146+230	30.00

2.9 Existing Cross-Sectional Elements

Variable cross-sectional parameters were found for the project road as mentioned in **Table 2.4**.

Table 2.4 : Existing Cross Sectional Parameters

Ext. Chainage (km)		Length (km)	Existing Carriageway		Existing Shoulder	
FromF	To		Type	Width (m)	Type	Width (m)
Section 6+7						
113+300	124+800	11500	Bituminous	10	Earthen	0.8-1.2
124+800	128+400	3600	Bituminous	9	Earthen	1-1.3
128+400	131+500	3100	Bituminous	9.8	Earthen	0.9-2
131+500	144+600	13+100	Bituminous	10	Earthen	0.7-1.0
144+600	146+230	1+630	Bituminous	7	Earthen	0.7-1.2

Presence of roadside drain is not that conspicuous. However, at few built up stretches concrete drains were observed along both side of road. In general, the project road is predominantly on embankment varying between 1.0m-1.5m height.

2.10 Geometry

Horizontal Geometry

Horizontal Alignment is found fair to poor along the project roads. However, at few locations sharp curves are observed with geometric deficiencies with respect to super elevation and sight distance where geometric improvements are required

Vertical Geometry

The vertical alignment is found mostly fair. However, at few locations inadequate sight distance is observed and vertical alignment improvements are required.

Specific HFL Data as collected through local enquiry indicates that there is no location of overtopping.

2.11 Pavement

Status of existing pavement is provided in **Table 2.5**.

Table 2.5: Status of Existing Pavement

Sections	Existing Chainage		Length(m)	Status of Existing Pavement
	From	To		
Section 6	113+300	128+000	14+700	Fair-Poor
	128+000	131+000	3+000	Fair
	131+000	131+500	0+500	VP

Sections	Existing Chainage		Length(m)	Status of Existing Pavement
	From	To		
	131+500	146+230	14+730	Fair-Poor

The pavement all along the project road of stretch is provided with paved shoulder except at some forest stretches.

2.12 Road Intersections/Cross-roads

The project road stretch forms at-grade intersection with cross road(s) at several locations. There is 1 existing Major Intersections along this section as presented below:

Section-6: Manja Junction

2.13 ROB/Railway Level Crossing

There is no Railway line crossing across both the project stretches.

2.14 Bridges and Culverts

Total 31 nos. structures are existing at site in this section. All the structures are 2-lane structures except few bridges which are not having sufficient width. Parapets for most of the structures were found fair to poor wherever present. Summary of existing structures are presented in **Table 2.8**.

Table 2.8: Summary of Existing Structures

Sections	Road Segment	No. of Existing Structures					Total
		MJB	MNB	UP	ROB	Culvert	
Section-6	Km 113+300 (Kwaram taro) to Km 1146+230 (Manja)	2	13	-	-	60	75

2.15 Other Facilities

Except passenger shelter, shops and vehicle repair center, no major roadside facilities have been found along the project corridor.

2.16 Existing Utilities

High tension and low-tension electrical lines exist on one or both sides of the project road at patches. High-tension electric transmission line crosses the project road at few locations. Indicating pillars of underground optical fiber cables were found at many locations. Oil pipelines crosses the project road of stretch 2 at one location. All necessary efforts shall be made to collect relevant information from respective departments. Necessary letters for the purpose have been obtained from client.

2.17 Project Road Deficiencies

At a glance, existing deficiencies of the project road vis-à-vis their possible preventive measures which needs attention during design stage are listed in **Table 2.6**.

Table 2.6: Existing Deficiencies and their Possible Preventive Measures

Sl No.	Deficiencies	Proposals
1.	Insufficient ROW	Acquisition of land wherever required
2.	Poor horizontal geometry at few locations	Geometric improvement
3.	Poor vertical geometry at few locations	Improvement of vertical geometry with optimum cut-fill quantity
4.	Poor condition of few structures	Reconstruction of the same
5.	Improper intersection layout, resulting in accidents at major intersections	Proper at-grade intersection improvement
6.	Use of road component (mainly shoulders) by local people for household purposes almost at all built-up areas	Provision of raised footpath
7.	Absence of roadside drains	Provision of unlined drains at rural areas and covered drains at urban areas
8.	Insufficient illumination	Provision of illumination
9.	Presence of congested settlement with poor geometry at Dokmoka	Provision of bypasses

2.18 Critical Areas Needing Attention

No major critical areas of concern are there for the sections under consideration.

2.19 Field Photographs

Field photographs are presented in **Plates 2.1-2.2**.

Chapter 3 : Socio-Economic Profile

CHAPTER 3

SOCIO ECONOMIC PROFILE

3.0 SOCIO ECONOMIC PROFILE

3.1 Introduction

A detailed accounting of the socio-economic profile of the Project Influence Area (PIA) has been prepared which traces the PIA's economic performance of the past and establishes the likely growth prospects of the future. The output of this Chapter is the economic growth prospects of the PIA with respect to certain selected economic variables and serves as the basis for arriving at a realistic traffic growth rate, for different vehicle categories.

3.2 Project Influence Area

The project, part of the Nagaon – Dimapur Economic Corridor, have three stretches viz., 1) Daboka – Manja, passing through the districts of Hojai and East Karbi Anglong, 2) Manja – Lahorijan, is in East Karbi Anglong district & 3) Numaligarh – Khatkhathi, plying through East Karbi Anglong and Golaghat district. All the project stretches are in Assam state of India. The details of the project road stretches are presented in Chapter 1 of this report. **This report is prepared for Section 6+7 of the project corridor of stretch-1.**

Section-6+7: From Km 113+830 (near Kwaram Taro Village) to Km 145+712 (near Dilai)

The direct influence of the project is identified as the vicinity on both sides of the project road. The indirect influence area will consist of Karbi Anglong district. The project road stretches, situated entirely Assam and the state is considered as the tertiary influence area.

The socio-economic profile of the project influence area is prepared based on secondary official sources of information.

3.3 The State of Assam at a Glance

The state of Assam is located in the in northeastern part of India. It is bounded by Bhutan and Arunachal Pradesh state in the north, Nagaland and Manipur states in the east, Mizoram and Tripura states in the south and Bangladesh, Meghalaya state and West Bengal state in the west. The neighboring states of Arunachal Pradesh, Nagaland, Mizoram and Meghalaya are one part of the Assam. The state capital of Assam, formerly Shillong (now the capital of Meghalaya) was shifted to Dispur in suburb of Guwahati, in 1972.

Now, Assam has an area of 78,438 sq. km. and has 33 districts, including newly created 6 districts. 214 Urban Centres include Guwahati, one of the 100 fastest growing cities in the

world. Guwahati is the gateway to the North-East India. Silchar, (in the Barak valley) the 2nd most populous city in Assam and an important centre of business, education and tourism. Other large cities include Dibrugarh, an oil, natural gas, tea and tourism industry centre, Jorhat, and Tinsukia.

Assam is shaped roughly like a “Y” laid on its side, is a land of plains and rivers valleys. The state has three principal physical regions: the Brahmaputra River valley in the north, the Barak River valley in the south, and the hilly region between Meghalaya (to the west) and Nagaland and Manipur (to the east) in the south-central part of the state.

Average temperatures in Assam range from 36 °C in August to about 7 °C in January. Although some rain occurs from March through May, the heaviest precipitation comes with the southwest monsoon, which arrives in June, stays through September, and often causes widespread and destructive flooding. Annual rainfall in Assam is not only the highest in the country but also ranks among the highest in the world; its annual average varies from about 1,800 mm in the west to more than 3,000 mm in the east.

In the early 21st century about one-third of Assam was covered with various types of woodlands, including tropical evergreen and deciduous forests, broad-leaved hill forests, pine forests, and swamp forests, as well as grasslands. Assam is home to some 75 species of trees, many of which have commercial value. Sal (*Shorea robusta*) and hollong (*Dipterocarpus retusus*) trees are among the most bountiful of the hardwoods. Bamboo, orchids, and ferns also are abundant.

Assam has numerous wildlife sanctuaries, the most prominent of which are two UNESCO World Heritage sites: 1) Kaziranga National Park (designated in 1985), on the bank of the Brahmaputra River, and 2) Manas Wildlife Sanctuary (designated in 1992), near the border with Bhutan. Both are refuges for the fast-disappearing Indian one-horned rhinoceros, and the sanctuary at Manas is known especially for its tigers and leopards. Among the other notable inhabitants of Assam’s forests are elephants, gaurs (wild oxen), wild pigs, various species of deer, and primates, such as langurs and hoolock gibbons. Common birds include cormorants, herons, ducks, and other water birds, as well as warblers, thrushes, owls, and peacocks. Hornbills are characteristic of Assam, although they are endangered in some areas. The state also has dozens of species of reptiles, including poisonous snakes, such as kraits, cobras, and vipers; an array of lizards, skinks, and geckos; and many types of turtles.

As per Census 2011, Assam has a population of 3,12,05,576. The decadal growth rate of population is 17.07% during 2001 and 2011. Assam has predominantly rural having the share of 84.6%. The population density is 398 persons per square kilometer. The sex ratio is 958 females per 1000 male population. The SC population is 7.15% and share of ST population is 12.45%, of which the Bodos constitute the majority with 40% among the ST. The overall literacy rate is 72.19%. The share of BPL families is 31.98%.

Assamese and Bodo are the major indigenous and official languages, while Bengali is the second most widely spoken languages after Assamese. Bodo is the third most spoken language.

Hinduism is the majority religion in the state at 61.47%, followed by Islam at 34.22% and Christianity at 3.7%. Other religions are Buddhism, Jainism, and Sikhism etc. Many Hindus in Assam are followers of the Ekasarana Dharma sect of Hinduism, which gave rise to Namghar, designed to be simpler places of worship than traditional Hindu temples.

Assam's economy is based on agriculture and oil. Assam produces more than half of India's tea. The Assam-Arakan basin holds about a quarter of the country's oil reserves, and produces about 12% of its total petroleum. The economy of Assam today represents of backwardness amidst plenty. Despite its rich natural resources, and supplying of up to 25% of India's petroleum needs. According to the quick estimates of 2016-17, Assam's Gross State Domestic Product (GSDP) is ₹249,801 crores at current prices and per capita income in Assam has reached ₹73,677.

The Agriculture, Forestry and Fishing sectors holds 19.33% of the GSDP, whereas Industrial Sector accounts for 28.72% and service sector contributes 45.51%.

Assam has four oil refineries in Digboi (Asia's first and world's second refinery), Guwahati, Bongaigaon and Numaligarh and with a total capacity of 7 million metric tonnes per annum. There are several other industries, including a chemical fertiliser plant at Namrup, petrochemical industries at Namrup and Bongaigaon, Paper mills at Jagirroad, Hindustan Paper Corporation Ltd. Township Area Panchgram and Jogighopa, sugar mills at Barua Bamun Gaon, Chargola, Kampur, Cement plant at Bokajan and Badarpur, cosmetics plant of Hindustan Unilever (HUL) at Doom Dooma, etc. Moreover, there are other industries such as jute mill, textile and yarn mills, Assam silk, and silk mills.

Assam has a rich tradition of crafts, Cane and bamboo craft, bell metal and brass craft, silk and cotton weaving, toy and mask making, pottery and terracotta work, wood craft, jewellery making, and musical instruments making have remained as major traditions.

The tourism in Assam in Wildlife, cultural, and historical destinations have attracted visitors. There are five national parks of 1) Kaziranga National Park, 2) Manas National Park, 3) Orang, 4) Dibru-saikhowa and 5) Nameri. The Sivasagar consists of historical statues and structures of the old Ahom Kingdom. The Kamakhya Temple in Nilachal Hills in Guwahati is a special Shaktipitha of Hindu Religion and attracts a huge number of devotees all the year round.

3.4 District Profile: Hojai

Hojai is a new district in the state of Assam, in India. It was formed on 15 August 2015. Hojai is

the Headquarter of the new district. Hojai district is formed with three tehsils of Nagaon district named Hojai, Doboka and Lanka. The area of Hojai district is 1685 sq. km.

3.4.1 Location

Hojai district is surrounded by districts of Nagaon and East Karbi Anglong in north, East Karbi Anglong and Dima Hasao in south, East Karbi Anglong in east and West Karbi Anglong and Dima Hasao in west.

3.4.2 Climate

The climate in Hojai is warm and temperate. The average annual temperature is 24.4 °C. Precipitation here averages 1562 mm.

3.4.3 Religion

The main religions are Muslim (54%), Hindu (46%) of district population. The other religions are Christian, Sikh, Buddhist, Jain etc.

3.4.4 Demography

As per Indian census 2011, those three tehsils together had a population of 931,218. So, newly formed Hojai district had a population of 931,218 in 2011, among them 51% are male and 49% are female. The sex ratio is 954. The majority of the population, nearly 81% live in Hojai District rural part and 19% population live in the Hojai District urban part.

3.4.5 Literacy

Hojai has an average literacy rate of 75%, while male literacy is 80%, and female literacy is 70%.

3.4.6 Working Profile

Hojai has 34% (about 3.2 lakh) population engaged in either main or marginal works. 53% male and 14% female population are working population. 43% of total male population are main (full time) workers and 10% are marginal (part time) workers. For women 6% of total female population are main and 8% are marginal workers.

3.5 District Profile: East Karbi Anglong

The East Karbi Anglong district is a new district formed out of the existing Karbi Anglong District of Assam in 2016. Diphu is the Headquarter of the newly formed district. The district is a part of Karbi Anglong Autonomous Council, Diphu and it is administered according to the Sixth Scheduled of the Indian Constitution. The total area of the district is 7,399 sq. km.

3.5.1 Location

East Karbi Anglong district is surrounded by districts of Nagaon and Golaghat in north, State of Nagaland in south, Golaghat district in east and Hojai and Dima Hasao districts in west. The district is with dense tropical forest covered hills and flat plains.

3.5.2 Climate

The district experiences different climate in different parts. January being the coldest with minimum temperature between 5°C to 6°C. Whereas, the summer temperature reaches as high as 32°C. Rainfall is heavy during June to September with average rainfall of 2416 mm.

3.5.3 Demography

The population of the district is predominantly tribal. The major tribal ethnic groups of this district are Karbis, Bodos, Kukis, Dimasas, Hmars, Garos, Rengma Nagas, Tiwas, Man (Tai Speaking's). Besides, a large number of non-tribals also live together in this hill region.

The population of the district is 6,60,955 with 85.61% of Rural population and 14.39% of urban. The males constitute of 51.29% and females are 48.71%. The sex ratio is 950.

3.5.4 Working Profile

The district is basically an agricultural district. Different types of agricultural crops are cultivated among which paddy is the main crop. Except for the valleys, the people follow the jhum system of cultivation.

3.5.5 Minerals

There are different kinds of minerals found in this hill district, as Lime stone, China-clay, Feldspar and Coal

3.5.6 Economy

The district economy depends mainly on the agriculture. The lands are more fertile and that is the boon to the people by nature, but they still use primitive methods of cultivation and frequently shifts the area of cultivation through Jhum farming. East Karbi Anglong has favourable climate for horticulture, however, the horticulture and plantation crops are generally not grown on commercial scale.

The 1,80,127.5 Hectres of forest in the district offers a big economy not only for the district but also for the state. The forests are covered with dense bamboo and grasses, valuable trees

like Hollock, Gamari, San, Sonaru, Titasopa, Bonsum, Koroi, Foma etc. are in abundance.

Although the district is abundant in raw materials, but only a few industries have come up. They are: 1) Bokajan Cement Plant, 2) Karbi Chemical Mini Cement Plant, 3) Food Processing, 4) Rubber Plantation Industry, 5) Citronella Plantation Industry. There are a number of Tea Gardens in the district.

The economic development of the area is dependent on land use pattern and efficient uses of the resources. Although resources are plenty but they are not properly utilized for the economic benefits.

Table 3.1: Population Data

Sl No.	Description	Assam		East Karbi Anglong	
		2011	2001	2011	2001
1	Total Population - Gender wise	31205576	26655528	956313	813311
	Male	15939443	13777037	490167	422250
	Female	15266133	12878491	466146	391061
	Sex Ratio (No. of females per 1000 males)	958	935	951	926
2	Total Population (0-6 years) - Gender wise	4,638,130	4,498,075	138407	150138
	Male	2,363,485	2,289,116	70559	76132
	Female	2,274,645	2,208,959	67848	47106
	Sex ratio (No. of females per 1000 males)	962	965	959	973
3	Total Population (Sector Wise)	31205576	26655528	956313	813311
	Rural	85.90%	87.10%	88.20%	NA
	Urban	14.10%	12.90%	11.80%	NA

Chapter 4 : Engineering Survey and
Investigations

CHAPTER 4

ENGINEERING SURVEY AND INVESTIGATIONS

4.0 ENGINEERING SURVEY AND INVESTIGATIONS

4.1 Introduction

The Consultants have conducted different types of field studies, engineering surveys and investigations to gather data and information necessary for project preparation. The aim of the investigations was to develop an adequate supportive database for selecting and preparing the most appropriate proposal to meet the functional and structural efficiency and safety requirements. The engineering investigations and surveys have been carried out in line with the specifications laid out in the TOR. The basic data and results of investigation are compiled and included in Volume-II of this Report.

The following engineering survey and investigations were conducted or yet to be conducted:

- a) Reconnaissance Survey
- b) Road Inventory
- c) Pavement Condition Survey by manual assessment and NSV
- d) Inventory and Condition Survey of Existing Bridges, Culverts and Other Structures
- e) Alternative Alignment Study for Bypasses
- f) Topographic Survey
- g) Traffic Survey
- h) Axle Load Survey
- i) FWD Survey
- j) Roughness Survey
- k) Pavement Investigation
- l) Material Investigation
- m) Sub Soil Exploration

4.2 Reconnaissance Survey

This is basically a visual survey of the project road and its environs, and this activity has already been completed by the concerned key personnel of the Consultant's team after a study of available maps of the area. Accordingly, teams for subsequent survey and investigation planned for mobilization to the site. Consultant has made videography of the entire corridor to have a general appreciation of the project road. The assessment of important aspects made during reconnaissance including few problems as perceived is brought out below:

a) Topographical Features of the Area

A preliminary observation of the topographical features in the project road corridor and surrounding area was made during reconnaissance survey. The terrain, the roadside physical features, road alignment, drainage characteristics, existence of major bridges and structures, railway crossings, junctions, problems at site, etc. were noted. This helped in making an assessment of the nature and complexity of the project, which in turn, determined the extent of the various surveys and investigations required for the project preparation.



b) Widening Scheme

Side of widening has been assessed during this study. Location of roadside settlements, water bodies, utilities, curvature, forest area, existing ROW etc. were considered to assess the most suitable widening scheme. Normally attempt shall be made to match the edge of existing carriageway with respective median edge of proposed road. Concentric widening shall be followed in built-up locations, forest areas and cut sections.

c) Realignment Requirements including Provision of Bypasses/Diversion at Congested and Critical Locations

The bypass/diversion option will be considered from the angle of relative economics/ physical feasibility of the alternative: (i) to acquire structures alongside the existing road and carry out parallel widening and (ii) to go in for bypass/diversion.



d) Preliminary Identification of Improvement Requirements including Treatments and Measures needed for the Cross Roads

There are many cross roads along the project road. During reconnaissance survey it was found that some roads seem to carry very low traffic and there is no prime facie warrant for grade-separation but for some of cross roads, it appears from first impression that there is a requirement of grade separator for the crossing of NH & SH's.

e) Inventory of Major Aspects of Existing Roadway and Bridges/Culverts/Other

Structures

Primary inventory data of road, bridge, culverts, intersections, utility lines, trees, land use, roadside features, etc. have also been collected from site. The inventory data will constitute an important input for the Report.

4.3 Road Inventory

A detailed inventory of the existing road has been prepared through dimensional measurements and visual inspection to assess the existing status. Features like existing kilometerage, terrain, land use, width of pavement and shoulders, height of embankment, geometric deficiencies, important road intersections, utilities, other features etc. were recorded. Findings of Road Inventory have been presented in **Appendix 4.1-4.9**(included in Volume-II) as mentioned below. The inventory is essentially included to collect physical information on the road and its environment for enabling preliminary assessment of the project.



Appendix 4.1	:	Road Inventory
Appendix 4.2	:	Details of Cross Roads
Appendix 4.3A	:	Schedule of Existing Utilities (Parallel and Across the Project Road)
Appendix 4.3B	:	Number of Electric Poles
Appendix 4.3C	:	Summary of Roadside Utilities along the Project Road
Appendix 4.4	:	Details of Built-Up Area
Appendix 4.5	:	List of Major Features
Appendix 4.6A	:	Summary of Trees to be Felled (Kilometer wise Details)
Appendix 4.6B	:	Break up of Approximate Numbers of Trees to be Felled
Appendix 4.7	:	List of Items to be Dismantled
Appendix 4.8	:	Details of Arboriculture
Appendix 4.9	:	Details of Geometric Deficiencies

4.4 Pavement Condition Survey

Pavement condition survey has been carried out for road and pavement surface conditions covering the following:

- pavement condition (surface distress type and extent);
- shoulder condition;
- embankment condition; and



- drainage condition

The survey was conducted through Network Survey Vehicle (NSV). The NSV Digital Laser Profiler (DLP) is an affordable, portable system that measures longitudinal profile, macro texture (MPD and SMTD) and roughness (IRI).

A World Bank Class 1 profiler, the NSV DLP measures road profile in one or two wheel-paths using accelerometers and up to two precision laser sensors to compensate for vehicle body movement. The DLP is completely portable using a detachable sensor beam and comes complete with a tow-bar mounting kit, making it perfect for less frequent survey demands. An accurate Distance Measuring Instrument (DMI) and the Heartbeat module are used to precisely link the data to distance/chainage. It is used in conjunction with the Hawkeye Processing Toolkit software, operators to produce a wide range of reports to review network condition and performance. This information can then be simply exported to CSV, or applications such as HDM-4 and GIS tools.



The NSV is capable of supporting a profiler with up-to three lasers, two digital imagery cameras, DGPS and a Gipsi-Trac Geometry system

Complete information about condition of existing pavement and shoulder was collected so that design parameters related to pavement can be established.

The information collected consists of the details of cracking (narrow and wide), rut depth, raveling, potholing, patching in the form of percentage area as well as edge break in terms of length and rut depth in mm. affected of the existing pavement and paved shoulder material loss, rut depth, corrugation, edge etc. in the case of unpaved shoulders.



The study shall identify defects and road section with similar characteristics i.e. homogeneous sections.

Pavement condition survey, using NSV, has been carried out for the stretches of NH-29

Besides, pavement condition survey has been carried out as per visual investigation with sample measurements. The existing pavement is of bituminous type with varying composition and characteristics. Detailed field study including pavement condition, shoulder condition, embankment condition, drainage condition etc. were carried out by visual means supplemented by measurements as per the guidelines mentioned in the TOR. The following measurements were involved:



- % area of fine cracks < 3 mm
- % area of wide cracks > 3 mm
- % area of raveling
- The length of edge failure expressed in meter
- % area of patching
- % area of potholes

Rut depth, measured transversely across the outer wheel paths using 2 meter long straight edge and graduated wedge. Shoulder and embankment conditions by visual means and the existence of distress modes and extent thereof were noted. The field data has been recorded at 500m interval.

4.5 Inventory and Condition Survey of Existing Bridges, Culverts

Inventory and condition survey of the existing bridges and culverts were carried out to identify their number, type, condition and hydrological aspects. Mainly visual inspection and dimensional measurements have been carried out during this survey. Data has been collected as per proforma mentioned in the QAP. Total 85 nos. structures are present along the corridor among which 13 nos. are bridges, 85 nos. are culverts.



4.6 Alternative Alignment Study for Major Realignment

Alternative alignment study was conducted in **section 6+7** to find out the best option for proposed **Manja bypass** to maintain the design speed, avoid congestion and environmental impact. These improvements are in addition to minor curve improvement proposed at various locations along the route.

4.6.1 Manja Bypass on NH 29

Three alternative options were studied for proposed Manja Bypass as mentioned below:

- Option-1 : Along left side of existing alignment
- Option-2 : Along right side of existing alignment
- Option-3 : Existing alignment

Among the three alternatives, option-1 was recommended based on evaluation studies with respect to technical, environmental and social aspects.

4.7 Topographical Survey

The specific objective of the topographical survey is to delineate accurately the complete existing natural and man-made features, so as to study and develop the existing road to 4 lane with paved shoulder, creating an accurate Digital Terrain Model, which is also a fundamental requirement to design the highway through latest software. The detailed topographical survey for the new and existing road shall be carried out in consonance with the procedure outlined in the TOR using LiDAR, Total Station and Auto Level.

The survey shall be performed over 35m (in general) on either side w.r.t. the proposed centre line or upto the existing Right-of-Way (ROW) line on either side, whichever is more. The survey involved the following sequential steps:

(1) Establishing GPS stations: in order to ensure the global co-ordinate system, the corridor shall be framed through GPS survey. A pair of GPS pillars shall be established at every 5.0km along the corridor.

(2) Establishing Bench Marks : in order to ensure locational and directional as well as vertical control along the project road, bench mark pillars (BM) shall be established at about 250m interval, in general, depending upon visibility between two pillars. This bench mark pillars shall be connected to the GPS pillars.

(3) Traversing and Levelling: shall be done to connect the reference BM pillars.

(3) Cross-section Surveying/Detailing: Detailed cross sections shall be surveyed at 25m interval, in general, using Total Station. The cross sections shall be extended up to the survey limits mentioned earlier. The main features captured in the cross-sections are:

- Ground level along the proposed corridor
- Carriageway crown, carriageway edges and two intermediate carriageway points
- Roadway edges (shoulder break-points)
- Embankment toe-line

- Borrow pit / pond / ditch / toe drain profile, where present
- All break-points of natural ground
- Positions of individual entities such as trees, utility lines and poles, wells and tube wells, other pillars like ROW, forest pillar etc.
- Property lines and structures (with description)
- Salient points on bridges and culverts (e.g. abutment, headwall, invert level, etc.)

The data for each survey point shall be recorded in terms of Northing, Easting, and Elevation. To ensure standardization of works of different survey teams and to facilitate further CAD works, a rational coding system shall be developed and used.

The survey data collected in the field shall be downloaded in text file format and converted to graphic files using suitable software.

4.8 Traffic Survey

Following traffic surveys were conducted at site to assess the present and future traffic on the project highway:

- Classified directional traffic volume count survey (TVC)
- Origin-Destination (O-D) and commodity movement survey
- Intersection Turning Movement Count Survey (TMC)

Details of traffic survey have been provided in Chapter 5 of this report.

4.9 Axle Load Survey

The survey was carried out at Hawraghat Tinali (Km. 85+400 of NH-29) & Bokajan (Km. 90+900 of NH-129) to study the traffic load characteristics on the project road.

The survey was conducted for 24 hours at suitable time interval in either direction. Necessary assistance was provided to the Consultants by the District police at the survey locations for stopping of the vehicles on sample basis and guiding them to the axle load pad.



VDF summary is presented in **Table 4.1a & 4.1b**.

Table 4.1a : VDF Summary: Daboka to Lahorijan (NH 29)

Km. 85+400 of NH-29 (Howraghat Tinali)				
Type of Vehicles	Directions of Traffic		Average VDF	Recommended VDF
	Diphu to Daboka	Daboka to Diphu		
2 Axle Truck	2.59	6.93	4.76	6.93
3 Axle Truck	3.52	9.46	6.49	9.46
Multi Axle Vehicles	5.97	13.07	9.52	13.07
LCV	1.17	2.40	1.79	2.40
Bus	1.07	1.92	1.49	1.92

4.10 Falling Weight Deflectometer (FWD) Survey

4.10.1 TOR Requirements

This survey was conducted to obtain the structural strength of existing pavement in accordance with IRC 115:2014 requirements.

Based on the data collected from condition survey, the road length has been classified into sections of uniform performance in accordance with the criteria given in the following table.

Table 4.2 : Criteria of Pavement Classification

Classification	Pavement Condition
Good	Isolated cracks of less than 3.0 mm width in less than 5% area of total paved surface and average rut depth less than 10 mm
Fair	Isolated or interconnected cracks of less than 3.0 mm width in 5 to 20% area of total paved surface AND/OR average rut depth between 10 to 20 mm
Poor	Wide interconnected cracking of more than 3.0 mm width in 5 to 20% area (include area of patching and raveling in this) of paved area OR cracking of any type in more than 20% area of paved surface AND/OR average rut depth of more than 20 mm

As it is inexpedient to change the sample size for deflection measurement at frequent intervals, it is always preferable to keep the length of each uniform section at a minimum of 1 km except in the case of localized failures or in other situations requiring closer examination where minimum length of section should be 0.3 km from the consideration of profile correction and constructability.

Deflection measurement scheme to be adopted is provided in **Table 4.3**.

Table 4.3 : Pavement Deflection Measurement Scheme

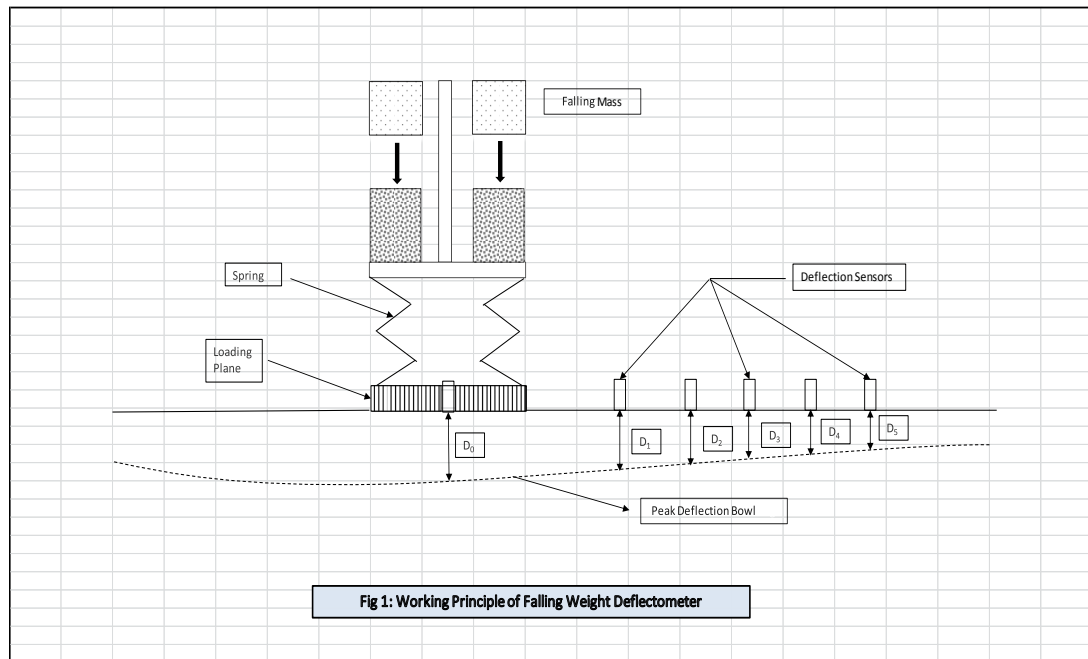
Type of Carriageway	Type of Measurement Scheme	Maximum Spacing for Test Points along Selected Wheel Path for Pavements of Different Classification		
		Poor	Fair	Good
Two Lane Two Way Single Carriageway	Measure along both outer wheel path	60	130	500

Note - The spacing given in the table are with the assumption that the length of uniform section is 1.0 km. The actual spacing to be adopted can be obtained by multiplying the spacing given in the table by the length of uniform section

4.10.2 Falling Weight Deflectometer (FWD)

FWD is an impulse-loading device in which a transient load is applied to the pavement and the deflected shape of the pavement surface is measured. The working principle of a typical FWD is illustrated below. DO, D1, etc., mentioned in the figure are surface deflections measured at different radial distances. Impulse load is applied by means of a falling mass, which is allowed to drop vertically on a system of springs placed over a circular loading plate. The deflected shape of the pavement surface is measured using displacement sensors which are placed at different radial distances starting with the center of the load plate. Trailer mounted as well as vehicle mounted FWD models are available commercially. The working principle of all these FWD models is essentially the same. A mass of weights is dropped from a pre-determined height onto a series of springs/ buffers placed on top of a loading plate. The corresponding peak load and peak vertical surface deflections at different radial locations are measured and recorded.





Different magnitudes of impulse load can be obtained by selection of a suitable mass and an appropriate height of fall. Under the application of the impulse load, the pavement deflects. Velocity transducers are placed on the pavement surface at different radial locations to measure surface deflections. Geophones or seismometers are used as displacement transducers. Load and deflection data are acquired with the help of a data acquisition system.

Typical Falling Weight Deflectometers (FWD) include a circular loading plate of 300 or 450 mm diameter. In these guidelines 300 mm diameter load plate is recommended. A rubber pad of 5 mm minimum thickness should be glued to the bottom of the loading plate for uniform distribution of load. Alternatively, segmented loading plates (with two to four segments) can be used for better load distribution.

A falling mass in the range of 50 to 350 kg is dropped from a height of fall in the range of 100 to 600 mm to produce load pulses of desired peak load and duration. Heavier models use falling mass in the range of 200 to 700 kg. The target peak load to be applied on bituminous pavements is 40 kN (+/- 4 kN), which corresponds to the load on one dual wheel set of a 80 kN standard axle load. The target peak load can be decreased suitably if the peak maximum (central) deflection measured with 40 kN load exceeds the measuring capacity of the deflection transducer. Similarly, the load can be increased to produce deflection of at least 10 μ m at a radial distance of 1.2 m. If it is known from construction records or from coring or from test pits that subgrade is stiff and hence smaller than 10 μ m deflections are expected, testing with increased loads will not be required. If the applied peak load differs from 40 kN, the measured deflections have to be normalized to correspond to the standard target load of 40 kN. The normalization of deflections can be done linearly. For example, if the measured deflection is 0.80 mm for an applied peak load of 45 kN, the normalized deflection for a

standard load of 40 kN is 0.711 mm ($0.80 * (40/45)$). The load cells used to measure load pulses produced by FWD should have a reading resolution of 0.1 kN or better and should give readings accurate to 2 percent of measured value.

The stiffness of bituminous layers and hence the response of a pavement depends on the pulse shape of the applied load (COST 336, 2005). Most FWDs have a load rise time (from start of pulse to peak) of between 5 ms and 30 ms and have a load pulse base width in the interval of 20 ms to 60 ms (COST 336, 2005). The duration of impulse load is maintained approximately equal to the time needed to traverse the length of a tyre imprint at a speed of about 60 km/h which is in the range of 20 to 30 ms. The FWDs used for evaluation should be capable of producing load pulses with loading time in the range of 15 to 50 ms.

Sufficient number of deflection transducers should be used to adequately capture the shape of deflection bowl. Six to nine velocity transducers (geophones) are generally adequate for measuring surface deflections of flexible pavements. Deflection sensors are placed on the surface of pavement at different radial direction aligned in the longitudinal direction. The deflection transducers used should have a reading resolution of at least 1 μ m and 5 should be accurate to +/- 2 percent of the reading. Typical geophone position configurations (number and radial distances measured from center of load plate) commonly used for flexible pavement evaluation are :- (i) 7 sensors at 0, 300, 600, 900, 1200, 1500 and 1800 mm radial distances (ii) 7 sensors at 0, 200, 300, 450, 600, 900, 1500 mm radial distances (iii) 6 sensors at 0, 300, 600, 900, 1200 and 1500 mm radial distances and (iv) 6 sensors at 0, 200, 300, 600, 900, 1200 mm radial distances.

4.10.3 Data Verification

The FWD test data collected from different load drops at each test point primarily consist of peak load, peak deflections at different radial locations. Unrealistic deflection values and obviously erroneous data must be removed. Some of the checks that should be applied to the deflection data are:-

- (i) deflections should decrease with increasing distance from the loading plate and
- (ii) Deflection values should not be more than the capacity of the sensors.

Average values of load and deflections are calculated from the three drop test data collected at a given location.

The deflections are normalized to correspond to a standard target load of 40 kN as explained in Clause 4.4.

4.10.4 Identification of Homogeneous Sub-sections

The identification of sections of uniform performance done in Section 6+7 of these guidelines was done primarily to select an appropriate sample size for conducting deflection testing. Since the assessment of the remaining life of existing pavement and the strengthening requirement in terms of bituminous overlay will be done on the basis of the back calculated moduli of in-service pavement layers, it is prudent to identify homogeneous sections for the purpose of structural design primarily based on deflection bowl parameters and other relevant information.

Identification of homogeneous sections is generally done on the basis of the following parameters: - peak deflections or peak deflection bowl parameters, subgrade strength, design traffic, layer thicknesses and extent and severity of distress, back calculated surface modulus of the total bituminous layers, remaining life of pavement and overlay thickness requirement. It is proposed in these guidelines that one of the deflection bowl parameters, which typically represent the stiffness of the upper layers along with design traffic and subgrade strength, should be used for identification of homogeneous sections.

Other parameters as may be deemed suitable can also be considered for this purpose. Surface Curvature Index (SCI) calculated as the difference between D_0 and D_{300} where, D_0 and D_{300} are the peak deflections (mm) measured at the center of loading plate and at a radial distance of 300 mm is a bowl shape parameter, which reflects the contribution of upper layers, is the bowl shape parameter to be used, along with other parameters, for identification of homogeneous sections. SCI is expressed in mm here whereas the parameter is used in inches or mils in many empirical expressions available in literature for empirically estimating moduli of layers.

A statistical technique popularly used for identification of homogeneous sections is the "Cumulative Difference" approach. This approach is already being used extensively in India in many highway projects. In this approach, the sequence of actual cumulative sums in a measurement series is compared with the sums that would have resulted from adding averages. The difference between these values is termed as cumulative difference. The series of cumulative differences (z_j for the measured sequence of a given variable 'x' (SCI, subgrade strength, etc.) can be obtained using the following expression.

$$Z_k = \sum_{i=1}^{i=k} (x_i - \bar{x})$$

For all $k = 1, \dots, n$

Where,

$$\bar{x} = (1/n) \sum_{i=1}^{i=n} x_i$$

$$i=1$$

Wherever the trend changes from positive to negative and vice-versa in the plot of cumulative difference VS distance (or number of test location), that should be considered as a possible delineator for identifying homogeneous sections. However, judgment has to be applied for considering a particular change in trend to be significant enough to suggest the presence of a delineator there.

Homogeneous sections can be identified with reference to different parameters such as SCI, traffic, subgrade strength, etc. Delineation carried out based on different parameters will yield a number of sub-sections. No sub-section should be shorter than 1.0 km in length and each subsection should have at least twelve deflection test locations. If a subsection has only one or two test points, it is a case of the pavement in need of localized rehabilitation measures. The spacing considered for deflection measurement in each subsection can be rounded off to convenient practical values.

4.10.5 Work Procedure

The following steps have been followed for measuring deflections at each test point. The exact Sequence of operations may be different for different models of FWD.

- (i) Mark the test point on the pavement.
- (ii) Centre the load plate of the duly calibrated FWD over the test point.
- (iii) Lower the loading plate onto the pavement. There should be no standing water (surface texture completely filled with water) on the pavement surface. The loading plate should be in proper contact with pavement surface. If a non-segmental plate is used the presence of rutting at test location should be noted if it affects the contact between plate and pavement surface. The longitudinal and transverse slope of the pavement should not exceed 10 percent at the test location for accurate measurement of deflection.
- (iv) Lower the frame holding the displacement transducers (geophones) so that the transducers are in contact with pavement surface
- (v) Raise the mass to a pre-determined height required for producing a target load of 40 kN
- (vi) Drop one seating load. Load and deflection data for seating load drop need not be recorded
- (vii) Raise the mass and drop. Record load and deflection data into the computer through data acquisition system. While peak load and peak deflections at different selected radial positions must be recorded, complete time history of load and deflections can be stored for each load drop if feasible
- (viii) Repeat step at least two more times.
- (ix) If, during steps vii and viii, the deflections measured are too large or too small as discussed in Clause 4.4, the test may be repeated by changing the peak load
- (x) Raise the geophone frame and load plate and move to the next test location
- (xi) Record air temperature at half hourly interval

- (xii) Record pavement surface temperature (optional) if non-contact temperature sensors are available
- (xiii) Measure pavement surface layer temperature at half-hourly intervals by drilling holes of 40 mm depth into the pavement surface layer. Fill the hole with a drop of glycerol. Insert the thermometer into the hole and record the temperature after three minutes
- (xiv) Deflection measurements should not be made when the pavement temperature is more than 45°C. Guidelines given in Clause 6.4.3 may be followed for deflection measurement in colder areas and areas of altitude greater than 1000m.

Summary of FWD survey data is provided in **Annexure 4.1 Roughness Survey**

The survey has been carried out to assess the roughness index survey of existing pavement. The results of the survey will be expressed in terms of BI and IRI, and shall be presented in both tabular and graphical forms. Based on the data, homogenous segments with respect to surface roughness has been determined based on cumulative difference method.

The roughness values which represent pavement functional performance are essentially intended for use in economic/financial analysis, and for checking against the pavement designs proposed for different sections.

The equipment used for the survey is Network Survey Vehicle (NSV) mounted laser profilometer. Detailed description of equipment, data capture methodology and type of output data are already provided in para 4.4 of this chapter.

In addition, the following criteria have been met by the process of defect detection:

- Roughness measurement with outputs of both raw longitudinal profiles and IRI calculation shall be reported at 100m referenced to the preceding LRP. The roughness must meet ASTM-E950 (equivalent to Class I road profiler).
- The IRI shall be determined for both wheel-paths over a minimum length of 250m for a minimum of 6 calibration sites with a roughness range between 2m/km and 8m/km. Calibration shall be made for speeds of 20, 30, 40, 50, 60 km/hour.

The survey was conducted along the outer wheel paths covering two runs along the wheel paths for each direction. The data derived from survey have been compared with the data obtained from the pavement condition survey and assessment of riding over the road.

Roughness survey, using NSV, has been carried out for the stretch of NH-29. Result obtained from the survey is summarized below:

❖ BI between 2000 & 3000 mm/km	-	29.87% Stretches
❖ BI > 3000 mm/km	-	70.13% Stretches

4.11 Sub grade Investigation

4.11.1 Sub-grade Investigation Methodology (Test Pits)

The basic objective of the investigation was to form a database for characterization of existing pavement. The investigation was carried out by digging trial pits staggered left/right.

4.11.2 Large Pits (1m x 1m x 1m) and small Pit (0.5m x 0.5m x 0.5m)

Large Trial pits of size 1m x 1m x 1m and small trial pit size 0.5m x 0.5m x 0.5m were dug at the pavement shoulder interface, extending through the pavement layers down to the subgrade level. Pits were at least 300 mm within the carriageway. Pits were made in such a way that half of the pit remains within the carriageway and the other half (in the shoulder), ensuring minimum damage to the original pavement and disruption to the traffic. Large test pits are done on both sides of the project road were dug at the pavement shoulder interface extending through the pavement layers down to the sub-grade level



The following sequence of operation was followed for each large test pit:

- Manual excavation of 1.0 m x 1.0 x 1.0 m and 0.5m x 0.5m x 0.5m pit down to subgrade level .The thickness of the different pavement layers were measured and type of material examined and logged from three sides.
- Field (in-situ) dry density using sand replacement method as per IS 2720: Part 28 was carried out at the subgrade level.
- Adequate sample in sealed polythene bag were collected for classification tests as per IS: 2720 (relevant parts)
 - Field moisture content
 - Grain size analysis
 - Atterberg limits

One sample of 40 kg was collected from the top 300 mm of subgrade for the following laboratory tests (as per IS:2720)

- Free swell index
- Moisture-Density test (heavy compaction)
- CBR (4 days soaked at three energy levels of 10, 35 and 65 blows)



After the completion of field tests and collection of samples, the pits were backfilled with the

excavated materials and compacted suitably so as not to jeopardize the smooth movement of traffic of the existing road.

The existing pavement structure mostly comprises of three layers, namely bituminous layer, base course and sub-base course. During the present investigation the surfacing course is reported, on the whole, as bituminous course (BC). The base course comprises of stone, gravel, cobble mix with clay mix with sand only and few stretches present in WBM mix. The sub-base course consists mainly occasional presence of sand layer along the stretches.

The total thickness of the pavement varies from 745 mm to 990 mm. The thickness of the bituminous surfacing layer varies from 20 mm to 110 mm. The thickness of the base layer ranges from 95 to 270 mm. The thickness of the sub-base layer ranges from 86 to 280 mm.

4.11.3 Existing Pavement Composition

The existing pavement structure mostly comprises of two and three layers, namely bituminous layer varies from 20mm to 180 mm thick, base course varies from 95mm to 320 mm and sub-base course varies from 70mm to 280 mm thick. Details of existing pavement composition (Large Pits) is provided in **Table 4.4**.

Table 4.4 : Details of Existing Pavement Composition
DABOKA TO MANJA (NH-29)

S.NO	Side	Chainage (KM)	Crust Composition (mm)		Total Thickness (mm)	DCPT CBR 200mm	DCPT CBR 400mm
			Bituminous	BASE COARSE			
1	RHS	38+600	60	270	330	8.39	8.38
2	RHS	43+000	45	230	275	3.60	4.10
3	RHS	49+000	20	270	290	6.01	5.23
4	LHS	53+500	35	270	305	2.08	3.31
5	RHS	57+500	50	270	320	5.03	6.97
6	RHS	65+000	50	420	470	1.68	1.97
7	RHS	70+000	35	210	245	1.80	3.30
8	LHS	75+000	50	340	390	3.32	3.18
9	RHS	80+000	65	250	315	5.26	7.71
10	RHS	85+000	43	400	443	23.66	32.16
11	RHS	90+000	50	290	340	1.77	2.11
12	RHS	95+000	110	380	490	6.72	7.69
13	RHS	100+000	80	240	320	1.57	2.13
14	RHS	104+000	55	410	465	15.48	16.94
15	LHS	113+000	50	250	300	3.74	3.25
16	RHS	118+000	45	270	315	3.94	4.72
17	RHS	123+000	50	250	300	6.23	8.03
18	RHS	128+000	50	190	240	2.80	5.78

MANJA TO LAHORIJAN (NH-29)							
S.NO	Side	Chainage (KM)	Crust Composition (mm)		Total Thickness (mm)	DCPT CBR 200mm	DCPT CBR 400mm
			Bituminous	BASE COARSE			
1	LHS	128+500	20	380	400	2.06	2.10
2	LHS	133+000	50	410	460	7.62	6.65
3	LHS	138+000	80	390	470	2.10	3.55
4	LHS	143+000	70	370	440	8.97	10.15
5	LHS	148+000	30	160	190	4.18	4.66
6	RHS	153+000	50	250	300	6.59	8.55
7	LHS	156+000	45	350	395	3.81	3.99

4.11.4 Laboratory Properties of Sub-grade Soil

The laboratory test results consist of gradation, Atterberg limits, field moisture content, Field dry density (FDD), compaction characteristics (maximum dry density and optimum moisture content relationship as per heavy compaction), CBR (soaked) etc. for the subgrade soils underneath the existing pavement.

4.11.5 Grain Size

The fraction of the materials of the sub-grade soils passing 75 μ sieve is 13.06% to 15.05 % on an average,

Stretch I – The soil is CL and SC type soil.

4.11.6 Atterberg Limit

The liquid limits for existing pavement of the soil are NP to plastic. Plasticity index for existing pavement soils are 7.7 to 11.7.

4.11.7 Moisture Content vs. Dry Unit Weight Relationship (Heavy Compaction)

Soil samples obtained by test pits have been compacted in the laboratory at various moisture contents to derive moisture content vs. dry unit weight relationship. The method of heavy compaction in accordance with IS 2720 (Part 8) has been used. The results of heavy compaction test carried out on sub-grade samples of existing pavement to determine the maximum dry density (MDD) and optimum moisture content (OMC) relationship.

For existing sub-grade soil the maximum dry density (MDD) of ranges between 18.10 kN/ m³ and 18.78 kN/m³. The optimum moisture content varies between 10.1 % and 12.7 %. The result indicates that the maximum dry density of existing sub-grade soil is greater than 17.5 kN/ m³ at all chainages which satisfies the unit weight requirement of sub-grade soil as specified by MORT&H.

4.11.8 CBR of Existing Sub Grade Soil

California Bearing Ratio (CBR) tests were carried out on the pit samples in the laboratory as per standard procedures. At optimum moisture content (OMC) soil samples were compacted at three different energy levels corresponding to 10 blows, 35 blows, 65 blows as per IS:2720 (Part 8). These compacted soils at different compaction levels were tested after immersion in water for four days. Soaked CBR at 97% maximum dry density (MDD) has been interpolated from CBR-dry density curve. The Stretch I soil, soaked CBR value at 97% MDU ranges from 7.5 % to 10.9 %.

4.11.9 Field Dry Density

Field dry density, as obtained from laboratory test results, is provided in **Table 4.5**.

Table 4.5 : Field Dry Density

DABOKA TO MANJA					
S.NO.	CHAINAGE (KM)	SIDE	MOISTURE CONTENT (%)	DRY DENSITY (gm/cc)	MDD (gm/cc)
1	38+600	RHS	7.00	1.736	1.846
2	43+000	RHS	6.00	1.715	1.816
3	49+000	RHS	8.00	1.695	1.810
4	53+500	LHS	5.00	1.706	1.825
5	57+500	RHS	7.00	1.714	1.840
6	65+000	RHS	4.00	1.738	1.878
7	70+000	RHS	5.00	1.697	1.832
8	75+000	LHS	4.50	1.717	1.827
9	80+000	RHS	5.50	1.734	1.887
10	85+000	RHS	4.50	1.726	1.865
11	90+000	RHS	6.00	1.704	1.835
12	95+000	RHS	5.00	1.719	1.829
13	100+000	RHS	5.50	1.696	1.821
14	104+000	RHS	8.00	1.709	1.844
15	113+000	LHS	9.00	1.735	1.859
16	118+000	RHS	8.00	1.742	1.854
17	123+000	RHS	6.00	1.704	1.831
18	128+000	RHS	4.00	1.714	1.839
MANJA TO LAHORIJAN					
1	128+500	LHS	7.00	1.690	1.831
2	133+000	LHS	6.00	1.764	1.883
3	138+000	LHS	8.00	1.704	1.822

DABOKA TO MANJA					
S.NO.	CHAINAGE (KM)	SIDE	MOISTURE CONTENT (%)	DRY DENSITY (gm/cc)	MDD (gm/cc)
4	143+000	LHS	6.00	1.734	1.865
5	148+000	LHS	4.00	1.699	1.809
6	153+000	RHS	5.00	1.732	1.853
7	156+000	LHS	6.00	1.724	1.848

4.11.10 Laboratory Properties of Sub-Grade Soil

Laboratory test results of sub-grade soils are presented in **Table 4.6**.

Table 4.6 : Test Results of Existing Subgrade Soil

DABOKA TO MANJA												
Sl. No.	SIDE	Chainage (Km.)	Grain size analysis			Heavy Compaction		Atterberg Limits			FSI	AT 97 % CBR Soaked
			Gravel (%)	Sand (%)	Silt & Clay (%)	MDD (gm/cc)	OMC (%)	LL (%)	PL (%)	PI (%)		
1	RHS	38+600	3.10	43.80	53.10	1.846	11.10	32.20	21.70	10.50	15.00	10.2
2	RHS	43+000	0.00	22.30	77.70	1.816	12.50	35.20	23.60	11.60	30.00	7.6
3	RHS	49+000	0.00	21.40	78.60	1.810	12.70	35.30	23.70	11.60	30.00	7.5
4	LHS	53+500	0.00	24.20	75.80	1.825	12.30	34.60	23.60	11.00	25.00	8.1
5	RHS	57+500	1.80	40.30	57.90	1.840	11.50	32.70	22.10	10.60	17.50	10.1
6	RHS	65+000	4.70	49.10	46.20	1.878	10.10	30.20	20.90	9.30	7.50	10.9
7	RHS	70+000	0.00	34.30	65.70	1.832	12.10	33.10	22.70	10.40	20.00	9.0
8	LHS	75+000	0.00	26.70	73.30	1.827	12.30	34.20	23.20	11.00	22.50	8.4
9	RHS	80+000	5.30	51.00	43.70	1.887	10.00	29.70	20.60	9.10	7.50	11.1
10	RHS	85+000	4.50	48.00	47.50	1.865	10.30	30.60	21.10	9.50	10.00	10.5
11	RHS	90+000	1.10	35.30	63.60	1.835	12.00	32.90	22.50	10.40	20.00	9.3
12	RHS	95+000	0.00	28.60	71.40	1.829	12.20	33.70	23.10	10.60	22.50	8.7
13	RHS	100+000	0.00	23.50	76.50	1.821	12.40	34.90	23.60	11.30	27.50	7.9
14	RHS	104+000	2.60	41.90	55.50	1.844	11.20	32.50	21.90	10.60	15.00	10.2
15	LHS	113+000	3.60	47.20	49.20	1.859	10.70	31.90	21.30	10.60	12.50	10.4
16	RHS	118+000	4.10	45.00	50.90	1.854	10.80	32.10	21.40	10.70	12.50	10.4
17	RHS	123+000	0.00	30.80	69.20	1.831	12.10	33.50	22.70	10.80	20.00	8.8
18	RHS	128+000	1.40	37.80	60.80	1.839	11.80	32.70	22.20	10.50	17.50	9.7
MANJA TO LAHORIJAN												
1	LHS	128+500	1.60	29.80	68.60	1.831	12.00	33.70	23.20	10.50	25.00	8.9
2	LHS	133+000	4.90	49.30	45.80	1.883	10.50	28.20	20.40	7.80	10.00	11.0
3	LHS	138+000	0.00	26.60	73.40	1.822	12.40	34.20	23.60	10.60	27.50	8.3

DABOKA TO MANJA												
Sl. No.	SIDE	Chainage (Km.)	Grain size analysis			Heavy Compaction		Atterberg Limits			FSI	AT 97 % CBR Soaked
			Gravel (%)	Sand (%)	Silt & Clay (%)	MDD (gm/cc)	OMC (%)	LL (%)	PL (%)	PI (%)		
4	LHS	143+000	4.20	40.50	55.30	1.865	11.00	29.90	21.70	8.20	12.50	10.4
5	LHS	148+000	0.00	20.20	79.80	1.809	12.90	35.60	24.00	11.60	30.00	7.7
6	RHS	153+000	3.50	35.90	60.60	1.853	11.30	31.20	22.40	8.80	17.50	10.2
7	LHS	156+000	2.80	34.00	63.20	1.848	11.60	32.10	22.90	9.20	20.00	9.8

4.12 Material Investigation

4.12.1 Borrow Area Material Survey

The Consultants has conducted necessary survey to find out the general characteristics of earth materials available in the area. The objective of this investigation is mainly to assess the general availability of soil required for construction of sub-grade and embankment as per design CBR recommended for design of new pavement.

Grain Size

The fraction of the materials of the Borrow area soils passing 75m sieve is 14.05 % on an average, indicating higher sand and clay content in the borrow area soil and that the soils are predominantly Gravely sandy Clay. (mix with moorum)

Atterberg Limit

The liquid limit for borrow soil are plastic to NP. Plasticity index for Borrow area soils are 08 to 11.4.

Moisture Content vs. Dry Unit Weight Relationship (Heavy Compaction)

For borrow area soil the maximum dry density (MDD) of ranges between 18.26 kN/ m³ and 18.52kN/ m³. The optimum moisture content varies between 10.40. % and 11.7 % . The result indicates that the maximum dry density of borrow area soil is greater than 17.5 kN/m³ at all chainages which satisfies the unit weight requirement of sub-grade soil as specified by MORT&H.

CBR of Borrow Area Soil



The Stretch I soil, soaked CBR value at 97% MDU ranges from 8.1 % to 9.2 %.

Table 4.7: Summary of the Laboratory Test Results

DABOKA TO MANJA											
SL. No	SAMPLE NO.	Grain Size Analysis			Heavy Compaction		Atterberg's Limit			FSI (%)	AT 97 %SHOAKED CBR
		Gravel (%)	Sand (%)	Silt & Clay (%)	MDD (gm/cc)	OMC (%)	LL (%)	PL (%)	PI (%)		
1	BA-1	3.80	37.40	58.80	1.852	10.40	33.10	22.80	10.30	20.00	9.2
2	BA-2	0.00	25.80	74.20	1.826	11.70	35.10	24.10	11.00	27.50	8.1
3	BA-3	2.30	31.70	66.00	1.844	10.60	33.90	23.20	10.70	22.50	8.8
4	BA-4	0.00	18.70	81.30	1.813	12.50	36.10	24.70	11.40	30.00	7.6
5	BA-5	7.60	47.20	45.20	1.891	9.40	29.40	20.30	9.10	10.00	11.9
6	BA-6	2.00	28.70	69.30	1.837	11.40	34.40	23.60	10.80	25.00	8.5
7	BA-7	6.30	44.10	49.60	1.875	9.70	30.30	20.90	9.40	12.50	10.7
8	BA-8	4.70	41.40	53.90	1.856	10.00	32.40	22.10	10.30	15.00	9.6
9	BA-9	1.60	27.00	71.40	1.831	11.90	34.60	23.80	10.80	25.00	8.4
10	BA-10	5.80	43.20	51.00	1.863	9.90	31.80	21.40	10.40	15.00	10.1
11	BA-11	0.00	23.40	76.60	1.818	12.10	35.70	24.30	11.40	30.00	7.9
MANJA TO LAHORIJAN											
1	BA-1	4.90	29.50	65.60	1.853	11.10	32.80	22.50	10.30	20.00	9.6
2	BA-2	7.50	32.30	60.20	1.861	10.60	31.30	21.90	9.40	20.00	10.8

4.12.2 Quarry Material Survey

The material investigation for road construction has been carried out to identify the potential sources of construction materials and to assess their general availability, engineering properties and quantities. This is one of the most important factors for stable, economic and successful implementation of the road program within the stipulated time. The material investigation is quite representative, but more exhaustive search may surely be explored by the contractors at the time of construction. For improvement work as well as for new construction the list of materials includes the following:



- Granular materials for sub-base works
- Crushed stone aggregates for base, bituminous surfacing and cement concrete works

- Sand for bituminous and cement concrete works, sub-base, filter materials and filling materials etc.
- Borrow earth materials for embankment, sub-grade and filling

Objective

The following are the basic objective to make material investigation:

- Source locations indicating places, kilometerage, availability and the status whether in operation or new source.
- Access to source, indicating the direction and nature of the access road i.e. left/ right of project road, approximate lead distance from the gravity center and type of access road.
- Ownership of land/ quarries, either government or private.
- Test results, indicating the quality of materials with respect to their suitability in construction.
- Probable use indicating the likely use of materials at various stages of construction work i.e. fill material, sub-grade, sub-base, base, bituminous surfacing and cross drainage structures.



The potential sources of construction materials were selected from consideration of the availability and suitability of the materials, easy access to the source and minimum hauling distance from the source in order to make the construction economical and feasible as far as possible. The samples from various identified sources have been collected for laboratory testing as per IRC/MORT&H/BIS standards.

A) Coarse Aggregate

Coarse aggregates such as trap rocks consisting of mainly basalt, black and grey in colour, are available in the vicinity of the project road. Stone quarries have been primarily identified as stone aggregate source for construction of various components of road, namely, Bituminous Concrete, Semi dense Bituminous concrete (SDBC), Dense Bituminous Macadam (DBM), Wet Mix Macadam (WMM), Granular sub-Base (GSB) as well as for the cement concrete works. The sources identified including their location details, lead distance and availability of the stones are tabulated in **Table 4.8**.

Table 4.8: Details of Coarse and fine Aggregates Quarry Sources

Sl. No.	Sample No	Crusher plant location/Village Name	Side	Lead (km)
1	Coarse Aggregate-1	Samul Basuno, Manja	RHS	Lead 0.050 Km. from Ext. Chainage 126+000 Km on Daboka to Manja Road

Laboratory Test Results of Coarse Aggregate Samples

Laboratory tests carried out for the abovementioned samples are presented in **Table 4.9** to **Table 4.10** respectively.

Table 4.9: Test results of Aggregate samples of size 20mm

Description	% of passing of Quarry Sample
Passing through 40MM	100
Passing through 20MM	94.60
Passing through 10MM	6.80
Passing through 4.75MM	2.30

Table 4.10: Test results of Aggregate samples of size 10 mm

Description	% of passing of Quarry Sample
Passing through 12.5MM	100
Passing through 10 MM	89.50
Passing through 4.75MM	12.40
Passing through 2.36MM	3.90

Laboratory test results summary of coarse aggregates has been presented in **Table 4.11**

Table 4.11: Summary of Laboratory Test Result of Aggregates-2

Sample No	Crusher plant location/Village Name	AIV	LAV	Specification	FI+EI	Specification	Specific Gravity	Water Absorption (%)	Specification
		(%)	(%)		(%)				
CA-2(20 MM)	SAMUL BASUNO, MANJA	15.7	23.1	Not more than 30% for non-bituminous work, 27% & 24% for DBM and BC work respectively	24.6	Not more than 35%	2.698	0.57	Not more than 2%
CA-2(10 MM)	SAMUL BASUNO, MANJA	19.3	24.3	Not more than 30% for non-bituminous work, 27% & 24% for DBM and BC work respectively	26.8	Not more than 35%	2.694	0.63	Not more than 2%

The results from **Table 4.11** indicate that all the quarry samples are of approved standard and can be used for Road construction.

B) Fine Aggregate

Many sources have been identified are available in the vicinity of the project road. The quarry location and approximate lead distance from project is given in **Table 4.12**

Table 4.12: Details of Fine Aggregate Sources

S. No.	Sample No	Crusher plant location/Village Name Village Name	Side	Lead (km)
1	FA-1	SAMUL BASUNO, MANJA	RHS	LEAD 0.050 KM FROM EXT. CHANAIGE 39+500 Km ON DABOKA TO MANJA ROAD

Laboratory Test Results of Fine Aggregate Samples

Laboratory tests were conducted on the sand samples collected from the River and are summarized below in **Table 4.13**.

Table 4.13: Gradation of Fine aggregate

Sl. No.	Sieve Size (mm)	% of passing	FA Zone I	FA Zone II	FA Zone III	FA ZONE IV
1	10	99.12	100	100	100	100
2	4.75	97.66	90 - 100	90 - 100	90 - 100	95-100
3	2.36	89.42	60 - 95	75 - 100	85 - 100	95-100
4	1.18	68.47	30 - 70	55 - 90	75 - 100	90-100
5	600 mic	43.20	15 - 34	35 - 59	60 - 79	80-100
6	300 mic	13.62	5-20	8-30	12-40	15-50
7	150 mic	2.08	0 - 10	0 - 10	0 - 10	0-15
8	Fineness Modulus (F.M) of FA	2.864				
9	Specific Gravity	2.628				
10	Water absorption	1.14				

Table 4.13 shows that fine medium coarse sand is available from the above river. The grading zone and fineness modulus of above stone crusher Zone II & Zone II (IS 383 2016) and 2.798 & 2.864 respectively, indicating that it is suitable for road pavement and structural concreting works.

4.12.3 Gradation of GSB/WMM Samples

Gradation of GSB and WMM sample are provided in **Appendix 4.21** and **4.22** respectively.

4.12.4 Manufactured Materials

Cement, bitumen, steel are the manufactured materials. Cement and steel with I.S. certification are indigenously available in abundance from the manufacturers. Bitumen of VG-10, VG-20, VG-30 & VG-40 viscosity grade and emulsion are available from IOCL Mumbai, within the vicinity of project road. The regular supply of bitumen and cement can be satisfactorily met by advance agreements with the manufacturers. The grades of bitumen should be selected as per the guidelines of the MORT&H Specifications for Road and Bridge Works.

A) Cement

Cement to be used in the construction work shall be any of the following types with the prior approval of the Engineer:

- Ordinary Portland cement, 33 Grade, conforming to IS: 269
- Rapid Hardening Portland Cement, conforming to IS: 8041
- Ordinary Portland cement, 43 Grade, conforming to IS: 8112
- Ordinary Portland cement, 53 Grade, conforming to IS: 12269
- Sulphate Resistance Cement, Conforming to IS: 12330

The chloride content in cement shall in no case exceed 0.05 percent by mass of cement. Also, total sulphur content calculated as sulphuric anhydride (SO_3) shall in no case exceed 2.5 percent and 3.0 percent when tri-calcium aluminates present by mass is upto 5 or greater than 5 respectively. Good quality Cement is locally available.

B) Steel

For plain and reinforced concrete (PCC and RCC) or pre-stressed concrete (PSC) works, the reinforcement/un-tensioned steel as the case may be shall consist of the following grades of reinforcing bars as shown in **Table 4.14** are available with local stockists. Before incorporation into the work, steel shall be got approved by the engineer.

Table 4.14: Characteristic Strength of Reinforcement Steel

Grade Designation	Bar Type conforming to governing IS Specification	Characteristic Strength f_y (MPa)	Elastic Modulus GPa
S 240	IS:432 Part I, Mild Steel Bar	240	200
S 415	IS:1786 High Yield Strength Deformed Bars (HYSD)	415	200

C) Bitumen

Bitumen of viscosity grade VG-10 and VG-30 is available from IOCL, Haldia within the vicinity of project road, either in bulk tanker or in drums. It is advised that Polymer Modified Bitumen

/ Crumb Rubber Bitumen to be used for construction of bituminous layer.

Sl No.	Name of Company	Location
1	IOCL	Haldia

D) Water

Detailed survey for locating water sources for the use in concrete works and for construction of road works were carried out in the vicinity of the project road. The most suitable source of water was which are in close proximity to some points of the alignment of the rivers, along with numerous nallas and irrigation canals cross the alignment at suitable intervals. However to facilitate construction works it is always advisable to install wells with due permission from authority at suitable places for obtaining water for construction purposes.

4.13 Lead Charts

Lead chart for borrow area materials for NH 29 are provided in **Figure 4.1**. The same quarry materials are presented in **Figure 4.2**.

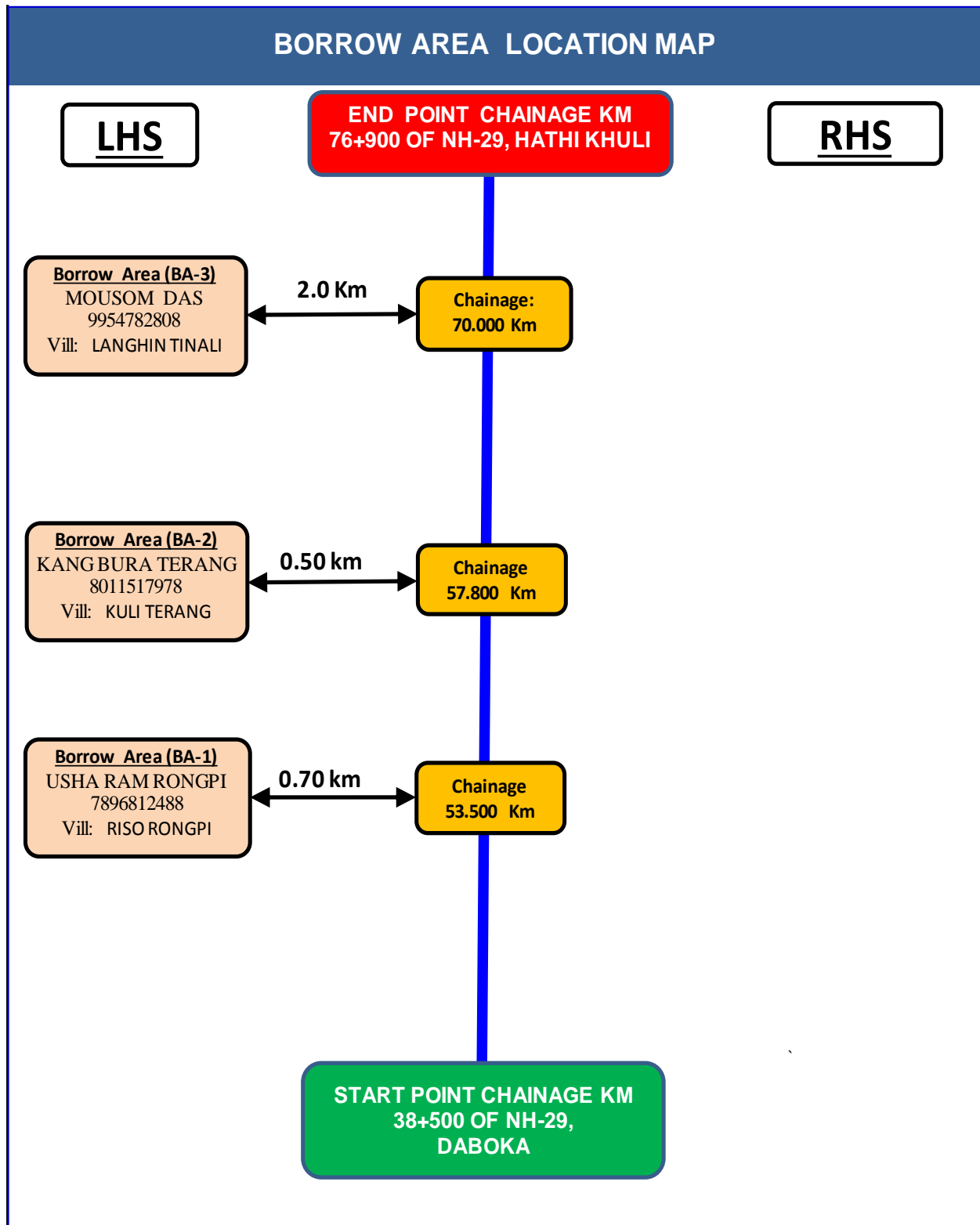


Figure 4.1 : Lead Chart for Borrow Area Materials

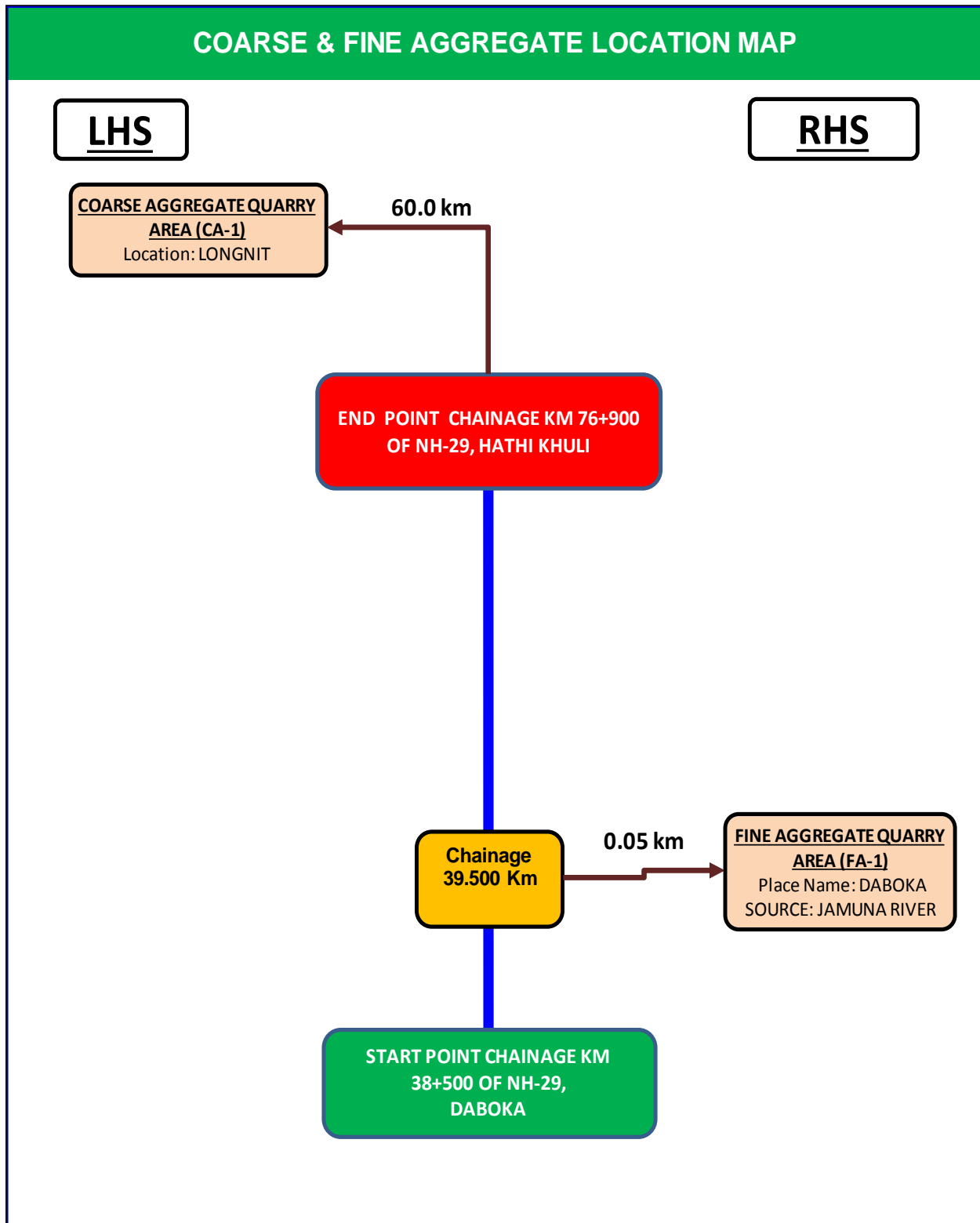


Figure 4.2 : Lead Chart for Quarry Materials

4.14 Sub Soil Exploration

Sub soil investigation has been taken up at bridge locations. The details of sub soil exploration provided in Vol. II – Design Report.

4.15 Hydrological and Hydraulic Study

Preliminary hydraulic and hydrological investigations have been carried out for economical design of drainage structures. The hydrological and hydraulic study for the project includes:

- Study of available open series maps (OSMs).
- checking the adequacy of existing cross-drainage structures and to determine the additional number and size of cross-drainage structures, if any, to allow the estimated design flow of the streams to cross the road safely.
- design of roadside drainage system along the alignment.

During the reconnaissance survey and further data collection/investigations, the Consultants approached local residents and different Government Organisations concerned to the project road to identify the high flood conditions on the project road and on structures. So far as local enquiry is concerned, there is no history of overtopping along the road. Gradual deposition of transported bed material in the wake of every monsoon at most of the bridge sites and on their upstream and downstream sides have resulted in partial blockage in the flow area leading to afflux and reduced clearance under some of the bridges.

Necessary Hydrological and Hydraulic features such as HFL, river bed condition, bank condition, land use, scouring have been noted for all the cross-drainage structures.

Based upon data availability, detailed hydrological and hydraulic study of the cross-drainage structures is being carried out. On initial assessment it has been found that number of cross-drainage structures is inadequate at some stretches. Adequate numbers of new culverts have been proposed at those stretches. Details of these new culverts have been presented in Chapter 6 of this report. Additional cross drainage structures would be required in bypass reaches also.

4.16 Secondary Data Collection

Besides the primary surveys conducted / arranged so far, the Consultants also endeavored to collect data and information from secondary sources, as necessary for conducting the study. Some of the secondary data, especially those related to land records are indeed very important, as besides the various formalities related to land transfer/acquisition, these aspects sometimes even dictate the alignments of new/widening proposals.

Consultants prepared a list of secondary data to be collected. Most of the data were collected and few are in process as these are not under direct control of consultant. List of secondary data collected is mentioned below:

1. Districts Involved
2. Existing road nomenclature
3. Ownership details of road
4. Survey of India open series maps
5. Forest maps and forest shape files
6. Accident data from concerned police stations
7. Fuel sale data from nearby fuel stations
8. Vehicle registration data from RTO office
9. Statistical handbooks
10. SOR, PWD NH 2013-14
11. Existing ROW information through discussion with concerned officers/site measurements
12. Future proposal of IWA
13. IOCL underground pipelines
14. Land and building rates
15. High flood level (through local enquiry)

Chapter 5 : Traffic Surveys and Analysis

CHAPTER 5

TRAFFIC SURVEY AND ANALYSIS

5.0 TRAFFIC SURVEY AND ANALYSIS

5.1 Introduction

Traffic studies and analyses carried out for consultancy services for preparation of detailed project report for Package II Lot 1 under Bharatmala Pariyojana are presented in this chapter. The results of analysis will form the inputs for developing capacity augmentation proposals for the project road, design of intersections, design of the pavement, wayside amenities and enhancement of other facilities.

5.2 Road Connectivity

NH-29 originates from Nagaon on NH37, connects Daboka, terminating on NH129 at Dimapur. NH 54 links Silchar, Manipur and Mizoram to NH 29. SH19 links Uttarborbil on NH-29 with Hojai on NH 54 and Nilbagan. SH36A connects Manja on NH 29 with Diphu. The road network in the area is shown in **Fig 5.1**

5.3 Traffic Homogeneous Sections

Based on traffic volume and nature of traffic flow, the project stretch has been divided into six traffic homogeneous sections as described in Table 5.1.

Table 5.1 : Traffic Homogeneous Sections

Sl No	Homogeneous Section	Description	Existing Chainage
1	HS1	Daboka to Howraghat Tinali	Km 38.5 of NH-29 to Km 85.4 of NH-29
2	HS2	Howraghat Tinali to Manja	Km 85.4 of NH-29 to Km 128.3 of NH-29
3	HS3	Manja to Lahorijan	Km 128.3 of NH-29 to Km 157.4 of NH-29

Source: Consultant's study

5.4 Traffic Survey Schedule

In order to capture the traffic flow characteristics and travel pattern along the project road, the Consultants have conducted the following primary surveys

- Classified Traffic Volume Count
- Origin-Destination Survey

- Speed and Delay Survey
- Turning Movement Survey
- Pedestrian/Animal Crossing Survey
- Truck Parking Survey
- Axle Load Survey

Traffic survey stations were selected by the consultants based on an understanding of the road network and a consideration of the following aspects:

- to represent homogeneous traffic section
- to be outside urban and local influence area
- to be located at a level with good visibility
- O-D stations to be preferably at some police/forest/sales tax barriers for the convenience and safety of stopping vehicles for roadside interview.

Traffic survey locations are depicted in **Fig 5.2**. The schedule of survey is given in Table 5.2.

Table 5.2: Schedule of Traffic Survey

Sl No.	Type of Survey	Date of Survey	Period of Survey	Location
1	Mid Block Volume Count	27.07.18 to 02.08.18 (8:00 AM) (8:00 AM)	7 days x 24 hrs	Km 62 of NH-29
		27.07.18 to 02.08.18 (8:00 AM) (8:00 AM)	7 days x 24 hrs	Km 127 of NH-29
		27.07.18 to 02.08.18 (8:00 AM) (8:00 AM)	7 days x 24 hrs	Km 138.450 of NH-29
		27.07.18 to 02.08.18 (8:00 AM) (8:00 AM)	7 days x 24 hrs	Km 138.450 of NH-29
2	O-D Survey	29.07.18 to 30.07.18 (8:00 AM) (8:00 AM)	1 day x 24 hrs	Km 127 of NH-29
3	Turning Movement Count Survey at Intersections	31.07.18 to 01.08.18 (10:00 AM) (10:00 AM)	1 day x 24 hrs	Daboka junction (Km39+500 of NH-29)
		30.07.18 to 31.07.18 (10:00 AM) (10:00 AM)	1 day x 24 hrs	Howraghat Tinali junction (Km 85+400 of NH-29)
		31.07.18 to 01.08.18 (8:00 AM) (8:00 AM)	1 day x 24 hrs	Manja junction (Km 128+300 of NH-29)

Sl No.	Type of Survey	Date of Survey	Period of Survey	Location
4	Speed Delay Survey	30.07.18-31.07.18	-	project road stretch
5	Axle load Survey	29.07.18 to 30.07.18 (8:00 AM) (8:00 AM)	2 days x 24 hrs	Km 127 of NH 29

Source: Consultant's schedule

5.5 Methodology of Traffic Survey

5.5.1 Classified Traffic Volume Counts

Classified traffic volume count survey was conducted at six mid-block locations. The count was conducted for a full week spread over 7 consecutive days and 24 hours a day. For carrying out the traffic survey, vehicle classification, as given in **Table** was adopted.

The survey was conducted using the Video Image Detection ATCC system. Manual counting by trained enumerators was conducted on a sampling basis for auditing the raw ATCC data. Trained supervisors were deployed to supervise the traffic surveys. Trained enumerators supervised by traffic engineers analyzed the video images to record the count data at 15-minute intervals for each vehicle group in each direction of travel.

Table 5.3 : Vehicle Classification System

Motorized Traffic		Non-Motorized Traffic
2 wheelers: : Scooters, bikes, motor cycles, mopeds etc		Bicycle
Auto Rickshaw/ Tempos/ other three wheelers		Cycle Rickshaw/ Rickshaw van
Passenger Car: car, taxi		Hand Cart
Bus	Mini Bus, Standard Bus	Animal Drawn
Truck	Light Commercial Vehicle	
	2 axle Truck	
	3 – Axle Rigid Truck (HCV)	
	Multi axle Truck	
	Agriculture Tractor, Tractor & Trailer	
Other Vehicles	Heavy Construction Machinery	

5.5.2 Origin-Destination Survey

The primary objective of conducting origin-destination survey was analyzing the travel pattern of freight and passenger traffic along the study corridor. To assess the influence of states/ regions, located nearby and those at large distances on the project road traffic, 66 traffic zones were delineated. The road network surrounding the project stretch was studied in detail in order to arrive at a practical zoning system. Origin- Destination zones and commodity types,

with respective code numbers, are presented in Appendix. OD survey was carried out for 24 hours duration. Roadside interview method was adopted for the survey. The vehicles were stopped on random sample basis with the help of police, and trained enumerators interviewed the drivers/ occupants collecting the required information/ data. The survey was conducted under the guidance of traffic engineers and supervisors. Information pertaining to trip length, trip purpose, occupancy as applicable for various vehicle types were recorded during the survey.

The results are useful for identifying the influence area of the project road, estimating the growth rates of traffic, planning tolling strategies and locating toll plazas on the most viable sections of the project road.

5.5.3 Speed and Delay Survey

The survey was conducted by adopting the Floating car or riding check method. The test vehicle was driven along the project corridor at the perceptible average speed of traffic stream. Observers traveling in the test vehicle noted the number of vehicles overtaking the test vehicle, number of vehicles overtaken by the test vehicle, number of vehicles travelling in direction opposite to the test vehicle, delay time at different locations, journey time. The test vehicle run in both directions of the traffic stream.

5.5.4 Turning Movement Survey

Turning movement survey was conducted at six intersections to obtain information on directional movement of traffic on the project road. The survey was conducted for 24 hours at a stretch to capture the traffic conditions during day and night. Trained enumerators were engaged for conducting the survey. Each turning movement at the intersection was recorded by deploying enumerators at suitable locations.

5.5.5 Axle Load Survey

The survey was carried out at two locations to study the axle load characteristics on the project road. The survey was conducted in both directions for 48 hours at a stretch. Axle load pads were installed at the side of the road in both travel directions. Vehicles were stopped on a sample basis by trained enumerators with the assistance of the District police and guided to the axle load pad. The vehicle type and wheel loads were recorded in prescribed format. The survey was monitored by trained supervisors and Engineers.

5.6 Data Analysis

5.6.1 Traffic Volume Count

Data collected from the site were collated, edited and entered into the computer and analyzed using spread sheet. The various vehicle types having different sizes and characteristics were converted into a single unit called passenger car unit. Passenger Car Unit (PCU) values are

adopted from Indian Road Congress publication on “Capacity of Roads in Rural areas”, IRC-64-1990. The PCU values used are presented in **Table 5.4**.

Table 5.4 : PCU Factors Adopted for the Study

Vehicle Type	PCU	Vehicle Type	PCU
Passenger Car/ Utility Vehicle	1.0	Tractor	1.5
Mini Bus	1.5	Tractor with Trailer	4.5
Standard Bus	3.0	Two Wheeler	0.5
Light Commercial Vehicle (LCV)	1.5	Auto Rickshaw (Three Wheeler)	1.0
2 Axle Truck (MCV)	3.0	Bullock Cart (small)	6.0
3 Axle Truck (HCV)	3.0	Cycle	0.5
MAV (semi-articulated & articulated)	4.5	Cycle Rickshaw/Rickshaw Van	2.0

Source: IRC 64-1990

The summary of seven day volume counts, in number and PCU, leading to estimation of Average Daily Traffic (ADT) is provided in Appendices.

For the TVC locations on NH-29, the directional distribution is given in **Table 5.5**.

Table 5.5: Directional Distribution on NH-29

TVC Location	Directional distribution in Vehicle Nos	Directional distribution in PCU
	Daboka to Lahorijan : Lahorijan to Daboka	Daboka to Lahorijan : Lahorijan to Daboka
Km 62 of NH-29	50:50	49:51
Km 127 of NH-29	50:50	49:51
Km 138.450 of NH-29	50:50	49:51

Source: Consultant's analysis

Traffic Composition

Composition of traffic as observed at Km 62 of NH-29 is presented in Figure 5.3. Out of total traffic, share of non-motorized traffic is 16% and that of motorized traffic is around 84%. Passenger and Freight vehicles contribute about 86% and 14% respectively in the total motorized traffic.

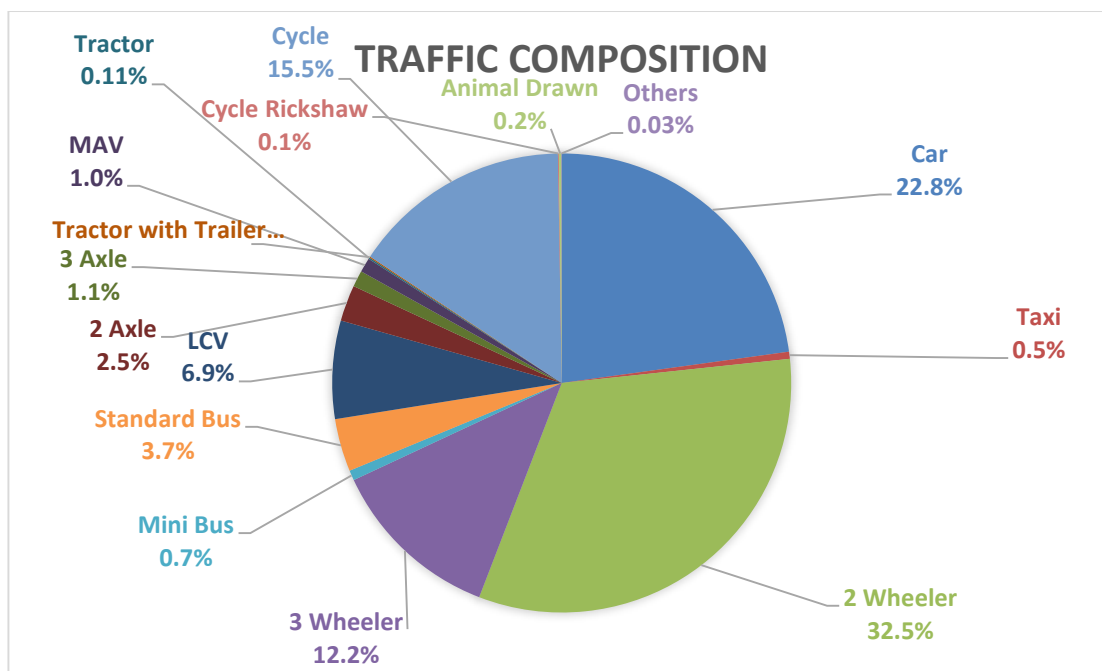


Figure 5.3 : Composition of Traffic at km 62 of NH-29

Composition of traffic as observed at Km 127 of NH 29 is presented in Figure 5.4. Out of total traffic, share of non-motorized traffic is 16% and that of motorized traffic is around 84%. Passenger and Freight vehicles contribute about 86% and 14% respectively in the total motorized traffic.

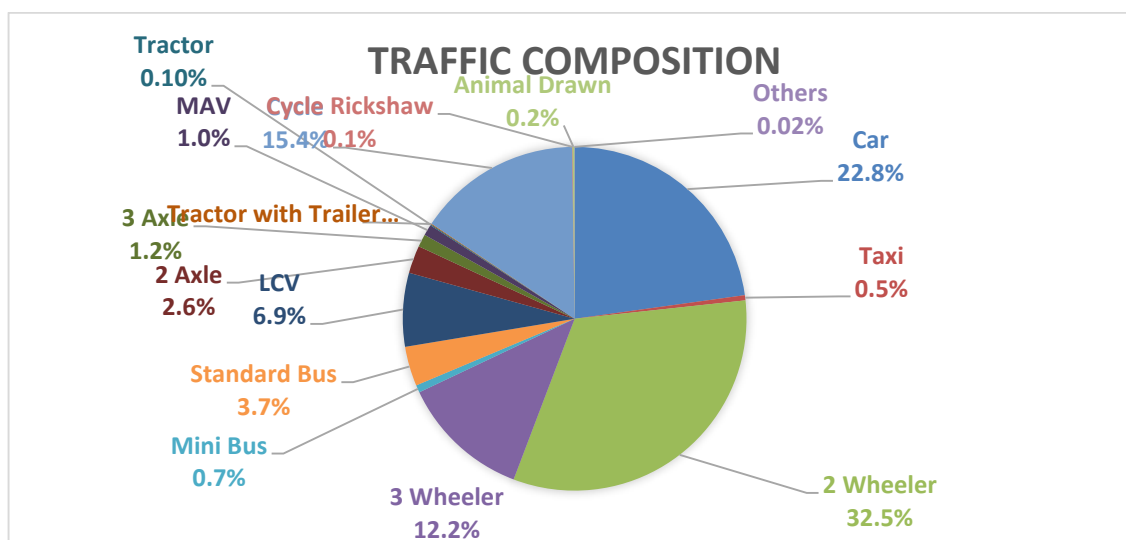


Figure 5.4 : Composition of Traffic at km 127 of NH-29

Composition of traffic as observed at Km 138+450 of NH 29 is presented in Figure 5.5. Out of total traffic, share of non-motorized traffic is 16% and that of motorized traffic is around 84%. Passenger and Freight vehicles contribute about 86% and 14% respectively in the total motorized traffic.

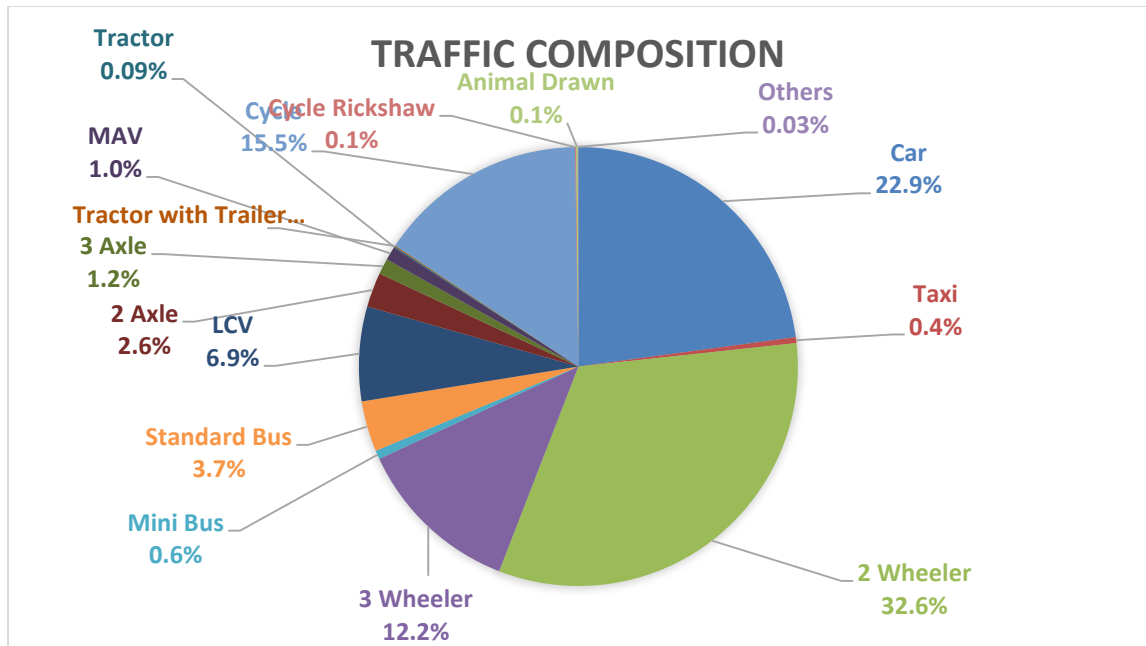


Figure 5.5 : Composition of Traffic at km 138+450 of NH-29

Average Daily Traffic (ADT)

ADT by vehicle type for Km 62 of NH-29, Km 127 of NH-29 and Km 138+450 of NH-29 are presented in **Table 5.6**.

Table 5.6: Average Daily Traffic on Project Road at Km 62 of NH-29, Km 127 of NH-29 and Km 138+450 of NH-29 (in Numbers)

Vehicle Type	At Km 62 of NH-29	At Km 127 of NH-29	At Km 138+450 of NH-29
Car	1454	1571	1212
Taxi	32	33	23
2 Wheeler	2072	2238	1727
3 Wheeler	777	840	647
Mini Bus	45	48	34
Standard Bus	237	256	198
LCV	440	477	368
2 Axle	162	180	135
3 Axle	73	82	62
MAV	65	71	53
Tractor	7	7	5
Tractor with Trailer	5	5	4
Cycle	984	1063	820
Cycle Rickshaw	4	4	4
Animal Drawn	11	11	7
Others	2	2	2
Total (numbers)	6370	6889	5299
Total (PCU)	6342	6875	5263

Source: Consultant's analysis

IHMCL data was also collected at a few locations along the project road.

Average Annual Daily Traffic (AADT)

Seasonality factor was determined using the sale of diesel and petrol at petrol pumps along/near the project road. Seasonality correction factor (SCF) used to calculate the AADT is presented in **Table 5.7**.

Table 5.7: Seasonality Correction Factor (SCF) on NH-29

Vehicle Type	Car	Taxi	Shared Auto	Two Wheeler	Three Wheeler	Mini Bus	Standard Bus	LCV	2-Axle
SCF	1.05	1.01	1.10	1.10	1.10	1.01	1.01	1.01	1.01
Vehicle Type	3-Axle	MAV	Tractor	Tractor with Trailer	Cycle	Cycle Rickshaw	Animal cart	Others	
SCF	1.01	1.01	1.01	1.01	1.00	1.00	1.00	1.00	

Source: Consultant's analysis

The AADT obtained for the existing ADT for different vehicle types at Km 62 of NH-29, Km 127 of NH-29, Km 138+450 of NH-29 and are presented in **Table 5.8**.

Table 5.8: Average Annual Daily Traffic at Km 62 of NH-29, Km 127 of NH-29 and Km 138+450 of NH-29 (in Numbers)

Vehicle Type	At km 62 of NH-29	At km 127 of NH-29	At km 138+450 of NH-29
Car	1533	1657	1278
Taxi	32	34	23
2 Wheeler	2274	2455	1894
3 Wheeler	852	921	710
Mini Bus	46	49	35
Standard Bus	240	259	200
LCV	445	483	373
2 Axle	164	182	137
3 Axle	74	83	62
MAV	65	72	54
Tractor	7	7	5
Tractor with Trailer	5	5	4
Cycle	984	1063	820
Cycle Rickshaw	4	4	4
Animal Drawn	11	11	7
Others	2	2	2

Vehicle Type	At km 62 of NH-29	At km 127 of NH-29	At km 138+450 of NH-29
Total (numbers)	6739	7288	5606
Total (PCU)	6627	7184	5500

Source: Consultant's analysis

Daily Variation of Traffic

The daily variation of traffic in number and PCU at Km 62 of NH-29, Km 127 of NH-29 and Km 138+450 of NH-29 are presented in **Figure 5.6-5.8**.

The difference between daily traffic and the ADT in PCU expressed as a percentage of ADT at the above locations are tabulated in **Table 5.9-5.11**.

Table 5.9: Variation between Daily Traffic and ADT (in PCU) at km 62 of NH-29 as Percentage of ADT

Location	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Maximum Variation	
								-ve (%)	+ve (%)
Km 62 of NH 29	3.4%	-3.4%	-3.9%	1.3%	10.3%	-3.1%	-4.6%	-4.6%	10.3%

Source: Consultant's analysis

Table 5.10: Variation between Daily Traffic and ADT (in PCU) at km 127 of NH-29 as Percentage of ADT

Location	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Maximum Variation	
								-ve (%)	+ve (%)
Km 127 of NH-29	3.5%	-3.2%	-4.1%	1.4%	10.2%	-3.2%	-4.4%	-4.4%	10.2%

Source: Consultant's analysis

Table 5.11: Variation between Daily Traffic and ADT (in PCU) at km 138+450 of NH-29 as Percentage of ADT

Location	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Maximum Variation	
								-ve (%)	+ve (%)
Km 138+450 of NH-29	3.9%	-3.5%	-3.9%	1.3%	10.2%	-3.7%	-4.3%	-4.3%	10.2%

Source: Consultant's analysis

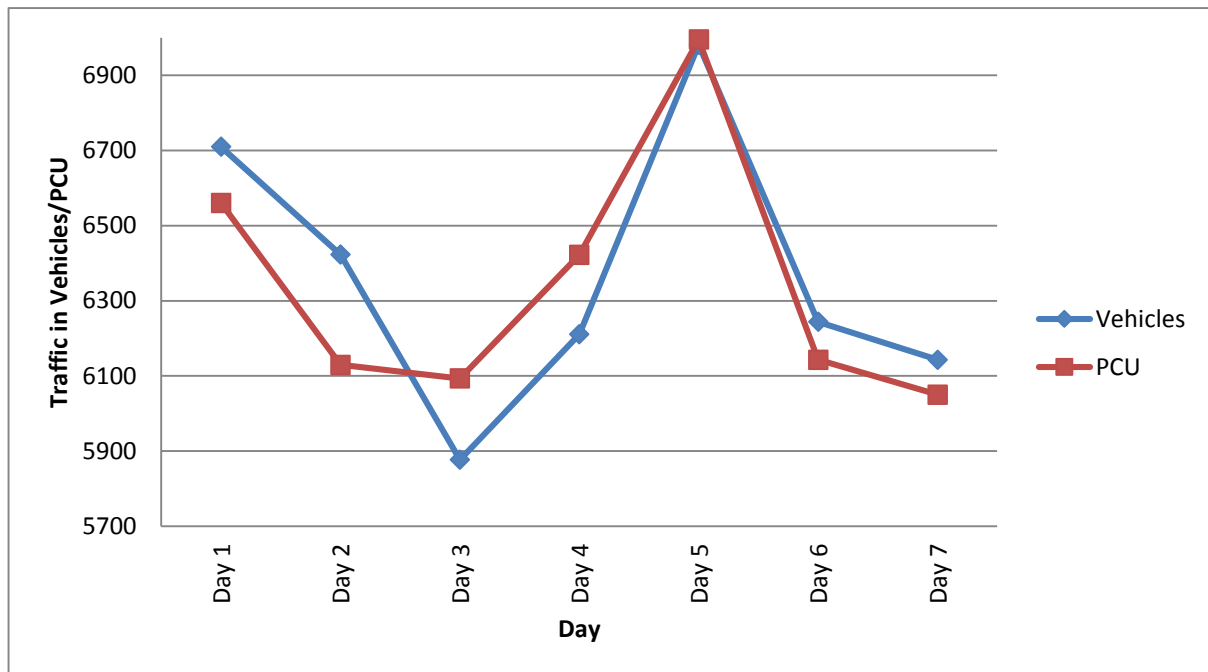


Figure 5.6 : Daily Variation of Traffic at km 62 of NH-29

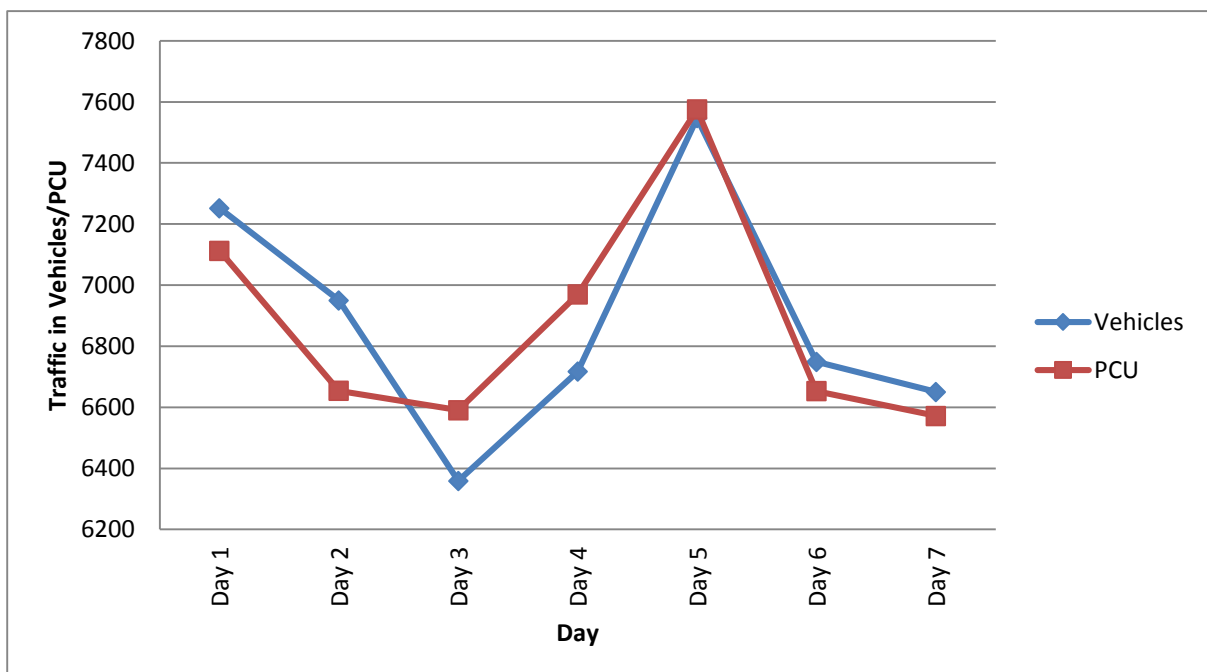


Figure 5.7 : Daily Variation of Traffic at km 127 of NH-29

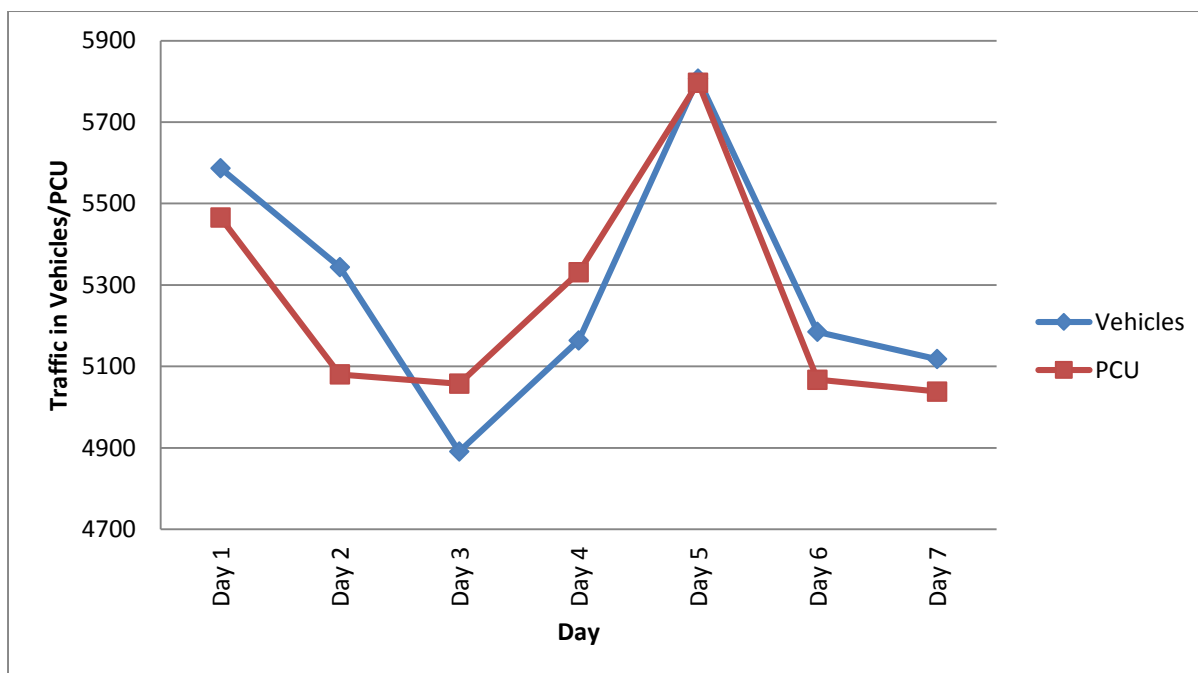


Figure 5.8 : Daily Variation of Traffic at km 138+450 of NH-29

5.6.2 Analysis of OD Survey Data

Travel Pattern

The travel pattern of vehicles along the project corridor was studied. The data collected from the field was subsequently grouped according to origin and destination of vehicles, which led to development of the zoning system.

Zoning System

Origin-Destination (OD) analysis is required for designation of the PIA in terms of codified origin and destination zones. It is thus important to code the trips recorded at site for origin and destination zones. The zoning, emanating from the understanding of the surrounding road network and the travel pattern of the vehicles by the consultants, was done in four levels.

In the first level, all-important towns located along the project stretch were assigned zone code. Secondly, immediate influence areas of project road were considered and nearby areas/towns were defined as separate zones. In next level, all nearby district were grouped in different zones. Finally, states beyond the influence area were aggregated broadly in terms of direction and entry point to the project road.

Zone list is provided in Appendices in Volume-II.

Commodity Groups

Due consideration was given to include all possible commodities moving along the project road and to categorize them into homogeneous groups.

Data Coding and Checking

The collected data were coded and computerized. Checking of data for incorrect entries and coding was carried out by cross checking with original field data sheets. The data were also checked for inconsistencies. The checking included:

- Code number exceeding highest code
- Matching vehicle type with commodity carried
- Vehicle type with their corresponding lead/load/occupancy for any inconsistencies

Development of Origin-Destination Matrices

After coding of Origin and Destination data, expansion factors were calculated by comparing the sample size collected for each vehicle type with traffic count data. After calculating expansion factors, vehicle-wise O-D matrices were developed. On the basis of O-D matrices, travel pattern of the vehicles moving on the project road was determined.

Commodity Analysis

Commodity movement pattern shows that there is considerable movement of petroleum products, finished and manufactured products. Significant movement of food grains, other agricultural products, fruits and vegetables is also observed. A large proportion of empty vehicles was recorded at the location.

Mode-wise distribution of various commodities observed at km 127 of NH-29 is presented in **Table 5.12**.

Table 5.12: Vehicle wise Commodity Distribution (in Percentage) at km 127 of NH-29

Sl No	Commodities	LCV	MCV	HCV	MAV
1	Food grains and other agricultural products	3	2	0	0
2	Fruits, vegetables - perishables	2	0	0	0
3	Wood and Forest Products	0	0	1	0
4	Petroleum, oil, gas, lubricants	1	2	0	0
5	Minerals, chemicals, fertilizer	0	0	0	0
6	Iron , Metal, Steel	2	0	0	0
7	Finished and manufactured products	1	1	0	0
8	Parcel Service & Containers	3	2	0	0
9	Building materials	0	0	0	0
10	Mining (Sand, Bajri, Coarse Aggregate)	1	0	0	0
11	Cement	1	2	1	1
12	Miscellaneous goods (Livestock, Waste, paper etc)	10	2	1	0
13	Empty vehicles	34	12	6	7

Source: Consultant's analysis

Passenger Vehicle

The analysis of passenger vehicles recorded at Km 127 of NH-29 shows that 23% traffic circulates within Karbi Anglong district (Assam). Traffic between Karbi Anglong and Rest of Assam is 30%, between Guwahati and Rest of Assam 11%, between Nagaon and Rest of Assam 15%. Traffic between Dimapur and Assam is 16%.

Spatial distribution of passenger trips at km 127 of NH-29 is presented in **Table 5.13**.

Table 5.13: Major Distribution of Passenger Vehicle at km 127 of NH-29

Between	% Share
Between	% Share
Within Karbi Anglong	23
Hojai - Rest of Assam	3
Karbi Anglong - Rest of Assam	30
Dimapur - Assam	16
Nagaon - Rest of Assam	15
Guwahati - Rest of Assam	11

Source: Consultant's analysis

Desire line diagram for Passenger vehicles are presented in **Figure 5.9**.

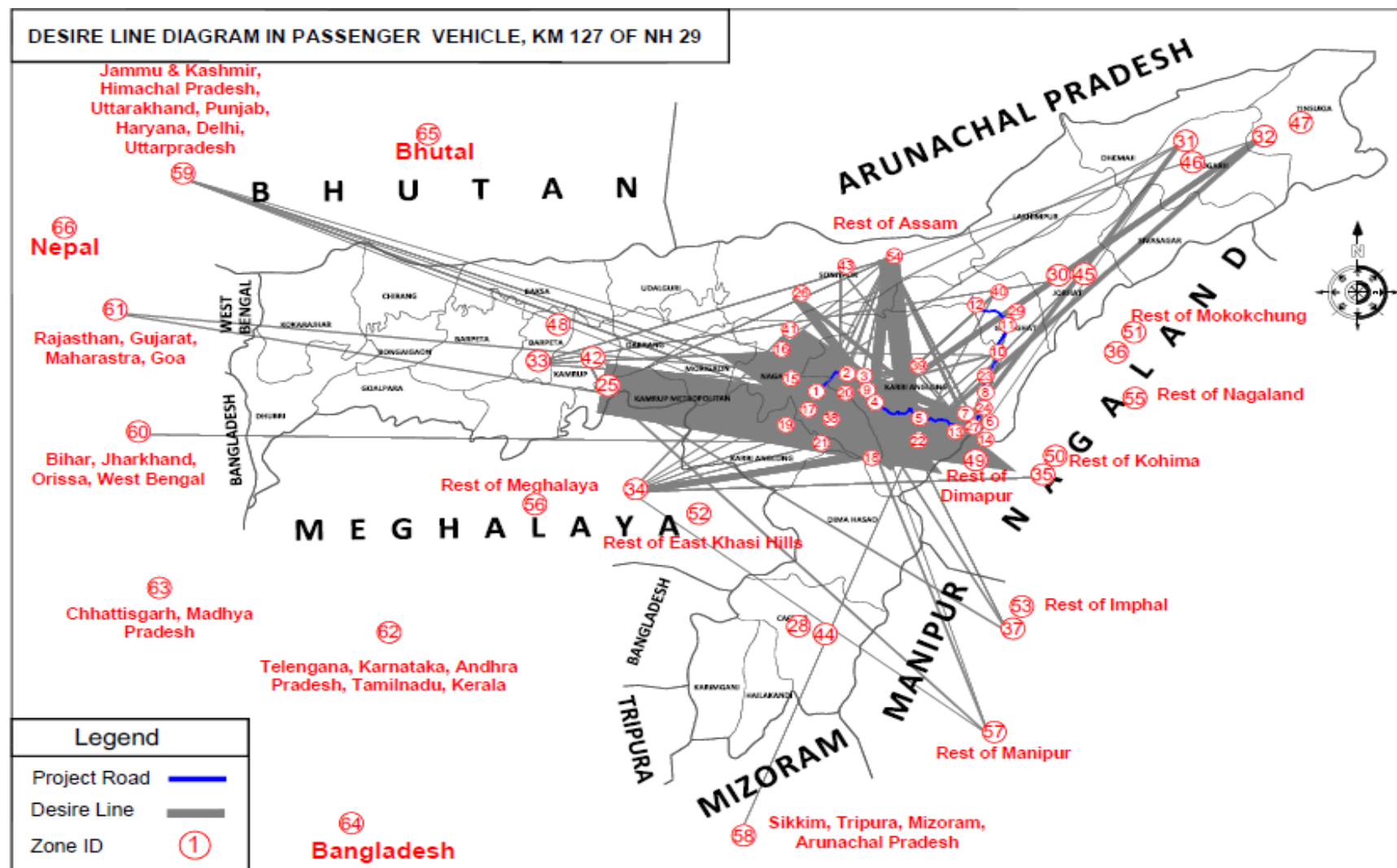


Figure 5.9 : Desire Line Diagram in Passenger Vehicle, Km 127 of NH-29

Freight Vehicles

Analysis of goods vehicles at km 127 of NH-29 reveals that 25% trips are between Dimapur and Guwahati and 15% between Diphu and Rest of Assam.

Table 5.14: Major Distribution of Goods Vehicle at km 127 of NH-29

Between	% Share
Within Karbi Anglong	9
Karbi Anglong - Dimapur	6
Karbi Anglong - Guwahati	10
Dimapur - Guwahati	25
Dimapur - Rest of Assam (except Karbi Anglong, Guwahati)	16
Diphu - Rest of Assam	15
Nagaon - Rest of Assam	7
Hojai - Rest of Assam	7
Sonitpur - Rest of Assam	2

Source: Consultant's analysis

Desire line diagram for Goods vehicles are presented in **Figure 5.10**.

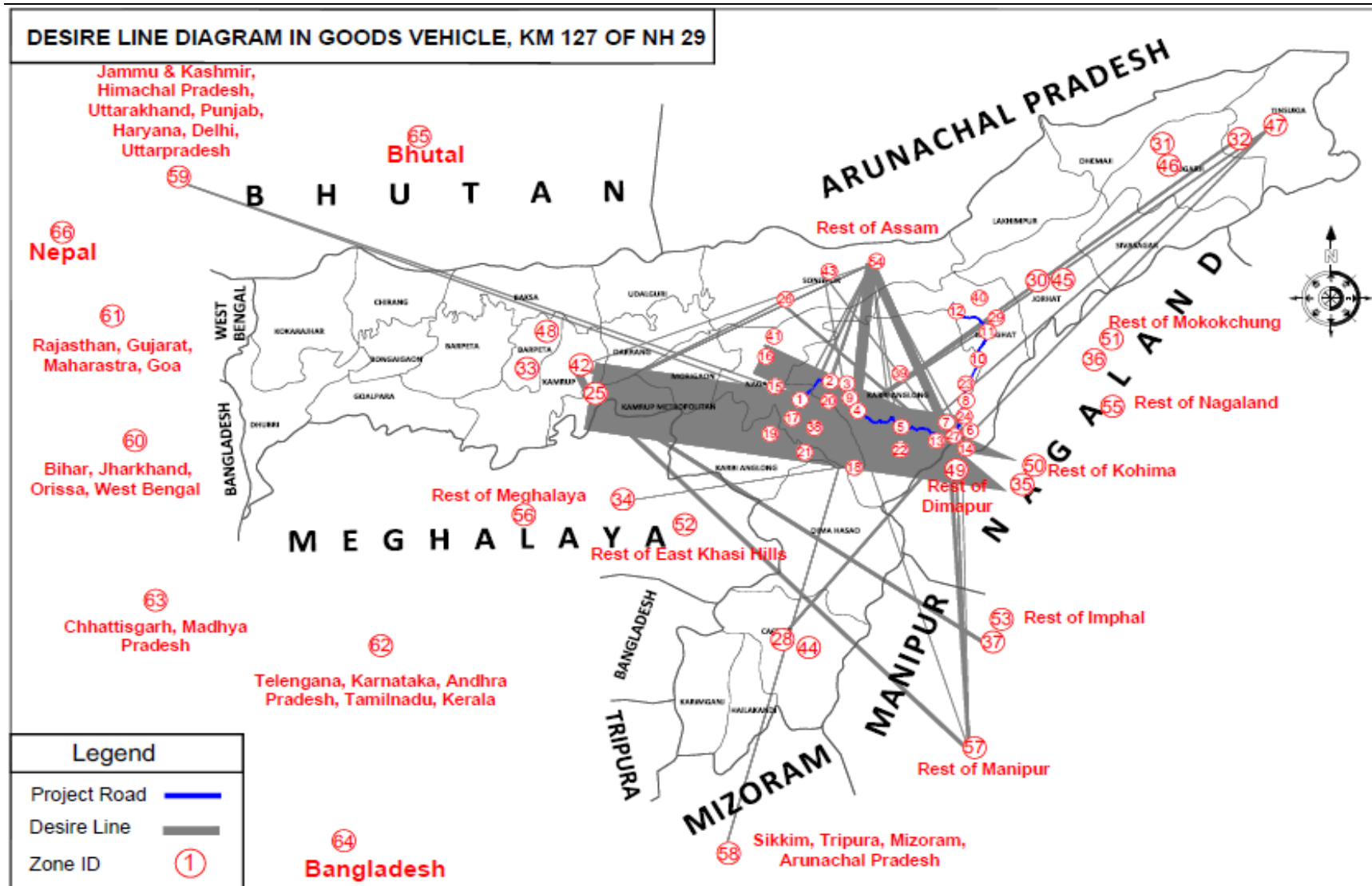


Figure 5.10 : Desire Line Diagram in Goods Vehicle, Km 127 of NH-29

Occupancy and Trip Purpose

Average occupancy for passenger cars and buses at Km 127 of NH 29 is observed as 3 and 38 respectively. At Km 100 of NH 129 average occupancy of cars and buses is 3 and 29.

The distribution of car passengers by trip purpose at the OD location is shown in Table 5.15

Table 5.15 : Distribution of Car Passengers by Trip Purpose at Km 127 of NH-29

Trip Purpose	Percentage of Car Trips
Work	75
Business	10
Social	3
Others	12

Source: Consultant's analysis

Lead Distribution

The lead distribution of vehicles at the OD survey locations is given in **Table 5.16**.

Table 5.16: Trip Lead Distribution at Km 127 of NH 29

Vehicle Type	Lead in Km							Total
	0-20	20-50	50-100	100-200	200-500	500-1000	>1000	
Car	13.5	9.9	34.1	16.4	25.6	0.5	0.0	100.0
Bus	3.9	3.8	32.8	42.2	17.3	0.0	0.0	100.0
LCV	29.2		13.9	22.8	30.0	4.1	0.0	100.0
MCV	8.7		8.5	26.8	47.8	8.2	0.0	100.0
HCV	0.0		21.9	28.1	50.0	0.0	0.0	100.0
MAV	4.0		8.1	39.9	48.1	0.0	0.0	100.0

Source: Consultant's analysis

It is evident that passenger and goods vehicles have different trip characteristics.

5.6.3 Analysis of Turning Movement Count Survey

Turning movement count survey was conducted at six major intersections along the project road. The 24 Hour Classified Traffic Volume Count, Peak Hour Traffic and flow diagrams are presented in Appendices. Peak hour, peak hour PCUs and vehicles are separately provided in given in **Table 5.17**.

Table 5.17 : Peak Hour Traffic

Junction	Type	Peak Hour	Peak Hour Traffic in 2017 (Vehicles)	Peak Hour Traffic in 2017 (PCU)	Total Traffic (PCU)
Km39+500 of NH-29	4 Leg	10am - 11am	863	987	12814
Km 85+400 of NH-29	3 Leg	8am - 9am	380	413	4889
Km 128+300 of NH-29	4 Leg	5pm - 6pm	641	664	8533

5.6.4 Analysis of Speed and Delay Survey

The survey was conducted by adopting the Floating car or riding check method. The test vehicle was driven along the project corridor at the perceptible average speed of traffic stream. Observers traveling in the test vehicle noted the number of vehicles overtaking the test vehicle, number of vehicles overtaken by the test vehicle, number of vehicles travelling in direction opposite to the test vehicle, delay time at different locations, journey time. Analysis of speed-delay survey data is provided in **Appendix-5.1**.

5.6.5 Analysis of Axle Load Survey

Summary of VDF as obtained from axle load survey is presented in Chapter 4 of this report.

5.7 Traffic Forecast

Investment priorities are governed by the traffic demand, assessed benefits and cost of the project. Demand plays the important role, governing which type of facility / infrastructure needs to be created. A highway project of this nature calls for significant investment. Thus prediction of traffic demand becomes an important task which necessitates realistic estimation of traffic growth rates. Accurate estimation of traffic has direct bearing on the viability of the project. Recognizing this, efforts need to be made to carefully assess all the parameters that help in predicting the traffic demand. Transport demand changes due to shifts in the pattern of economic activities in the surrounding regions. Hence, traffic estimation necessitates a preview of the probable pattern of future growth of the economy. In this project, traffic growth rates have been estimated using elasticity method as per IRC: 108.

5.7.1 Past Vehicle Registration Details

It is revealed from OD survey that traffic in the project stretch is mainly influenced by Assam and also by Nagaland to some extent. For establishing traffic growth rates, economic data of Assam and Nagaland state have been considered. The vehicle registration data of Assam and Nagaland are presented in **Table 5.18**.

Table 5.18: Past Vehicle Registration Data of Assam and Nagaland

Year	Car / Jeeps	Two Wheelers	Bus	Commercial Vehicles
Assam				
2012-13	49,611	145,010	1,091	222,942
2013-14	48,513	167,602	1,102	243,780
2014-15	57,085	189,102	1,109	282,709
2015-16	28,118	206,135	1,556	188,144
2016-17	63,891	203,413	1,419	252,350
CAGR	6.5	8.8	6.8	3.1
Nagaland				
2013-14	128,597	70,873	6,876	108,689
2014-15	134,210	75,158	6,919	114,120
2015-16	146,398	81,482	7,268	139,202
CAGR	6.7	7.2	2.8	13.2

Source: India Stat Organization, Central Statistical Organization and various websites of state governments

5.7.2 Past Growth of the Economy

Growth of traffic on the project road is influenced by the existing development and future growth prospects of the project influence area (PIA). The time series data of state income NSDP at constant prices, state population, and per-capita income of PIA states have been collected and analyzed to assess the past performance of the influencing state economies.

Table 5.19 and **Table 5.20** depicts these economic indicators.

Table 5.19: Economic Indices of Assam at Constant Prices (2011-2012)

Year	Indices of Assam		
	NSDP	PCI	Population
2012-13	13,251,760	46,247	30,945,000
2013-14	13,872,476	49,339	31,319,000
2014-15	14,931,269	52,601	31,693,000
2015-16	16,072,406	56,003	32,069,000
2016-17	17,892,900	60,126	32,132,440
CAGR	7.8	6.8	0.95

Source: of www.indiastat.com, Office of the Registrar General & Census Commissioner, ministry of statistics and programme implementation and various websites of state governments

Table 5.20: Economic Indices of Nagaland at Constant Prices (2004-2005)

Year	Indices of Nagaland		
	NSDP	PCI	Population
2013-14	988,690	49,962	2,700,000
2014-15	1,052,220	51,887	2,860,000
2015-16	1,120,253	61,363	2,920,000
CAGR	6.4	10.8	4.0

Source: of www.indiastat.com, Office of the Registrar General & Census Commissioner, ministry of statistics and programme implementation and various websites of state governments

5.7.3 Transport Demand Elasticity

As discussed earlier, the elasticity approach has been used for determining growth rates of future traffic. Since time series traffic data on project road is not available, traffic growth rates and elasticity values are established by using registered vehicles by type as the dependent variables and economic parameters as independent variables.

5.7.4 Description of Regression Analysis

The Regression Analysis tool performs linear regression analysis by using the "least squares" method to fit a line through a set of observations. It analyzes how a single dependent variable is affected by the values of one or more independent variables. In the present case, registered vehicles by type are the dependent variables whereas the economic parameters are independent variables. Regression analysis is carried out by creating econometric models suggested in IRC: 108. The explanatory variable used for different vehicle categories and the elasticity coefficient for each vehicle class obtained from Regression Analysis are presented in **Table 5.21**.

5.7.5 Traffic Forecasting Methodology

Growth rates of a vehicle class 'a' in a particular state 'i' is calculated from Eqn (a).

$$G_{ai} = R_i \times E_{ai} \dots\dots\dots \text{Eqn (a)}$$

Where

G_{ai} = growth rates of vehicle class 'a' in state 'i'

R_i = Growth rate of economic indicator in state 'i'

E_{ai} = elasticity coefficient for vehicle class 'a' in state 'i'

Traffic growth rates for Assam and Nagaland calculated from Regression Analysis is presented in **Table 5.21**.

Table 5.21: Traffic Growth Rate for Assam and Nagaland calculated from Regression Analysis

Mode	Explanatory Variable (EV)	Average Growth Rate of EV	Elasticity	Growth Rate of Vehicle (%)	Correlation Coefficient
Assam					
Two-Wheeler	PCI	6.8	1.35	9.14	0.94
Car	PCI	6.8	0.004	0.03	0.001
Bus	Population	0.9	8.83	8.36	0.84
Trucks	NSDP	7.8	0.002	0.016	0.002
Nagaland					
Two-Wheeler	PCI	11.06	0.62	6.84	0.97

Mode	Explanatory Variable (EV)	Average Growth Rate of EV	Elasticity	Growth Rate of Vehicle (%)	Correlation Coefficient
Assam					
Car	PCI	11.06	0.60	6.60	0.99
Bus	Population	4.01	0.58	2.32	0.77
Trucks	NSDP	6.45	1.98	12.77	0.94

Source: Consultant's analysis

Growth rate of a vehicle class for the project is given by

$$G_{ap} = \sum G_{ai} \times I_{ai}$$

where G_{ap} = growth rate of vehicle class 'a' for the project

G_{ai} = growth rates of vehicle class 'a' in state 'i'

I_{ai} = influence factor for vehicle class 'a' in state 'i'.

The Influence Factor for different states is estimated from OD survey analysis.

5.7.6 Traffic Growth Rates

Based on past trend of economic performance, development potential and development thrust in the region three traffic growth scenarios are envisaged. Traffic growth rates for the most likely scenario, optimistic scenario and pessimistic scenario are presented in **Table 5.22-5.24**.

Table 5.22: Traffic Growth Rates in Most Likely Scenario

S.No.	Year	2/3 Wheeler	Car	Bus	LCV/2 Axle Truck	3 Axle Truck	MAV
1	2018-2020	8.7	7.7	7.7	7.2	7.0	7.0
2	2021-2025	8.6	7.6	7.5	7.2	6.8	6.8
3	2026-2030	7.8	6.3	5.8	6.2	5.8	5.8
4	Beyond 2030	6.8	5.5	5.2	5.6	4.8	4.8

Source: Consultant's analysis

Table 5.23: Traffic Growth Rates in Optimistic Scenario

S.No.	Year	Two Wheeler/Three Wheeler	Car	Bus	LCV/2 Axle Truck	3 Axle Truck	MAV
1	2018-2020	10.7	9.7	9.7	9.2	9.0	9.0
2	2021-2025	10.6	9.6	9.5	9.2	8.8	8.8
3	2026-2030	9.8	8.3	7.8	8.2	7.8	7.8
4	Beyond 2030	8.8	7.5	7.2	7.6	6.8	6.8

Source: Consultant's analysis

Table 5.24: Traffic Growth Rates in Pessimistic Scenario

S.No.	Year	Two Wheeler/Three Wheeler	Car	Bus	LCV/2 Axle Truck	3 Axle Truck	MAV
1	2018-2020	6.7	5.7	5.7	5.2	5.0	5.0
2	2021-2025	6.6	5.6	5.5	5.2	4.8	4.8
3	2026-2030	5.8	4.3	3.8	4.2	3.8	3.8
4	Beyond 2030	4.8	3.5	3.2	3.6	2.8	2.8

Source: Consultant's analysis

The slow moving vehicles essentially cater to short haul traffic, meeting localised demand for transportation. Non-motorised traffic will be gradually replaced by motorised vehicles with economic improvement. Therefore nonmotorized vehicles are expected to decline by a negative growth rate of -2% per annum. Growth rates of tractors have been considered at 2% per annum.

5.7.7 Diverted Traffic

A study of the road network reveals that diversion of traffic from or to the project road is not expected.

5.7.8 Generated Traffic

No proposed industrial development is reported in the project area. Hence generated traffic is not considered.

5.7.9 Total Traffic

Total traffic is the sum of normal, diverted and generated traffic. As explained above diverted and generated traffic are not considered in this project. Hence Total traffic equals Normal traffic.

5.7.10 Traffic Projection

Based on the traffic growth rates estimated, the existing traffic volume (expressed in AADT) was projected for thirty years of operation. The final projected traffic for the project road section for a particular year is the sum of projected normal traffic using the estimated rate of growth, diverted traffic and generated traffic. As diverted and generated traffic are not considered in this project, Total traffic equals Normal traffic.

Table 5.25 presents the total traffic on homogeneous sections for the cardinal years considering traffic growth rates presented in **Table 5.23** (Optimistic Scenario).

Table 5.25: Total Traffic on Project Road Stretch (in PCU) (Optimistic Scenario)

Year	2018	2020	2025	2030	2035	2040	2045	2050
Total Traffic (PCU)	7184	8515	13155	19628	28433	41385	60442	88503

Source: Consultant's analysis

Year wise projected traffic for optimistic scenario is presented in Appendix.

Table 5.26 presents the total traffic on homogeneous sections for the cardinal years considering traffic growth rates presented in **Table 5-24** (Pessimistic Scenario)

Table 5.26: Total Traffic on Project Road Stretch (in PCU) (Pessimistic Scenario)

Year	2018	2020	2025	2030	2035	2040	2045	2050
Total Traffic (PCU)	7184	7951	10278	12743	15285	18400	22216	26892

Year wise projected traffic for pessimistic scenario is presented in Appendix.

Table 5-27 presents the total traffic on homogeneous sections for the cardinal years considering traffic growth rates presented in **Table 5-22** (Most Likely Scenario)

Table 5.27: Total Traffic on Project Road Stretch (in PCU) (Most Likely Scenario)

Year	2018	2020	2025	2030	2035	2040	2045	2050
Total Traffic (PCU)	7184	8231	11636	15834	20883	27661	36761	48986

5.8 Capacity Analysis

As per IRC SP73-2015, the traffic volume at which upgradation from two lane to four lane will trigger is presented in **Table 5.26**.

Table 5.26: Design Service Volume of Two Lane Highway (PCU/day)

Terrain	Design service Volume (PCU/day)
Plain	18,000
Rolling	13,000
Mountainous and Steep	9,000

Source: IRC SP73-2015

However, this has been superseded by MoRT&H Circular No. F.No. RW/NH-33044/37/2015/S&R(R) dated 26.05.16. As per this circular, the traffic at which the upgradation from two lane to four lane will trigger has been revised as indicated in **Table 5.27**.

Table 5.34: Design Service Volume Standards for Four Lane Facility

Nature of Terrain	Traffic at which up gradation to four lane will trigger (in PCU per Day)
	Clause No - 4
Plain	10,000
Rolling	8500
Mountainous / Steep	6000

Source: MoRT&H Circular

5.9 Recommendation

Based on traffic projection the year in which up gradation to four lane will trigger for the respective homogeneous sections is presented in **Table 5.28**.

Table 5.28: Year in which Up gradation to Four Lane Will Trigger

Homogeneous Section	Existing Chainage	Traffic in Base Year in PCU	Traffic in Year of Opening (2023) in PCU	Year in which up gradation to four lane will trigger
HS1	Km 39.5 of NH-29 to Km 85.4 of NH-29	6627	8704	2024
HS2	Km 85.4 of NH-29 to Km 128.3 of NH-29	7184	9438	2023
HS3	Km 128.3 of NH-29 to Km 157.4 of NH-29	5500	7229	2027

Source: Consultant's analysis

Recommendation for immediate development is provided in **Table 5.29**.

Table 5.29: Recommendation for Immediate Development

Road Segment	Homogeneous Section	Existing Chainage	Recommendation	Remarks
NH-29	HS1	Km 39.5 to Km 85.4	4-Lane with paved shoulder	<ul style="list-style-type: none"> Major connectivity from Nagaland, Manipur with Guwahati. Traffic of 9438 PCU in the year of opening (2022) is close to 10000 PCU i.e. Design Service Volume Standards for four lane facility.
	HS2	Km 85.4 to Km 128.3		
	HS3	Km 128.3 to Km 157.4		

Chapter 6 : Development Proposals

CHAPTER 6

DEVELOPMENT PROPOSALS

6.0 Development Proposals

6.1 General

The salient proposals for up-gradation and improvement of the project road are classified into the following engineering aspects:

Where Proposed Alignment Overlaps with Existing Roads

- In general, in this section of proposed stretch follows existing Sections except at Dokmoka where bypass is being proposed.
- Widening of the project road based on traffic capacity/requirement.
- Improving the horizontal geometry of the existing road based on the design standards as per IRC:SP:84-2019
- Design of new pavement for widening and realignment of the existing road.
- Provision of overlay at strengthening stretches.
- Improvement of all major and minor intersections.
- Rehabilitation and widening of the existing structures including bridges, culverts etc. and design of new ones as per requirement.
- Provision of comprehensive road furniture for complete road safety measures.

6.2 Geometric Improvement

6.2.1 Codes and Guidelines

The design criteria / method applied for important components of the project are as follows:

Geometric Design : IRC: SP: 84-2019 Manual of Specification & Standards for Four Laning of Highways with Paved Shoulder
IRC: 73-1980 Geometric design standard for rural highways
IRC and other relevant IRC Codes and guidelines on Geometric design.

Pavement Design : Overlay
- IRC 115-2014 for designing and strengthening requirements of existing pavement

New Pavement

- IRC 37-2018 for design of flexible pavements
- IRC 58-2015 for design of rigid pavements

Road Furniture & : Related standards of IRC Manual of Specification &
 Roadside Facilities MoRT&H publications

The Codes and references as per the following table are followed for the Design of the structures for the project stretch.

IRC:5-2015	Standard Specification & Code of Practice for Road Bridges, Section I- General Features of Design (7th Revision)
IRC:6-2017	Standard Specifications & Code of Practice for Road Bridges, Section II- Loads & Stresses (Fourth Revision)
IRC:78-2014	Standard Specifications & Code of Practice for Road Bridges, Section VII- (Foundations & Substructure Second Revision)
IRC:83-2015	Standard Specifications & Code of Practice for Road Bridges, (Part II Section IX- Elastomeric Bearings, Part-III: POTPOT-CUM-PTFE, PIN AND METALLIC GUIDE BEARING)
IRC:112-2011	Code of Practice for Concrete Road Bridges
IRC: SP:69-2005	Guidelines & Specifications for Expansion Joints
MORTH	Specification for Road and Bridge Works- 2013 (Ministry of Road Transport & Highways)
IS:1786-1985	High Strength Deformed Steel Bars and Wires for Concrete Reinforcement
IS: 800:2007	General Construction in Steel - Code of Practice
IS:432-1982	Mild Steel & Medium Tensile Steel Bar and Hard-Drawn Steel Wire for Concrete Reinforcement : Part I- Mild Steel and Medium Tensile Steel Bars
IS:2062-2011	Hot Rolled Medium and High Structural Steel-Specifications.
IS:2911 (Part-I/ Sec 2)	Design and Construction of Pile Foundation-Concrete Piles Bored Cast-in- situ
IS:2911 (Part-IV)	Load Test of Piles
IS:14268-1995	Uncoated Stress Relieved Low Relaxation Seven-Ply Strands for Pre-stressed Concrete
IS:2502-1963	Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement
IS:13920-1993	Ductile Detailing

6.2.2 Design Concept

Following points have been considered during preparation of layout at this stage:

- Minimum curvature as compatible to 100 to 80 kmph design speed, in general at normal section;
- Safe distance from village limits to avoid acquisition of structures as far as possible;
- Safe distance from religious structures and other sensitive features like schools, Govt./Pvt. properties etc. as far as possible;
- Safe distance from designated water bodies as far as possible;
- Safe distance from flood prone zones;
- Crossing of rivers, streams with minimum skew angle;
- Safe distance from water logged areas as far as possible;
- Sufficient embankment heights as well as proper protection works like pitching / chutes have been considered, where it was unavoidable to pass through low lands / submerged areas. HFL / HWL were enquired from site and accordingly proposals have been framed.
- Efficiency and Comfort in Vehicle Operation
- Access Control

The design philosophy basically involves providing suitable horizontal alignment, longitudinal section, cross section layout, and safety and access control to cater to the fast and uninterrupted movement of through traffic.

6.2.3 Geometric Design Standards

This project is essentially widening the existing standard/sub-standard 2-lane road to 4-lane with paved shoulder as the alignment follows predominantly existing roads. The geometric designs are as per recommendations of IRC: SP: 84-2019. The general design standards for improvement are enumerated in **Table 6.1**.

Table 6.1: Geometric Design Standards for Road Works (Plain/Rolling Terrain)

SI No.	Attributes	Geometric Design Standards
1	Design Speed	
	Plain and Rolling Terrain (Cross slope of the ground upto 25per cent)	Ruling: 100 kmph Minimum: 80 kmph
2	Carriageway Width	For four lane: 2 x 7.0m with 0.5 m Kerb shyness at either side
3	Width of Shoulder	
	a) Paved Shoulder	2 x 2.5 m
	b) Earthen Shoulder	1.5 m
4	Footpath width at built-up areas	2 x 1.5 m drain cum footpath
5	Camber	

SI No.	Attributes	Geometric Design Standards
	a) Carriageway	2.5%
	b) Shoulder	3.0%
6	Maximum and Minimum Super-elevation	Maximum limited to 7.0% (for Radius less than Desirable minimum) Minimum limited to 5% (for Radius more than Desirable minimum)
7	Minimum Radius of Horizontal Curves	
	a) Plain and rolling Terrain	Desirable Minimum: 400m Absolute Minimum: 250m
8	Sight Distances for Various Speeds	180m – 360m
9	Longitudinal Gradient	
	a) Plain and Rolling Terrain	Ruling: 2.5%, Limiting: 3.3%
10	Extra Width of Pavement	
	Radius of Curve	Extra Width
	75-100m	0.9m
	101-300m	0.6m

6.2.4 Widening Proposal

The majority of the stretch is proposed with eccentric widening as the 2-lane with paved shoulder configuration is present almost all along the stretch. The concentric widening is proposed at the built-up locations. At dense built –up location bypass is proposed.

6.2.5 Cross-section for Improved Facility

Cross-section for the improved facility should be adequate to cater to the traffic expected over the design period and offer safe and convenient traffic operation at speeds consistent with the terrain conditions and functional classification of this road.

The cross-sectional elements (lane/shoulder width etc.) are as per standards specified in geometric design manual. Eight nos. typical cross sections have been envisaged for the subject project at this stage as mentioned below. These have been prepared on the basis of site reconnaissance and design guidelines.

TYPE –1	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN IN RURAL AREA (CONCENTRIC WIDENING)
TYPE –1A	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN IN BYPASS/REALIGNMENT STRETCHES
TYPE –2	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN IN RURAL AREA (ECCENTRIC WIDENING)
TYPE –3	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE

Type-4	RAISED MEDIAN AND WITH SERVICE ROAD ON BOTH SIDES IN BUILT UP AREA. TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN INFOREST AREA (CONCENTRIC WIDENING).
Type-4A	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN INFOREST AREA (ECCENTRIC WIDENING).
Type-5	TYPICALCROSS SECTION OF APPROACHES OF ELEPHANT UNDERPASSES (FOREST AREA).
Type-6	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN INFOREST AREA (NEW CONSTRUCTION).
Type-7	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY AT GRADE SEPARATOR APPROACHES WITH SERVICE ROAD AND RE WALL ON BOTH SIDES
Type-8	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN (NEW CONSTRUCTION) IN CUT SECTION ONE SIDE (MOUNTAINOUS TERRAIN ONE SIDE - HILL AND ONE SIDE - VALLEY)
Type-8A	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN (NEW CONSTRUCTION) IN CUT SECTION ONE SIDE(MOUNTAINOUS TERRAIN ONE SIDE - HILL AND ONE SIDE - VALLEY)
Type-9	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN(NEW CONSTRUCTION) IN CUT SECTION BOTH SIDE

Typical cross sections for the project road are presented in **Annexure 6.1& 6.6**. Summary of cross sections is shown in **Table 6.2**.

Table 6.2: Summary of Cross Sections For Section-6+7 (km 113+830 to km 145+712):

TCS	Description	Length (m)
TCS-1	Typical Cross Section of 4-Lane Divided Carriageway with 1.5m Wide Raised Median in Rural Area (Concentric Widening)	1640
TCS-1A	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN IN BYPASS/REALIGNMENT STRETCHES	9163.7
TCS-2	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN IN RURAL AREA (ECCENTRIC WIDENING)	13723.6
TCS-8	Typical Cross Section Of 4-Lane Divided Carriageway With 1.5m Wide Raised Median (Eccentric Widening) In Cut Section (Mountainous Terrain, One Side - Hill And One Side - Valley)	2852.0
TCS-8A	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN (NEW CONSTRUCTION) IN CUT SECTION ONE SIDE(MOUNTAINOUS TERRAIN ONE SIDE - HILL AND ONE SIDE - VALLEY)	930
TCS-9	TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN(NEW CONSTRUCTION) IN CUT SECTION BOTH SIDE	2500
	Toll plaza	700.0
STR	Structure (MJB/MNB)	373.7
	Total length	31883

6.2.6 Cross-section for Bridges, Culverts and Other Structures

Cross section for bridges, culverts and other structures shall be as per relevant guidelines of IRC: SP-84-2019. In general, full roadway width will be proposed between the outer to outer face of crash barrier/ parapet for culverts. General 4 or 6 lane configurations for bridges/culverts/other structures are provided in **Table 6.3**.

Table 6.3: General Structural Configuration

Type of Structure	Width of Structural Components for One Direction (m)					Reference
	C/W	FP	CB	Railing	Overall	
4-Lane Bridge	10.5	1.5	2x0.55	0.4	13.5	Fig. 7.2A of IRC: SP:84-2019
6-Lane Bridge	14.0	1.5	2x0.55	0.4	17.0	Fig. 7.3 of IRC: SP:84-2019
6-Lane Gr. Separator	14.0	-	2x0.55	-	15.1	Fig. 7.8 of IRC: SP:84-2019

The overall width of culverts for 4 and 6 lane configurations shall be 2x11.0m+Median and 2x12.05m+Median (as per Fig. 7.1A and Fig. 7.1B of IRC: SP: 84-2014).

Thickness of wearing course shall be 65 mm (40 mm BC + 25 mm mastic asphalt).

6.2.7 Horizontal Alignment

The geometric design has been done within the broad framework of design specifications. The design speed adopted is 80-100kmph as far as possible, with an allowable maximum super elevation of 5%, in general. While designing, utmost attempt has been made to avoid acquisition of residential as well as commercial / religious / historic structures. Details of horizontal curves proposed along project road is given in **Annexure 6.2**. Design of horizontal alignment has been done separately for three sections.

Extra widening for horizontal curves with radius $\leq 300\text{m}$ has been considered as clause 2.7.2 of IRC: SP: 84-2019.

6.2.8 Vertical Alignment

The existing vertical geometry is generally good except at few stretches where inadequate sight distance has been observed. The longitudinal grade of the project road is generally within the limits, in general it has been kept as it is with necessary corrections/strengthening/profile corrective courses. However, at the existing submersible bridge locations, the vertical profile shall be raised as per codal provisions. Longitudinal gradient of the proposed profile shall be followed as per prevailing standards. The details of the proposed curves is presented in **Annexure-6.3**.

6.2.9 Proposal for Built-up Areas

Proposed alignment basically follows the Manja Bypass. Considering this for future development, TCS Type-3 have been proposed at Built up locations. The details of which are provided in in **Table 6.4**.

Table 6.4: Stretches with Footpaths and Covered Drains

SI No.	Design Chainage (km)		Length (m)	Village
	From	To		
Daboka – Lahorijan Road (NH 29)				
Section 6+7				
NIL				

6.2.10 Proposal for Forest Areas

Some part of the project road is passing through the reserve forest under Daboka – Lahorijan section. A list showing the forest stretches is presented in **Table 6.5**.

Table 6.5: List of Forest Stretches

Sl No.	Design Chainage (km)		Length (m)	Forest Name
	From	To		
Daboka – Lahorijan (NH 29)				
Section 6+7				
NIL				

6.2.11 Realignments

The proposed alignment is mostly overlapping with the existing with geometric improvement. **Table 6.6** provides the list realignment stretches where the proposed alignment does not overlap with the existing roads.

Table 6.6: List of Stretches with Realignments

drain	Design Chainage (km)		Length (m)	TCS	Remarks
	From	To			
Daboka – Lahorijan Road (NH 29)					
Section 6+7					
1	114+470	114+590	120	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
2	114+700	114+890	190	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
3	114+940	115+170	230	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
4	115+850	115+980	130	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
5	116+180	116+500	320	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment

drain	Design Chainage (km)		Length (m)	TCS	Remarks
	From	To			
6	117+120	117+260	140	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
7	117+570	117+710	140	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
8	117+810	118+150	340	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
9	118+250	118+420	170	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
10	118+830	119+840	1010	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
11	120+750	121+100	350	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
12	121+330	121+470	140	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
13	123+150	123+650	500	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
14	130+840	130+990	150	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
15	132900	133200	300	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
16	134291.8	134430	138.2	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
17	134430	134550	120	8A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in Cut Section (Realignment)
18	134700	134900	200	8A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in Cut Section (Realignment)
19	136900	136950	50	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
20	136950	137220	270	9	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in Cut Section (New Construction)
21	137220	137500	280	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
22	139000	139150	150	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
23	139150	139200	50	8A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
24	139430	139550	120	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
25	139800	139904.3	104.3	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
26	139926.8	140100	173.2	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
27	140500	140600	100	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment

drain	Design Chainage (km)		Length (m)	TCS	Remarks
	From	To			
28	140600	140750	150	8A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
29	141030	141200	170	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
30	143500	143616	116	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
31	143624	143800	176	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
32	144400	144530	130	8A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
33	144530	144700	170	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
34	145150	145200	50	9	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
35	145200	145350	150	9	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
36	145350	145550	200	1A	4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment

6.3 Drainage

Due consideration has been given to drainage while preparing the design. The cross-sections incorporating roadside drains have been proposed at various stretches of the highway taking into account the existing and natural conditions as well as anticipated situation. At super elevated sections with raised median, rectangular cross median drains have been considered @10m interval to facilitate drainage from outer carriageway to the inner carriageway. Earthen toe drain is considered on both sides of the road for all along the stretch. The details are provided below:

Type of Drain	Side	Total Length including both side (m)	Applicable TCSs
Section-6+7			
Unlined Trapezoidal Drains	Both	49052.6	TCS – 1,1A,2,4,4A,5,6
Lined Trapezoidal Drains	Hill	3502	TCS – 8,8A
Lined Trapezoidal Drains	Both	5280	TCS – 8, 8A, 9
RCC covered drain	Both	1400	Toll plaza location

6.4 Bridges, Culverts and Other Structures

Bridge and CD Structures

Bridges and other Cross Drainage (CD) structures are the vital infrastructure elements of a highway network. Maintaining serviceability of bridges and other CD structures, consequently retaining their level of reliability during their lifetime therefore deserves high priority from

techno-economic considerations. While bridges and structures are integral to the envisaged development of the Project Road, a comprehensive inventory and condition surveys is pivotal for an assessment of functional and operational adequacies of the existing structures. In turn such an assessment forms the basis for zeroing on to rehabilitation/widening, reconstruction and new-construction requirements.

A detailed condition survey along with visual inspection of the existing structures has been carried out by the concerned key professionals to assess and ascertain the existing condition/ characteristics of the bridges and other CD structures. Inventory of bridges has been prepared based on the condition survey, which consists of recording relevant technical data for each bridge, such as name, location, length, type of material, carriageway width, type of structure etc.

The existing road consists of 2 major bridges, 5 nos. minor bridges and 24 nos. culverts.

The summary of existing structures is presented in the **Table 6.7**.

Table 6.7 : Summary of Existing Structures

Sections	Road Segment	No. of Existing Structures					Total
		MJB	MNB	UP	ROB	Culvert	
Section-6+7	Km 113+300 (Kwaram taro) to Km 146+230 (Dilai)	2	13	-	-	63	78

During condition survey of these structures it was observed that all minor bridges are in good-fair and can be retained. The culverts found are overall in fair condition. Bed protection is to be provided for the Slab, Box and HP culverts.

Condition Assessment Surveys

Inventory and condition survey report have been prepared with the objective to verify the form of construction, the dimensions of the structure, the nature and condition of the structural components, etc. to assess necessary information on which decision would be made for carrying repairs, strengthening, widening, replacement of the structural part or rebuilding of the bridge and culverts. Inspection covered not only the condition of individual components but also the condition of the structure as an entity, especially noting signs of distress, if any, and its cause to ascertain long-term remedial measures to provide assurance that the bridge is structurally safe and fit for its designed use.

Inspection was not confined to only searching of defects that are existing, but also included the range of anticipating problems and recognizing these areas. During and following the inspection, it was aimed to determine the cause to prevent the repetition and spread of the deterioration.

Checklist for Visual Inspection

The reasons for deterioration are either physical or chemical process, which cause visible signs of damage. Therefore, during inspection, the following signs of deterioration were particularly noted at locations indicated in **Table 6.5**.

Table 6.8: Signs of Deterioration

Locations	Deterioration
All over	<ul style="list-style-type: none"> General condition of the structure and pre-stressed components in particular Condition of concrete/masonry Honeycombing Scaling of concrete Efflorescence Cracks Corrosion signs Spalling of concrete Condition of construction joints
Top and bottom of deck slab	<ul style="list-style-type: none"> Cracks Worn out wearing coat Leaching Damage due to accident or any other causes De-lamination Seepage Scaling Blocking of drainage Corrosion signs
Steel girders	<ul style="list-style-type: none"> Pitting Loss of Camber Painting condition Deformation Loose rivet Cracks and bends in flanges/webs
Support point of bearings	<ul style="list-style-type: none"> Whether the seating of girder over bearing is uniform Condition of anchor bolts, if any Spalling/crushing/cracking around bearing support
Webs of girders	<ul style="list-style-type: none"> Cracks Corrosion signs
Junction of slab and girder	<ul style="list-style-type: none"> Separation
Drainage spouts	<ul style="list-style-type: none"> Whether provided Adequacy of projection of spout on the underside Clogging Physical condition
Joints in precast construction	<ul style="list-style-type: none"> Separation Physical appearance
Expansion joints	<ul style="list-style-type: none"> Check whether the expansion joint is free to expand and contract Hardening/cracking of bitumen filler Condition of sliding plates – check for corrosion, damage of welds, etc. Debris in joints Alignment checking Distortion
Elastomeric Bearing:	<ul style="list-style-type: none"> Whether the bearing is free to move/rotate in different directions as envisaged in design Whether the bearings are fully and evenly seated Whether all the bearings are at same level Physical condition Cleanliness Flattening of bearings

Locations	Deterioration
	<ul style="list-style-type: none"> Splitting/tearing Bulging Oxidation Non uniform thickness other than that which may be the result of normal rotation Displacement (longitudinal or lateral) from original position Whether correct operation of the bearings is prevented or impaired by structural members built into abutment or pier.
Piers, Abutments, Retaining Walls and Wing Walls	<ul style="list-style-type: none"> Tilting and rotation, in any direction Rocking Cracking, splitting and spalling Erosion beneath water level Weathering and material deterioration, including lack of pointing for masonry Growth of vegetation Lack of effective drainage Internal scour, and leaching of fill Settlement of fill
Waterway	<ul style="list-style-type: none"> Width of Waterway Observed Scour Depth Crossing Angle Evidence of Submergence, if any Flow Direction Any obstruction to the free flow Vertical clearance
Parapet/ Railing, Wearing coat, Drainage spout, Utility lines, Floor protection, Approach slab and Embankment slope protection	
<ul style="list-style-type: none"> Whether provided Physical condition Material type 	

General Recommendations

Recommendation on structure includes widening, repair and reconstruction/ new construction of bridges and other cross drainage structures depend on its present structural condition, available width of carriageway, history/ past record of submergence of the existing structures & highway geometry.

Existing bridges having deck width less than 13.5m but in good condition, are proposed for widening to 13.5m deck width and those having the width more than 13.5m and in good condition are proposed to be retained with repair & rehabilitation measures to the existing bridge.

Since the structures are proposed for 4 lanes with shoulder, total width of 2x11m is proposed for slab culverts & pipe culverts depending upon road cross-section. However, the existing railing will be replaced with RCC crash barrier by chipping the edge of deck and exposing the reinforcement and then casting the RCC crash barrier in case of slab culverts.

Culverts: -

- The culverts proposed to be reconstructed are mainly for very poor structural condition in case of slab or arch culverts by Box culverts
- For slab culverts widening is to be done up to the overall width of the road with Box culvert of same span.

- All existing Hume Pipe culverts having vent opening less than 0.9 m shall be replaced with 1.2m diameter pipes.
- All new construction/reconstruction of Hume Pipe culverts is to be done by 1.2m diameter pipe.

Rehabilitation Scheme of Existing Structures

Rehabilitation measures for existing bridges have been recommended aiming at improving its structural adequacy and life span of the bridge. The basic measures taken into repair and rehabilitation are listed below:

- Repair of existing scour protection/ bed protection or slope protection (wherever necessary);
- Replacement of wearing coat if needed;
- Providing/repairing of drip course in all existing major and minor bridges;
- Providing/replacing expansion joints in all culverts, minor and major bridges;
- Providing new bearings in structures wherever require;
- Replacement of highly corroded reinforcement;
- Repair of cracks (width $\geq 0.5\text{mm}$) by epoxy injection; Repair of cracks (width $\leq 0.5\text{mm}$) by PMC mortar.
- General Repair / Rehabilitation recommended are given below:

a) Crack Repairs

For cracks smaller than 0.5 mm, high thermo set monomers such as Monopol of Krishna Conchem or equivalent are recommended. For crack between 0.5 mm to 1.0 mm, low viscosity epoxy injects such as 'KP 250/HP 259 of Krishna Conchem or equivalent is recommended. For the cracks more than 1 mm, polymer modified cement grout Rendroc –RG of Fosroc Chemical or equivalent is recommended.

b) Spalling

For minor distress, repair of concrete is carried out with anticorrosive polymer modified mortar such as 'Monoband 2000 of Krishna Conchem or equivalent.

c) Guniting

At places where large area of soffit of deck slab (RCC) is distressed and shows spalling of concrete, corroded and exposed reinforcement, guniting is recommended with the help of Sicken – Gunit

6.4.1 Major Bridges (MJB)

2 nos MJB (new construction) are been proposed for section-6+7.

6.4.2 Minor Bridges

Total 14 nos. minor bridges have been considered for the project road. In which 7 nos. are proposed to be retained with widening and repair. New 2 lane Bridge to be constructed alongside the existing bridges. 6nos MNB have been proposed for new construction & 1 no are proposed to be reconstruction.

Details of minor bridges are provided in **Table 6.9**.

Improvement proposals for proposed bridges are given in **Annexure-6.5**.

Table 6.9 : Details of Bridges Proposed

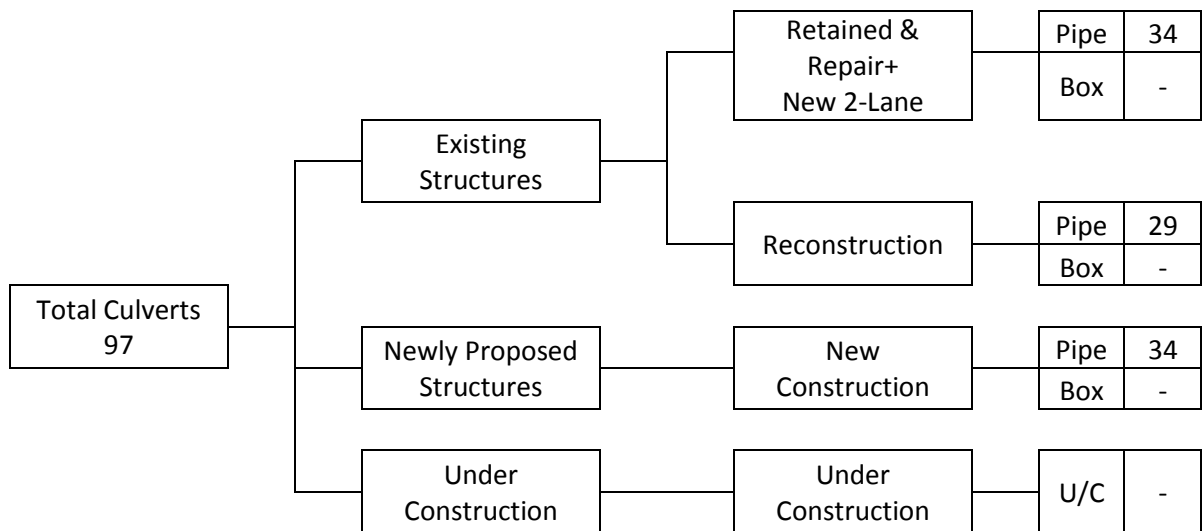
Section Details	Sl. No.	Design Chainage (km)	Proposed Span Arrang (No. of Span x Span length in m)	Proposed Total Length (m)	Width of proposed structure (m)	Proposed Type of Superstructure	Improvement Proposal	Remarks
Section -6+7 km.113+830 to km.145+712	1	116+640	1x10.6	10.6	Widening + 13.5	RCC Box	New 2 lane Bridge	Widened
	2	118+673	1x15.1	15.1	2x13.5	RCC-T-Girder	New 4 lane Bridge	New Construction
	3	119+535	3 x 30	90	2x13.5	PSC I-Girder	New 4 lane Bridge	New Construction
	4	121+200	2x8.9	17.8	Widening + 13.5	RCC Box	New 2 lane Bridge	Widened
	5	126+889	1x7.5	7.5	2x13.5	RCC Box	New 4 lane Bridge	New Construction
	6	128+320	2x7.5	15	2x13.5	RCC Box	New 4 lane Bridge	New Construction
	7	128+727	2x6.0	12	2x13.5	RCC Box	New 4 lane Bridge	New Construction
	8	128+977	3 x 30	90	2x13.5	PSC I-Girder	New 4 lane Bridge	New Construction
	9	131+600	2x7.6	15.2	Widening + 13.5	RCC Box	New 2 lane	Widening
	10	133+205	1x8.0	8	2x13.5	RCC Box	New 4 lane	Reconstruction
	11	134+280	1x23.6	23.6	Retain + 13.5	RCC T-Girder	New 2 lane	Retain & Repair
	12	139+915	1x22.5	22.5	2x13.5	RCC T-Girder	New 4 lane	Realignment
	13	142+195	2x6.1	12.2	Widening + 13.5	RCC Box	New 2 lane	Widening
	14	143+255	2x6.1	12.2	Widening + 13.5	RCC Box	New 2 lane	Widening
	15	143+620	1x8.0	8	2x13.5	RCC Box	New 4 lane	Realignment
	16	144+100	2x7.0	14	Widening + 13.5	RCC Box	New 2 lane	Widening

6.4.3 Culverts

Total 114 nos. of culverts have been considered for the project road as mentioned below:

Section – 6+7 : 97 Nos. of Culverts

Section-6+7: From Km 113+830 (near Kwaram Taro Village) to Km 145+712 (near Dilai)



Improvement schemes for these culverts have been decided on the basis of inventory, condition survey and proposed geometry. Details of widening and retain & repair for the culverts are provided in **Table 6.10**.

Table 6.10: Details of Culverts with Retain and Repair Plus New 2-Lane

Sl. No.	Design Chainage (km)	Type of Existing Culvert	Existing Span Arrangement/Dia. (m)	Type of Proposed Culvert	Proposed Span Arrangement (m)	Improvement Proposal	Remarks
1	113+935	Pipe Culvert	1x1.2	Pipe Culvert	1x1.2	New 2Lane	Ext. Retain
2	114+820	HP Culvert	1x1.2	Pipe Culvert	1x1.2	New 2Lane	Ext. Retain
3	116+770	HP Culvert	1x1.2	Pipe Culvert	1x1.2	New 2Lane	Ext. Retain
4	121+520	HP Culvert	1x1.2	Pipe Culvert	1x1.2	New 2Lane	Ext. Retain
5	124+740	HP Culvert	1x1.2	Pipe Culvert	1x1.2	New 2Lane	Ext. Retain
6	124+980	HP Culvert	1x1.2	Pipe Culvert	1x1.2	New 2Lane	Ext. Retain
7	125+260	HP Culvert	1x1.2	Pipe Culvert	1x1.2	New 2Lane	Ext. Retain
8	132+160	HP Culvert	1x1.0	Pipe Culvert	1x1.0	New 2Lane	Ext. Retain
9	133+510	HP Culvert	1x1.0	Pipe Culvert	1x1.0	New 2Lane	Ext. Retain
10	133+600	HP Culvert	1x1.0	Pipe Culvert	1x1.0	New 2Lane	Ext. Retain
11	134+530	HP Culvert	1x1.0	Pipe Culvert	1x1.0	New 2Lane	Ext. Retain
12	135+080	HP Culvert	1x1.0	Pipe Culvert	1x1.0	New 2Lane	Ext. Retain

Sl. No.	Design Chainage (km)	Type of Existing Culvert	Existing Span Arrangement/Dia. (m)	Type of Proposed Culvert	Proposed Span Arrangement (m)	Improvement Proposal	Remarks
13	135+310	HP Culvert	1x1.0	Pipe Culvert	1x1.0	New 2Lane	Ext. Retain
14	135+810	HP Culvert	1x1.2	Pipe Culvert	1x1.2	New 2Lane	Ext. Retain
15	136+040	HP Culvert	1x1.0	Pipe Culvert	1x1.0	New 2Lane	Ext. Retain
16	136+090	HP Culvert	1x1.2	Pipe Culvert	1x1.2	New 2Lane	Ext. Retain
17	136+400	HP Culvert	1x0.9	Pipe Culvert	1x0.9	New 2Lane	Ext. Retain
18	136+730	HP Culvert	2x1.0	Pipe Culvert	2x1.0	New 2Lane	Ext. Retain
19	136+870	HP Culvert	1x1.0	Pipe Culvert	1x1.0	New 2Lane	Ext. Retain
20	137+610	HP Culvert	1x1.2	Pipe Culvert	1x1.2	New 2Lane	Ext. Retain
21	137+805	HP Culvert	1x1.2	Pipe Culvert	1x1.2	New 2Lane	Ext. Retain
22	138+075	HP Culvert	2x1.0	Pipe Culvert	2x1.0	New 2Lane	Ext. Retain
23	138+120	HP Culvert	1x1.2	Pipe Culvert	1x1.2	New 2Lane	Ext. Retain
24	138+300	HP Culvert	1x1.0	Pipe Culvert	1x1.0	New 2Lane	Ext. Retain
25	138+500	HP Culvert	Under Construction	Pipe Culvert	1x1.2	New 2Lane	Ext. Retain
26	138+840	HP Culvert	1x1.2	Pipe Culvert	1x1.2	New 2Lane	Ext. Retain
27	138+910	HP Culvert	1x1.0	Pipe Culvert	1x1.0	New 2Lane	Ext. Retain
28	139+080	HP Culvert	1x1.2	Pipe Culvert	1x1.2	New 2Lane	Ext. Retain
29	139+420	HP Culvert	1x1.2	Pipe Culvert	1x1.2	New 2Lane	Ext. Retain
30	141+220	HP Culvert	2x1.2	Pipe Culvert	2x1.2	New 2Lane	Ext. Retain
31	141+280	HP Culvert	2x1.2	Pipe Culvert	2x1.2	New 2Lane	Ext. Retain
32	142+050	HP Culvert	1x1.2	Pipe Culvert	1x1.2	New 2Lane	Ext. Retain
33	144+660	HP Culvert	1x1.0	Pipe Culvert	1x1.0	New 2Lane	Ext. Retain
34	145+380	HP Culvert	1x1.0	Pipe Culvert	1x1.0	New 2Lane	Ext. Retain

Table 6.11: Details of New Construction of Culverts

Sl. No.	Design Chainage (km)	Type of Proposed Culvert	Proposed Span Arrangement (m)	Improvement Proposal	Remarks
1	114+570	Pipe Culvert	1x1.2	New 4Lane	New Construction
2	117+660	Pipe Culvert	1x1.2	New 4Lane	New Construction
3	118+060	Pipe Culvert	1x1.2	New 4Lane	New Construction
4	118+390	Pipe Culvert	1x1.2	New 4Lane	New Construction
5	118+660	Pipe Culvert	1x1.2	New 4Lane	New Construction
6	118+850	Pipe Culvert	1x1.2	New 4Lane	New Construction
7	120+510	Pipe Culvert	1x1.2	New 4Lane	New Construction
8	120+900	Pipe Culvert	1x1.2	New 4Lane	New Construction
9	121+330	Pipe Culvert	1x1.2	New 4Lane	New Construction
10	123+300	Pipe Culvert	1x1.2	New 4Lane	New Construction
11	123+540	Pipe Culvert	1x1.2	New 4Lane	New Construction
12	125+960	Pipe Culvert	1x1.2	New 4Lane	New Construction
13	126+220	Pipe Culvert	1x1.2	New 4Lane	New Construction
14	126+570	Pipe Culvert	1x1.2	New 4Lane	New Construction

Sl. No.	Design Chainage (km)	Type of Proposed Culvert	Proposed Span Arrangement (m)	Improvement Proposal	Remarks
15	126+760	Pipe Culvert	1x1.2	New 4Lane	New Construction
16	127+080	Pipe Culvert	1x1.2	New 4Lane	New Construction
17	127+280	Pipe Culvert	1x1.2	New 4Lane	New Construction
18	127+580	Pipe Culvert	1x1.2	New 4Lane	New Construction
19	127+940	Pipe Culvert	1x1.2	New 4Lane	New Construction
20	128+210	Pipe Culvert	1x1.2	New 4Lane	New Construction
21	128+550	Pipe Culvert	1x1.2	New 4Lane	New Construction
22	128+860	Pipe Culvert	1x1.2	New 4Lane	New Construction
23	129+290	Pipe Culvert	1x1.2	New 4Lane	New Construction
24	129+600	Pipe Culvert	1x1.2	New 4Lane	New Construction
25	129+850	Pipe Culvert	1x1.2	New 4Lane	New Construction
26	130+220	Pipe Culvert	1x1.2	New 4Lane	New Construction
27	130+480	Pipe Culvert	1x1.2	New 4Lane	New Construction
28	130+620	Pipe Culvert	1x1.2	New 4Lane	New Construction
29	130+850	Pipe Culvert	1x1.2	New 4Lane	New Construction
30	130+950	Pipe Culvert	1x1.2	New 4Lane	New Construction
31	136+920	Pipe Culvert	1x1.2	New 4Lane	New Construction
32	137+250	Pipe Culvert	1x1.2	New 4Lane	New Construction
33	141+080	Pipe Culvert	2x1.2	New 4Lane	New Construction
34	143+700	Pipe Culvert	3x1.2	New 4Lane	New Construction

Table 6.11A: Details of Reconstruction of Culverts

Sl. No.	Design Chainage (km)	Type of Existing Culvert	Existing Span Arrangement/Dia. (m)	Type of Proposed Culvert	Proposed Span Arrangement (m)	Improvement Proposal	Remarks
1	114+090	HP Culvert	1x0.6	Pipe Culvert	1x1.2	New 4Lane	Reconstruction
2	115+765			Pipe Culvert	1x1.2	New 4Lane	Reconstruction
3	115+920			Pipe Culvert	1x1.2	New 4Lane	Reconstruction
4	115+980	Pipe Culvert	1x0.6	Pipe Culvert	1x1.2	New 4Lane	Reconstruction
5	116+090	Pipe Culvert	1x0.6	Pipe Culvert	1x1.2	New 4Lane	Reconstruction
6	116+340	Pipe Culvert	1x0.6	Pipe Culvert	1x1.2	New 4Lane	Reconstruction
7	116+525			Pipe Culvert	1x1.2	New 4Lane	Reconstruction
8	116+920			Pipe Culvert	1x1.2	New 4Lane	Reconstruction
9	117+350			Pipe Culvert	1x1.2	New 4Lane	Reconstruction
10	117+530			Pipe Culvert	1x1.2	New 4Lane	Reconstruction
11	117+780			Pipe Culvert	1x1.2	New 4Lane	Reconstruction
12	117+920			Pipe Culvert	1x1.2	New 4Lane	Reconstruction
13	118+350			Pipe Culvert	1x1.2	New 4Lane	Reconstruction
14	118+470			Pipe Culvert	1x1.2	New 4Lane	Reconstruction
15	120+000			Pipe Culvert	1x1.2	New 4Lane	Reconstruction
16	120+250			Pipe Culvert	1x1.2	New 4Lane	Reconstruction
17	120+630			Pipe Culvert	1x1.2	New 4Lane	Reconstruction
18	122+340			Pipe Culvert	1x1.2	New 4Lane	Reconstruction

Sl. No.	Design Chainage (km)	Type of Existing Culvert	Existing Span Arrangement/Dia. (m)	Type of Proposed Culvert	Proposed Span Arrangement (m)	Improvement Proposal	Remarks
19	123+060	HP Culvert		Pipe Culvert	1x1.2	New 4Lane	Reconstruction
20	123+600			Pipe Culvert	1x1.2	New 4Lane	Reconstruction
21	123+820	HP Culvert		Pipe Culvert	1x1.2	New 4Lane	Reconstruction
22	124+220	HP Culvert		Pipe Culvert	1x1.2	New 4Lane	Reconstruction
23	124+330	HP Culvert		Pipe Culvert	1x1.2	New 4Lane	Reconstruction
24	135+660	HP Culvert	1x0.6	Pipe Culvert	1x1.2	New 4Lane	Reconstruction
25	136+630	HP Culvert	1x0.6	Pipe Culvert	1x1.2	New 4Lane	Reconstruction
26	139+130	HP Culvert	1x0.6	Pipe Culvert	1x1.2	New 4Lane	Reconstruction
27	141+700	HP Culvert	1x0.6	Pipe Culvert	1x1.2	New 4Lane	Reconstruction
28	141+730	HP Culvert	1x0.6	Pipe Culvert	1x1.2	New 4Lane	Reconstruction
29	143+020	HP Culvert	1x0.6	Pipe Culvert	1x1.2	New 4Lane	Reconstruction

6.4.4 Underpasses

One underpasse has been proposed in this section. Details of these underpasses are provided in **Table 6.12**.

Table 6.12: Details of Underpasses

Sl No.	Type of Underpasses	Design Chainage (km)	Span Arrangement (Nos. x Length in m)	Total Length (m)	Overall Width (m)	Structure Type
Section 6+7						
1	VOP	129+230			12	RCC Box

6.4.5 Rail Over Bridge (ROB)

No ROB are proposed for the road sections.

6.4.6 Flyover

No flyover are proposed for the road sections.

6.4.7 Interchanges

No Interchanges are considered for the road sections.

6.5 Intersection Improvement Proposals

The proposed project road will form a no. of intersections with existing roads. 2 nos. of major intersections shall have to be developed. Improvement of these intersections has been

thought off with minimum of land acquisition. However, proper acceleration and deceleration lanes have been considered with proper traffic signage. In general, standard codal provisions have been followed for design of these intersections. Detail layouts are provided in Drawing Volume. 3 nos. major intersections have been proposed. Besides, there are 35 nos. of minor intersections along the project road which shall be operated as normal left-in and left-out principle. Improvement proposals of major and minor intersections are provided in **Table 6.13**.

Table 6.13a: Improvement Proposals of Major Intersections

Sl. No.	Design Chainage (km)	Type of Intersection	Type	Side	Improvement Proposals
1	125+500	Major	3 - legged	Right	At Grade
2	130+500	Major	3 - legged	Right	At Grade
3	144+940	Major	3 legged	Left	At Grade

Table 6.13b: Improvement Proposals of Minor Intersections

Sl. No.	Design Chainage (km)	Type of Intersection	Type	Side	Improvement Proposals
1	114+000	Minor	3 legged	Right	At Grade
2	114+530	Minor	3 legged	Right	At Grade
3	115+100	Minor	3 legged	Left	At Grade
4	116+500	Minor	3 legged	Left	At Grade
5	116+950	Minor	3 legged	Right	At Grade
6	117+420	Minor	3 legged	Left	At Grade
7	118+200	Minor	3 legged	Left	At Grade
8	119+860	Minor	3 legged	Left	At Grade
9	120+660	Minor	3 legged	Left	At Grade
10	121+300	Minor	3 legged	Right	At Grade
11	121+950	Minor	3 legged	Both	At Grade
12	123+800	Minor	3 legged	Left	At Grade
13	124+000	Minor	3 legged	Right	At Grade
14	124+600	Minor	3 legged	Left	At Grade
15	125+890	Minor	3 legged	Both	At Grade
16	126+850	Minor	3 legged	Both	At Grade
17	129+190	Minor	4 legged	Both	Grade Separated
18	131+480	Minor	3 legged	Right	At Grade
19	131+940	Minor	3 legged	Right	At Grade
20	132+170	Minor	3 legged	Left	At Grade
21	132+880	Minor	3 legged	Left	At Grade
22	133+370	Minor	3 legged	Left	At Grade
23	135+100	Minor	3 legged	Left	At Grade
24	135+640	Minor	3 legged	Left	At Grade

Sl. No.	Design Chainage (km)	Type of Intersection	Type	Side	Improvement Proposals
25	135+770	Minor	3 legged	Left	At Grade
26	139+650	Minor	3 legged	Left	At Grade
27	139+760	Minor	3 legged	Right	At Grade
28	140+680	Minor	3 legged	Left	At Grade
29	140+950	Minor	4 Legged	Both	At Grade
30	141+650	Minor	3 legged	Left	At Grade
31	142+120	Minor	3 legged	Right	At Grade
32	143+480	Minor	4 Legged	Both	At Grade
33	143+950	Minor	3 legged	Left	At Grade
34	144+680	Minor	3 legged	Left	At Grade
35	144+770	Minor	3 legged	Left	At Grade

6.6 Pavement Design

6.6.1 General

The pavement existing on the project stretch is flexible in nature. The project envisages new Two Lane with Paved Shoulder as well as Four Lanes with Paved Shoulder configuration. The general design Procedure for the flexible pavement for the proposed road as new construction of whole stretch as per the guidelines of IRC: 37-2018 – “Guidelines for the design of Flexible Pavements”.

New pavement design is based on the design traffic (MSA) and the subgrade strength (soaked CBR).

6.6.2 Methodology of Pavement Design

Introduction

The flexible pavements are usually referred as a layered structure comprising generally bituminous surface like Bituminous Concrete (BC) and Dense Bituminous Macadam (DBM), Wet Mix Macadam (WMM) base and Granular Sub-Base (GSB) course of finite thickness, resting on subgrade of minimum thickness of 500 mm. The thickness design of these layers principally depends on the subgrade CBR and the traffic loads that the pavement has to carry during its design life. Ideally, the flexible pavement is built to such a depth that stresses on any given layer should not cause unwarranted rutting, fatigue, shoving, or other differential movements which may result in an uneven wearing surface. The chief function of the surfacing course is to provide a smooth wearing surface, resistant to traffic. However, the wearing course can provide some shearing resistance to the base structure and some added resistance to deformation.

Base courses are usually layers of aggregates that must possess high resistance to deformation in order to withstand the higher pressures imposed by wheel loads. High –quality processed aggregates are usually required, which also provide good internal drainage sub bases and generally made up of locally available aggregates, satisfying codal specification/requirements.

The design methodologies widely used for the flexible pavement design are Indian Road Congress (IRC) method, AASHTO methods and Asphalt Institute Method. For this project latest IRC (IRC:37-2018) method is used for designing the flexible pavement. The brief about the method is given below.

IRC: 37-2018 Method of New Flexible Pavement Design

It gives pavement design catalogue for subgrade CBR values ranging from 5% to 15 % and eight levels of design traffic ranging from 5 to 50 MSA. The pavement compositions given in the design catalogues are relevant to Indian conditions, materials and specifications. For higher traffic values, the pavement layer thicknesses are worked out using IITPAVE software.

IRC: 58-2015 Design of Rigid Pavement

IRC: 58-2015 “Guidelines for the design of plain jointed rigid pavements for highways” gives the design of rigid pavements and adopted for designing the rigid pavement for carriageway.

6.6.3 Design of New Flexible Pavement

IRC: 37-2018 method is adopted for the design which is based on the empirical – analytical approach, and provides catalogues for design of flexible pavements. The design inputs required for pavement design are explained as follows.

Design Theory

The pavement design method is based on elastic response of the pavement to traffic stresses (i.e. each of the materials in the pavement structure behaves in an elastic manner). The materials in the pavement are characterized by parameters whose values are determined from field and laboratory testing. The method assumes that failure will not occur as a result of permanent deformation of granular or bound materials (and this assumption will be valid as long as good construction procedures are followed, and the pavement is not subjected to very high wheel loads such as can be caused by a very heavily overloaded vehicle). The method also assumes that loss of pavement serviceability can occur due to:

- fatigue of bitumen bound or cemented layers due to repetitions of tensile strains at the bottom of such layers; and/or
- Permanent deformation of the sub-grade due to repeated vertical compressive strains induced in the sub-grade

The critical locations for pavement failure are therefore the bottom of bitumen bound layers (where tensile strains occur) and the top of the sub-grade (where compressive strains occur). The base course and sub-grade are structural elements of the pavement. In conjunction with the overlying bituminous surface, their purpose is to distribute traffic wheel loads over the whole foundation. To perform this function, we build the base course and sub-grade with the necessary internal strength properties.

Bituminous pavement layers have both tensile and compressive strength to resist internal stresses. For example, **Figure 6.1** shows how wheel load (W) slightly deflects the pavement structure, causing both tensile and compressive stresses within the pavement.

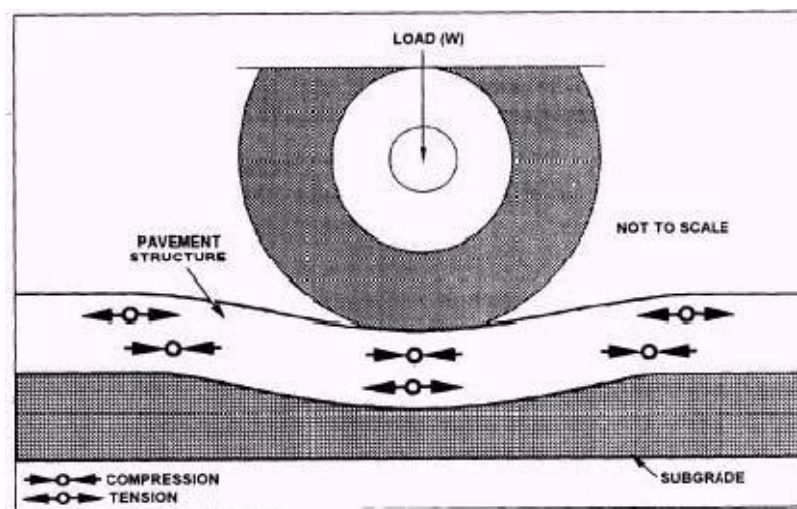


Figure 6.1: Pavement Deflection Results in Tensile and Compressive Stresses in Pavement Structure

Required total thickness of the pavement layers is determined by engineering design procedure. Factors considered in the procedure are as follows:

- Traffic to be served initially and over the design service life of the pavement
- Strength and other pertinent properties of the prepared sub-grade
- Strength and other influencing characteristics of the materials available or chosen for the layers (or courses) in the total pavement structure
- Special factors such free swelling property of existing soil

Design of New Flexible Pavement

Design of new pavement has been carried out based on IRC 37-2018 “Guidelines for the Design of Flexible Pavements” for design life of 15 years. Procedure for the same is given below:

Step 1: To find out initial traffic in the year of completion of construction in terms of the number of the number of commercial vehicles per day (CVPD)

Step 2: To determine traffic growth rate factor by studying the past trends of traffic growth

Step 3: Design life of Pavement

Step 4: To find out Vehicle Damage Factor to convert the number of commercial vehicles of different axle loads and axle configuration to the number of standard axle load repetition. It may be obtained by conducting axle load survey at site.

Step 5: To find out lane distribution factor of traffic over the carriageway

Step 6: To determine design traffic in cumulative number of standard axles (msa) by the following formula mentioned below:

$$N = [365 \times \{(1+r)^n - 1\} / r] \times A \times D \times F$$

Where,

N = Cumulative number of standard axles to be catered for in the design in terms of msa

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

D = Lane Distribution Factor

n = Design life in years

r = Annual growth rate of commercial vehicles

F = Vehicle damage factor

Step 7: To determine total pavement thickness and crust composition by charts/graphs with respect to CBR and cumulative number of standard axles.

Methodology flow chart for the design of new Flexible pavement has been shown in **Figure 6.2** below.

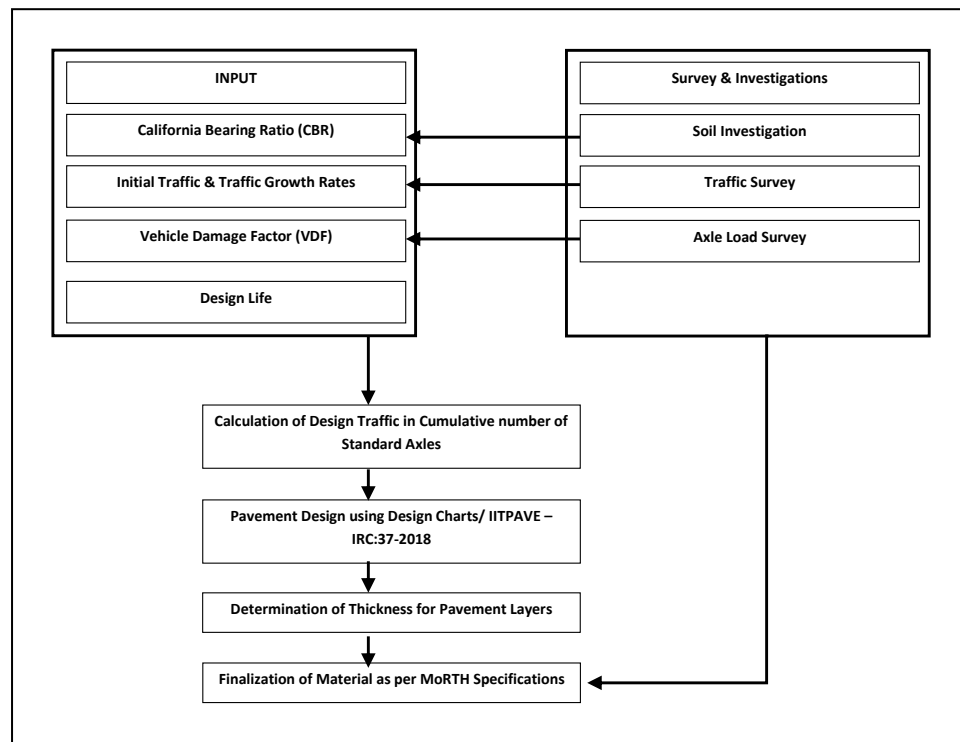


Figure 6.2 : Methodology Flow Chart for Design of New Flexible Pavement

MSA Calculation

MSA calculation has been presented in **Annexure 6.4** for Daboka-Lahorijan section.

Adopted design life for pavement design has been considered for 15 years period.

Lane Distribution Factor

The lane distribution factor adopted for the project road is as given under:

- Dual Two Lane carriageway roads: 75 percent of number of Commercial vehicles in each direction as per IRC-37-2018.

Vehicle Damage Factor (VDF)

VDF summary is provided below.

Type of Vehicle	Daboka – Lahorijan Road (NH-29)	
	From Daboka to Lahorijan	From Lahorijan to Daboka
2-Axle Trucks	6.93	2.59
3-Axle Trucks	9.46	3.52
MAV	13.07	5.97
LCV	2.40	1.17
Bus	1.92	1.07

Design CBR

The subgrade CBR for design has been considered as 8.0%. Subgrade of 500 mm thickness is required as an integral part of the pavement structure. Details of msa calculated for flexible pavement design are provided in **Table 6.14** for Daboka-Lahorijan Section.

For Daboka – Lahorijan stretch (NH-29)

Axle Load Survey conducted for the road stretch reveals that the Axle Load patterns differ significantly. Hence the pavement design is done considering different VDF values for the two carriageways as per Clause 4.5.2 of IRC:37-2012.

VDF values for LHS of the Daboka – Lahorijan stretch for 2-Axle Trucks, 3-Axle Trucks, MAVs, LCVs and Buses are 6.93, 9.46, 13.07, 2.40 and 1.92 respectively.

VDF values for RHS of the Daboka – Lahorijan stretch for 2-Axle Trucks, 3-Axle Trucks, MAVs, LCVs and Buses are 2.59, 3.52, 5.97, 1.17 and 1.07 respectively.

Traffic Surveys were conducted at Km. 62, Km. 127 and Km. 138.45 of the Daboka – Lahorijan road (NH-29) and *the total stretch is to be developed as 4-Lane Dual Carriageway road*. The details of the msa calculated are presented below:

Table 6.14A - MSA for 4-Lane Dual Carriageway on LHS from Daboka to Lahorijan (NH-29)

Location	msa	Adopted msa
Km 62	17.21	20 msa
Km 127	18.95	
Km 138.45	14.34	

As all the calculated msas are below 20, the **Design msa is considered as 20**.

Table 6.14B MSA for 4-Lane Dual Carriageway on RHS from Daboka to Lahorijan (NH-29)

Location	msa	Adopted msa
Km 62	7.59	20 msa
Km 127	8.34	
Km 138.45	6.32	

As all the calculated msas are below 20, the **Design msa is considered as 20**.

Pavement layer thicknesses based on inputs mentioned above is given in **Table 6.15**. The GSB-II layer will be extended till earthen shoulder to facilitate of proper drainage in the pavement structure. The design has been carried out as per Plate-6 of IRC:37-2018.

Table 6.15 : Proposed Pavement Thickness

Pavement Layer Thickness in mm					
msa	BC	DBM	WMM	GSB	Total Pavement Thickness
20	30	90	250	200	570

6.6.4 Overlay Design

Condition of existing pavement is generally fair to poor.

Overlay design has been carried out based on the results of the FWD Tests. The Summary of the Analysis and selection of the 15th percentile moduli of in-service layers are presented in **Annexure 4.1** under Chapter 4.

The Analysis is carried out for the stretch. The 15th Percentile Moduli of the in-service layers and the average existing pavement thicknesses are presented in **Table 6.16**.

Table 6.16 : 15th Percentile Moduli of the In-Service Layers and Average Existing Pavement Thicknesses

Road Sections	15 th Percentile Moduli of in-service Pavement Layers (MPa)			Existing Pavement Layers (mm)	
	Bituminous	Granular	Subgrade	Bituminous	Granular
Daboka to Lahorijan	918.5	215.6	98.0	53	311

Considering the above data, the remaining fatigue life and rutting life of the pavement are obtained from equation 16 and 17 respectively from IRC:115-2014 as presented in **Table 6.17**.

Table 6.17: Fatigue Life and Rutting Life of Pavement

Road Sections	Tensile Strain at the Bottom of the Bituminous Layer	Vertical Strain at the Top of the Subgrade	Fatigue Life	Rutting Life
Daboka to Lahorijan	480.6×10^{-6}	652.4×10^{-6}	1.70	3.90

From the above results it is evident that the existing pavement crust is not sufficient to carry the corresponding design traffic. Hence considering the bituminous overlay the results obtained are presented in **Table 6.18**.

Table 6.18: Results of FWD Data Analysis and Overlay Thickness

Road Sections	Considered Bituminous Overlay (mm)	Tensile Strain at the bottom of the Bituminous Layer	Vertical Strain at the top of the subgrade	Fatigue Life (msa)	Rutting Life (msa)	Design Traffic (msa)
Daboka to Lahorijan	30mm BC + 70mm DBM	250.2×10^{-6}	343.1×10^{-6}	21.48	71.88	20

Hence, the bituminous overlay as presented in Table 6.18 above is recommended.

6.7 Protection Works

Various protection works have been considered as per design requirement as well as from safety point of view as mentioned below:

- Metal Beam Crash Barriers
- Kerb and Kerb with Channel: Kerb has been considered all through except at inner edges of outer carriageway at super elevated stretches where kerb with channel are considered.

6.8 Other Highway Facilities

6.8.1 Bus Bays

Several towns, villages and settlements are abutting the project corridor and buses shall be one of the major mode of passenger traffic movement along the corridor. It is imperative to provide bus bays in order to eliminate the conflict between buses and other moving vehicles as well as to ensure safety of passengers boarding and alighting. Proposed bus bays have been kept sufficiently away from the intersections to avoid traffic congestion. Total 14 nos. of bus bays have been considered for the section.

6.8.2 Truck Lay Bye

4 location have been identified for proposed truck lay-byes.

6.8.3 Toll Plazas

NIL

6.8.4 Wayside Amenities

NIL

6.8.5 Illumination

Highway illumination shall be considered at various location as per clause 12.3 of IRC: SP: 84-2014. Details are considered as follows:

- A. Double Arm Poles –major intersections, bus bays and truck lay byes
- B. High Mast Poles – Considered at major intersections and truck lay byes.

6.8.6 Miscellaneous Provisions for Traffic Guidance and Safety

The objective of a high-speed facility includes providing safe, efficient and economic movement of motorized through traffic with comfort and pleasing environment during the journey. This requires certain miscellaneous provisions for traffic guidance and safety. However, it is evident that after implementation of the project, high speed environment will make the areas more accident-prone unless proper safety controls are exercised. The Consultants propose to rectify any geometric and engineering deficiency existing along the critical stretches. The safety measures and devices as proposed are described below:

- Traffic Guidance, Regulation, Control and Safety Measures
- Pedestrian Facilities
- Speed Breakers

Traffic Guidance, Regulation, Control and Safety Measures

For notification of road features and also for safety and guidance of the road users, the project road will be provided with all the necessary traffic control and safety devices. These include:

- Traffic Signs – mandatory, cautionary and informatory Road Markings
- Provision of road studs or similar tools, for carriageway centerline and edge delineation
- Metal Beam Crash Barrier
- Concrete Beam Crash Barrier
- Pedestrian Guard Rail
- Guard Posts

To ensure safety of vehicles, W-Beam type metal beam crash barriers shall be provided on both edges of the road where embankment height (road height) is equal to or greater than 3m. Suitable reflectors have been proposed to be fixed on the beam @ 3 m centre-to-centre for proper delineation of the barrier line. The metal beam crash barrier sections shall start and finish with a parabolic flare away from the carriageway. Concrete guard posts shall be provided on both side of the carriageway for the balance reaches. Besides, trapezoidal reflectors have been considered on guard posts at forest stretches.

Pedestrian Facilities

The facilities to be provided for pedestrian safety include:

- Pedestrian crossings at important intersections and urban areas
- Footpaths of adequate width
- Road signs cautioning drivers of Pedestrian Crossings ahead
- Pedestrian signals at intersections

The above will be provided at important intersections.

Speed Breakers

Speed breakers shall be provided on minor cross-roads to alert the drivers and control the speed of vehicles approaching the project road, forming priority junctions, and these shall be constructed as per IRC: 99-1988. The speed breaker will be provided at about 10m into the cross-road from the project road. Another speed breaker will precede this at 100-120m. Appropriate warning signs “hump ahead” will be provided in advance to caution the drivers.

6.9 Landscaping and Arboriculture

- (i) The aim of landscaping will be conservation of existing natural or manmade features e.g. ponds, historical buildings and scenic vistas along the highway.
- (ii) Landscaping will address the issue of drainage to ensure minimum disturbance to the natural drainage and at the same time ensure protection of natural surfaces from erosion.

- (iii) Proper landscaping will be provided for highway Alignment, to fit-in with surroundings for pleasing appearance, reducing adverse environmental effects such as air pollution, noise pollution and visual intrusion.
- (iv) Landscaping will include stabilization of embankment by pitching and/or turfing/plantation. The treatment of embankment slopes along the highway will be as per recommendations of IRC:56–1974, depending upon soil type involved.
- (v) Trees, their spacing and arrangement in different situations will be as per IRC:21–1979 and IRC:SP:66–1976.
- (vi) Compensatory afforestation as per applicable rules.

6.10 Proposed ROW and Land Acquisition

Proposed ROW of 42m is considered for the road sections in rural area. In built-up area 47m PROW is considered. In forest area, to minimize the land acquisition, 35.5m PROW and at the approach of elephant underpasses, 42.5m PROW are considered. In Manja Bypass 60m ROW is considered.

As per assessment at this stage tentative land acquisition is assessed as below:

- ***For Section 6+7: 84.20 Ha***

6.11 Protection Work For Hilly Terrain

Breast Wall

Breast wall has been proposed in hilly terrain where cut height is more than 6m. Total length of 4762m breast wall has been proposed with a height of 2.5m to 5m

Soil Nailing

Soil nailing has been proposed in hilly terrain where cut height is more than 20m. A total area of 1250sqm Soil Nailing has been proposed.

6.12 Protection Work For High Embankment Zone

Toe / Retaining Wall

Toe wall has been proposed in high embankment zone such to restrict the embankment toe within the PROW. Total length of 3240m toe wall has been proposed with a height of 2m to 3m

Chapter 7 : Environmental Screening

CHAPTER 7

ENVIRONMENTAL SCREENING

7.1 INTRODUCTION

7.1.1 Project Background

The National Highways & Infrastructure Development Corporation Limited has been constituted through an Act of Parliament for faster, economical and quality Road Construction work throughout India. The National Highways & Infrastructure Development Corporation Limited (NHIDCL) has been entrusted with the assignment of preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojana.

In view of the above work NHIDCL has appointed M/s Voyants Solutions Pvt. Ltd. to carry out the Feasibility Studies and Detailed Project Report including field investigations, road inventory, structure inventory, FWD test, road crust sample (trial pits), material investigation, secondary data collection and traffic survey (classified traffic volume count, O-D, intersection counts, axle load survey, animal/pedestrian crossing counts and speed-delay survey). The letter of invitation (LOI) has been issued vide memo no. NHIDCL/Bharatmala/DPR/Phase-I /Lot-1/2017, dated October 30, 2017, whereas, the letter of acceptance (LOA) has been issued vide letter no. NHIDCL/Bharatmala/DPR/Phase-I /Lot-1/Package II/2017/27, dated February 02, 2018. Letter of commencement (LOC) for the consultancy services was issued vide letter no. NHIDCL/Bharatmala/DPR/Phase-I /Lot-1/Package II/2017/80, dated April 13, 2018..

7.1.2 Project Road Description

The project road comprises 5 stretches as mentioned in the RFP as mentioned below in Table 7.1

Table 7.1: List of Road Segments as per RFP

Stretches	Description
Strech-1	Daboka – Manja (NH-29)
Strech-2	Manja- Lahorijan (NH-29)
Strech-3	Lahorijan – Khatkhathi (NH-129)
Strech-4	Numaligar- Khatkhathi (NH 129)
Strech-5	Khatkhathi – Chumukademia (Dimapur Bypass)

As mentioned earlier, the project road has 5 (Five) stretches as below:

- The Daboka – Manja stretch under Nagaon – Dimapur Economic Corridor starts at Daboka – Sutargaon More (26°6'56.85"N, 92°52'28.97"E) which is a junction of the project road i.e. NH-29 (Old NH-36) and Nagaon - Lumding/ Silchar road. The chainage of the start point is Km 39+500 of NH-29. The stretch runs along South-East direction and ends at the junction (Manja Market) of the Project Road with Manja – Diphu – Lumding Road at

existing Km 128+300 of NH-29 (25°58'14.79"N, 93°26'14.79"E). The Length of the stretch is about 88.8 Km.

- ii) The Manja – Lahorijan stretch under Nagaon – Dimapur Economic Corridor starts at existing Km 128+300 (25°58'14.79"N, 93°26'14.79"E) and ends at Lahorijan (25°55'15.60"N, 93°43'49.75"E), the outskirts of Dimapur. The end point is about 2 Km towards North from the City Tower (Junction of NH-29 and NH-129). The stretch passes mainly forest stretches and partly through the vicinity of Marat Wild Life Sanctuary. The Length of the stretch is about 40.1 Km.
- iii) The Numaligarh – Khatkhathi stretch under Numaligarh – Dimapur Economic Corridor starts at the Junction (26°37'51.90"N, 93°43'38.58"E) of NH-129 and NH-37 at Numaligarh and ends at Khatkhathi (25°57'19.36"N, 93°44'8.86"E) about 7 Km towards North from the City Tower in Dimapur. The Length of the stretch is about 102 Km.

This report includes the road sections as mentioned below from the Stretch -1&2 in Table 7.1.

Section-6+7: From Km 113+830 (near Kwaram Taro Village) to Km 145+712 (near Dilai)

7.1.3 Project Location

Segment wise variation of lengths from RFP document is provided in **Table 7.2** as follows:

Table 7.1: Variation in Lengths of Different Segments from RFP Document

Stretches as per RFP	Node Reference	Description	RFP Length (km)	Ground Length (Km)	Remarks
1	A-B	Daboka - Manja	90	88.8	-
2	B-C	Manja - Lahorijan	38.8	29.3	Variation due to relocation of project end point from Dimapur Town to Start of Dimapur Bypass at Lahorijan
3	C-D	Lahorijan - Khatkhathi	1	N/A *	Stretch already included in Dimapur Bypass (Under Construction)
4	E-D	Numaligarh – Khatkhathi (NH-129)	99	99	-
5	D-F	Khatkhathi – Chumukedeima (Dimapur Bypass)	23	N/A *	Stretch already included in Dimapur Bypass (Under Construction)
Total			251.8	217.1	

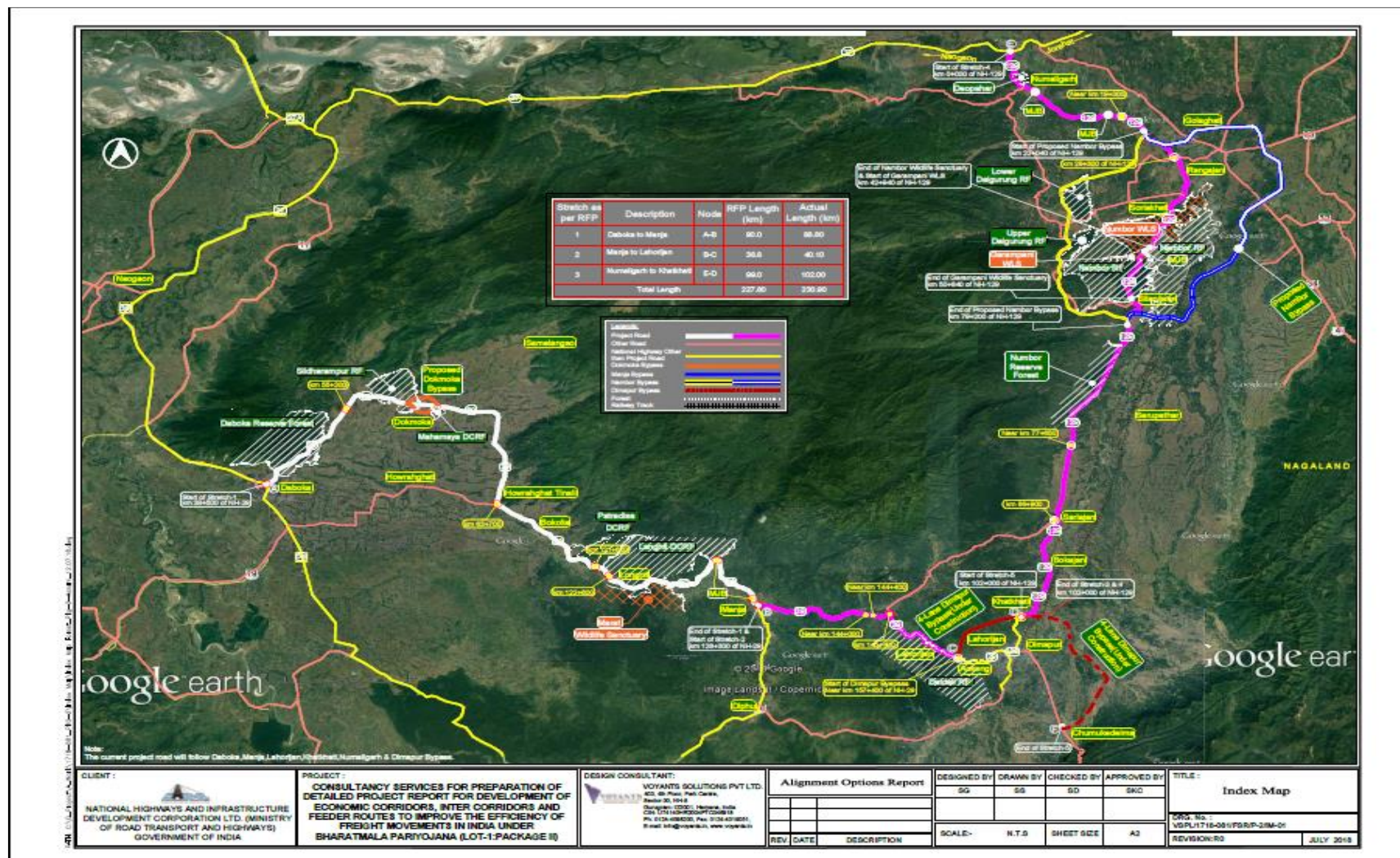


Figure 7.1: Project Road Index Map

7.2 ENVIRONMENTAL SCREENING

Project screening in EIA is the first step in the initial assessment of the possible environmental impacts of the proposed project. The purpose of the environmental screening is to identify if the proposed project requires an EIA through the elimination of irrelevant environmental issues and the forcing on the attention at the planning stages on potentially significant issues. The scope of the screening studies includes:

- Consideration of biophysical and socio-economic issues and the relevant legislative framework
- Consultation with key decision-makers and experts to identify key issues.

The screening process can have one of four outcomes:

- i. No further level of EIA is required;
- ii. A full and comprehensive EIA is required;
- iii. A less detailed/ limited EIA is required; or
- iv. Further study is necessary to determine the level of EIA required (often called an ¹Initial Environmental Examination (IEE).

The screening exercise establishes the basis for scoping, which identifies the key impacts to be studied and establishes terms of reference for an EIA. Typical environmental screening procedure is illustrated in the **Figure 7.2** below:

¹ Initial Environmental Examination (IEE) as defined by several multilateral-funding agencies such as The World Bank (WB), The Asian Development Bank (ADB) and the United States Agency for International Development (USAID) is "a preliminary attempt to evaluate environmental impacts in order to determine whether a full-scale environmental impact assessment is needed. Also called Initial Environmental Investigation (IEI), partial EIA or "Preliminary EIA"."

In Accordance to USAID "Initial Environmental Examination (IEE) is the first review of the reasonably foreseeable effects of a proposed action on the environment. Its function is to provide a brief statement of the factual basis for a Threshold Decision as to whether an Environmental Assessment or an Environmental Impact Statement will be required." (Reference: USAID Automated Directives System - ADS - Chapters 200-204)

Source: <https://www.usaid.gov/sites/default/files/documents/1865/204.pdf>

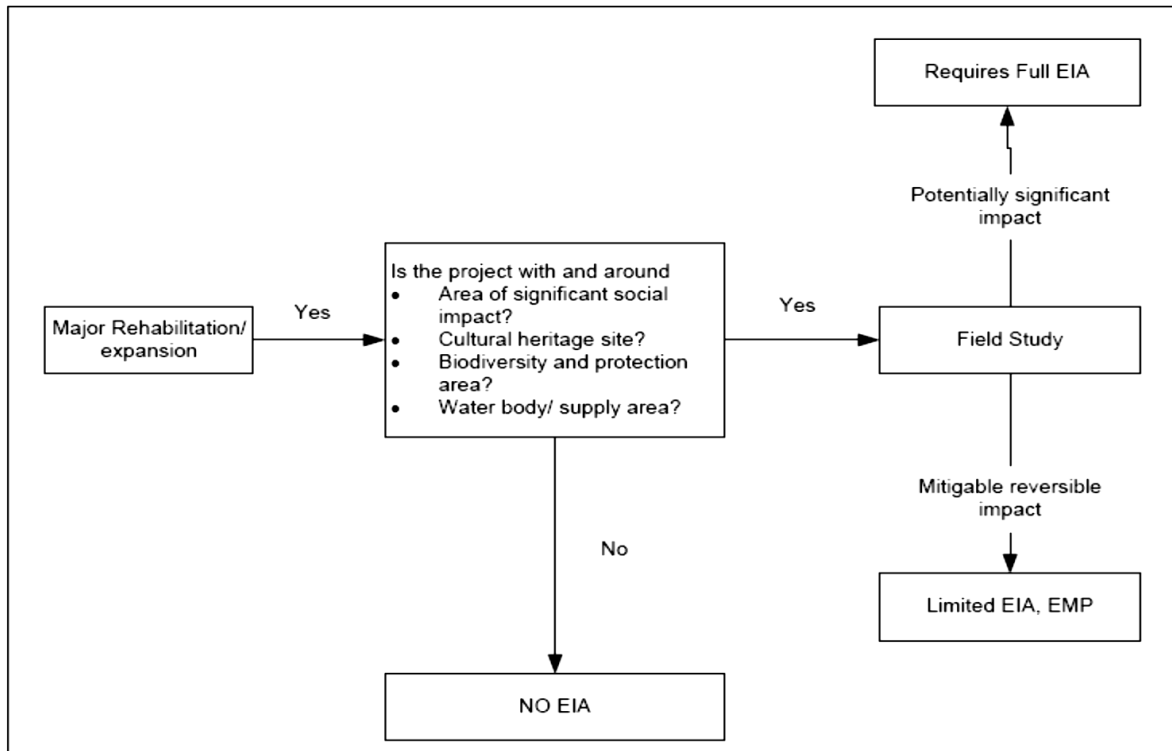


Figure 7.2: Typical Environmental Screening Procedure

7.2.1 Scope of Environment Screening

The purpose of the Environmental Screening (ES) is to:

- Categorize the project in terms of potential environmental impact based on Ministry of Environment, Forests and Climate Change (MoEF&CC) definitions and guidelines detailed in Environmental Impact Assessment (EIA) Notification, 2006 and its subsequent amendments
- Provide environmental direction early in the project; Alert the proponent and design team of any potential environmental concerns that must be addressed in detail in the EIA; and

The ES shall identify:

- Required environmental baseline data and analyses to be scoped in or out of the EIA, with sound justification;
- Potential positive and/or negative environmental impacts during the life cycle of the project, including construction and operation, that shall be analyzed in detail in the EIA;
- Potential catastrophic pollution releases (e.g., Solid & Hazardous waste, etc.) to be analyzed in detail in the EIA; and
- The survey methodology and techniques to be used in the EIA process.
- The project's category according to its likely level of environmental impact

The planned road development for the aforesaid 02 sections of the road stretch-1 under Lot-I of Package-II in the state of Assam may have adverse environmental impacts on the immediate surrounding and ambient environment, an Environmental Screening (ES) Report is prepared with a view to properly categorizing the project and identifying and prioritizing environmental issues to be scoped in and scoped out during the detailed EIA Stage.

The important environmental component studied during the Environmental Screening Stage are given in **Table 7.3** as follows:

Table 7.2: Important Environment Components

S. No.	Environmental Attributes	Environmental Components
1	Topography	Plain/Rolling
2	Land use	Agriculture, settlements, forest, industrial areas, tourism etc.
3	Water resources	Rivers, canals and ponds in study area
4	Forests & Wild Life	<ul style="list-style-type: none"> • Designated Protected Areas like Biosphere Reserves, National Parks and Sanctuaries etc.) within 10 Km from the proposed project location boundary • Presence of Wildlife Corridor along the project stretch • Presence of Reserve Forests (RF), Protected Forest (PF) and other forests within study area
5	Road side Plantations	Green Tunnels, Strip Plantation
6	Settlements	Towns and villages abutting the road corridor
7	Sensitive Receptors	Sensitive receptors such as educational and health facilities
8	Drinking water sources	Wells, hand pumps, community water points / taps etc.
10	Religious Structures	Temples, shrines, mosque, Church, Gurudwara etc.
11	Cultural Properties	Protected / unprotected archaeological monuments
12	Common Property Resources	Community recreational areas; cremation / burial grounds etc.

7.3 METHODOLOGY AND WORK PLAN

7.3.1 Approach to Screening and Scoping

Several guideline documents have described screening in different ways. The overall approach for the environmental screening has taken into account:

- Preparation of baseline;
- Identification & assessment of impacts;
- Policy & Legal Implications;
- Scoping of Work under EIA.

The scoping process is designed to ensure that the environmental studies provide all the relevant information on:

- The impacts of the project, in particular focusing on the most important impacts;
- The alternatives to the project;
- Time frame for the EIA based on potential impact; and
- Any other matters to be included.

7.3.2 Project Work Plan

The following activities have been carried out:

- **Task 1:** Mobilization/Orientation of Staff
- **Task 2:** Literature and Related Policies/Legal Review
- **Task 3:** Field investigation and data collection for environmental screening and scoping;
- **Task 4:** Analysis of Environmental Screening data;
- **Task 5:** Recommendations; and
- **Task 6:** Reporting

Task 1: Mobilization and Orientation of Staff

VSPL has mobilized thematic experts experienced in environmental and social impact assessments to carry out screening surveys for the planned road stretches under Package-II (Lot-I).

The Project's EIA have been discussed reviewed and discussed by the VSPL's thematic experts. Thereafter methodology and approach for project execution has thoroughly been discussed.

Task 2: Literature and Policy/Legal Reviews

The project documents (RFP document, project alignment and other relevant documents) collected from the client have been reviewed to have better understanding of the project objectives. These documents guided in the impact screening. All the Environmental Rules and Regulations enacted by MoEF&CC have been reviewed alongside other national and multilateral funding agency policies formulated by Asian Development Bank and World Bank safeguard policies relevant to Environmental Impact Assessment. In addition, relevant baseline data on the physical, biological and social environment have also been reviewed and findings incorporated into the report.

Task 3: Field Investigation and Data Collection

Field data gathering checklist: Field data gathering checklist (for Air, Noise, Water Soil & Socio-economic etc.) have been developed by the project team (thematic experts). The data

gathering checklist have been used to capture all relevant information on environmental features, Environmental Sensitive Locations Wildlife flora and fauna (if any) etc.

Data Entry Team: Data entries into the computers have been done by experienced data entry personnel and data entered have been re-validated by the thematic experts to ensure correctness of the data as per the information and data collected during site visit such as GPS Coordinates, Noise Measurements, nearby commercial and industrial facilities, nearest settlements, flora and fauna, water sources etc. In the context of the planned project, important parameters identified in the field are grouped into three categories:

- Physical Environment (Air Quality, Noise Quality, Waste generation and disposal, Water Resources, Soil Erosion)
- Biological Environment (No. of trees, reserved or protected areas, wetlands, rare or endangered wildlife and vegetation)-if any
- Social Environment (displaced persons, sacred groves, commercial structures on Right of Way (ROW), infrastructure etc.)-if any.

The data have been gathered to provide a reliable basis on which to predict effects likely to arise from the proposed project.

Task 4: Environmental Screening (ES) for Environmental and Social Impact Assessment

The ES identified the types of environmental impacts to be investigated and reported in the environmental impact assessment. The environmental topics that will be considered within the ES report are: air quality, noise and vibration, climate & meteorology, hydrology & draining, waste (solid, liquid & hazardous) management, ecology, soil/land contamination, socioeconomic, cultural heritage; For each topic, the likelihood of significant effects arising has been considered in terms of direct and indirect effects during construction and direct and indirect effects during operation and maintenance. The important Environmental Components considered in the Environmental Screening

7.4 PROJECT DESCRIPTION

7.4.1 Widening Proposal

At about 23% stretches the alignment passes through green field areas. For the balance reaches, where the alignment overlaps with the existing roads, eccentric widening has been followed with the objective to use the existing ROW to the maximum extent possible. At few locations, concentric widening also proposed to allow use of existing crust. However, minor realignments have been incorporated at few locations for geometric correction. Attempts have been made to avoid realignments at built up locations.

This project is essentially widening the existing standard/sub-standard 2-lane road to 4-lane with paved shoulder as the alignment follows predominantly existing roads. The geometric

designs are as per recommendations of IRC: SP: 84-2019. The general design standards for improvement are enumerated in **Table 7.4**.

Table 7.3: Geometric Design Standards for Road Works (Plain/Rolling Terrain)

SI No.	Attributes	Geometric Design Standards
1	Design Speed	
	Plain and Rolling Terrain (Cross slope of the ground upto 25per cent)	Ruling: 100 kmph Minimum: 80 kmph
2	Carriageway Width	For four lane: 2 x 7.0m with 0.5 m Kerb shyness at either side
3	Width of Shoulder	
	a) Paved Shoulder	2 x 2.5 m
	b) Earthen Shoulder	1.5 m
4	Footpath width at built-up areas	2 x 1.5 m drain cum footpath
5	Camber	
	a) Carriageway	2.5%
	b) Shoulder	3.0%
6	Maximum and Minimum Super-elevation	Maximum limited to 7.0% (for Radius less than Desirable minimum) Minimum limited to 5% (for Radius more than Desirable minimum)
7	Minimum Radius of Horizontal Curves	
	a) Plain and rolling Terrain	Desirable Minimum: 400m Absolute Minimum: 250m
8	Sight Distances for Various Speeds	180m – 360m
9	Longitudinal Gradient	
	a) Plain and Rolling Terrain	Ruling: 2.5%, Limiting: 3.3%
10	Extra Width of Pavement	
	Radius of Curve	Extra Width
	75-100m	0.9m
	101-300m	0.6m

7.4.2 Project Proponent

The proposed development will be managed by National Highway Infrastructure Development Corporation Ltd. (NHIDCL), Assam, (MoRTH), Govt. of India.

7.4.3 Need of the Project and benefits associated

- Will provide easy access to commuters
- Will cater the traffic growth on the road
- Will provide easy accessibility for school, medical facilities, etc. for the nearby villages even in the rainy season

- Project Road would bring about all-round development activities in the region, such as movement of people and goods, agriculture, commerce, education, health and social welfare, or even maintenance of law and order and security

The need of the project is to create a 4-lane partially access controlled facility with provision of at grade intersections, grade separators with/without ramps etc. as appropriate/necessary, within the stipulated Right-of-Way by improving the existing single/two lane road and/or developing a new 4-lane road in case of locations with poor geometry and dense settlements to a standard 4-lane road with paved shoulder. To this end, land to the extent necessary will be acquired. Further, the development cost may be recouped, to the extent practicable, from collection of tolls from users of the improved facility. As such, the improvement schemes for the project road should be as economical as possible consistent with the functional requirements and amenable for quick implementation without much gestation delays.

7.4.4 Proposed Features of Road

A. Development Proposal

The salient proposals for up-gradation and improvement of the project road are classified into the following engineering aspects:

Where Proposed Alignment Overlaps with Existing Roads

- In general, in this section of proposed stretch follows existing Sections except the bypass proposed (Dokmoka).
- Widening of the project road based on traffic capacity/requirement.
- Improving the horizontal geometry of the existing road based on the design standards as per IRC: SP: 84-2019
- Design of new pavement for widening and realignment of the existing road.
- Provision of overlay at strengthening stretches.
- Improvement of all major and minor intersections.
- Rehabilitation and widening of the existing structures including bridges, culverts etc. and design of new ones as per requirement.
- Provision of comprehensive road furniture for complete road safety measures.

B. Bypass and Realignment

The proposed alignment is mostly overlapping with the existing geometric improvement. **Table 7.5** provides the list realignment stretches where the proposed alignment does not overlap with the existing roads.

Table 7.4: List of Stretches with Realignments

Sl no.	Design Chainage (km)		Length (m)	TCS	Remarks
	From	To			
Daboka – Lahorijan Road (NH 29)					
Section 6+7					
1	114+470	114+590	120	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
2	114+700	114+890	190	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
3	114+940	115+170	230	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
4	115+850	115+980	130	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
5	116+180	116+500	320	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
6	117+120	117+260	140	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
7	117+570	117+710	140	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
8	117+810	118+150	340	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
9	118+250	118+420	170	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
10	118+830	119+840	1010	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
11	120+750	121+100	350	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
12	121+330	121+470	140	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment

Sl no.	Design Chainage (km)		Length (m)	TCS	Remarks
	From	To			
13	123+150	123+650	500	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
14	130+840	130+990	150	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
15	132900	133200	300	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
16	134291.8	134430	138.2	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
17	134430	134550	120	8A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in Cut Section (Realignment)
18	134700	134900	200	8A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in Cut Section (Realignment)
19	136900	136950	50	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
20	136950	137220	270	9	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in Cut Section (New Construction)
21	137220	137500	280	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
22	139000	139150	150	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
23	139150	139200	50	8A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
24	139430	139550	120	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
25	139800	139904.3	104.3	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment

SI no.	Design Chainage (km)		Length (m)	TCS	Remarks
	From	To			
26	139926.8	140100	173.2	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
27	140500	140600	100	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
28	140600	140750	150	8A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
29	141030	141200	170	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
30	143500	143616	116	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
31	143624	143800	176	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
32	144400	144530	130	8A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
33	144530	144700	170	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
34	145150	145200	50	9	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
35	145200	145350	150	9	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment
36	145350	145550	200	1A	Typical Cross Section of 4-Lane Divided Carriageway with 1.5 m Wide Raised Median in bypasses and realignment

C. Service Road

Service Road with Footpath have been considered at Major Built up locations & VUP approaches as mentioned below.

Design Chainage (km)		Length (m)	TCS	Remarks
From	To			
Daboka – Lahorijan Road (NH 29)				
Section 6+7				
Nil				

D. Cross Drainage Structure

Cross section for bridges, culverts and other structures shall be as per relevant guidelines of IRC: SP-84-2019. In general, full roadway width will be proposed between the outer to outer face of crash barrier/ parapet for culverts. General 4 or 6 lane configurations for bridges/culverts/other structures are provided in Table 7.6.

Table 7.6 : General Structural Configuration

Type of Structure	Width of Structural Components for One Direction (m)					Reference
	C/W	FP	CB	Railing	Overall	
4-Lane Bridge	10.5	1.5	2x0.55	0.4	13.5	Fig. 7.2A of IRC:SP:84-2019
6-Lane Bridge	14.0	1.5	2x0.55	0.4	17.0	Fig. 7.3 of IRC:SP:84-2019
6-Lane Gr. Separator	14.0	-	2x0.55	-	15.1	Fig. 7.8 of IRC:SP:84-2019

The overall width of culverts for 4 and 6 lane configuration shall be 2x11.0m+Median and 2x12.05m+Median (as per Fig. 7.1A and Fig. 7.1B of IRC: SP: 84-2019).

Thickness of wearing course shall be 65 mm (40 mm BC + 25 mm mastic asphalt)

Due consideration has been given to drainage while preparing the design. The cross-sections incorporating roadside drains have been proposed at various stretches of the highway taking into account the existing and natural conditions as well as anticipated situation. In general unlined trapezoidal drains have been considered on either side of road. Lined rectangular uncovered RCC drains have been considered for cut section as well as approaches of major bridges. Covered rectangular drain sections have been proposed in urban stretches as well as approaches of underpasses. At super elevated sections with raised median, rectangular cross median drains have been considered. All the drains shall discharge into the nearest outfall. At high embankment stretches (where embankment height more than 3.0m) chute drains with energy dissipation basins have been proposed @ 5m interval.

The details are provided below:

Type of Drain	Side	Total Length including both side (m)	Applicable TCSs
Section-6+7			
Unlined Trapezoidal Drains	Both	49052.6	TCS – 1,1A,2,4,4A,5,6
Lined Trapezoidal Drains	Hill	3502	TCS – 8,8A
Lined Trapezoidal Drains	Both	5280	TCS – 8, 8A, 9
RCC covered drain	Both	1400	Toll plaza location

E. Land Acquisition

Proposed ROW of 42m is considered for the road sections in rural area. In built-up area 47m PROW is considered. In forest area, to minimize the land acquisition, 35.5m PROW and at the approach of elephant underpasses, 42.5m PROW are considered. In Manja Bypass 60m ROW is considered.

As per assessment at this stage tentative land acquisition is assessed as below:

- **For Section 6+7: 84.20 Ha**

F. Intersection Design

All junctions have been studied thoroughly with respect to traffic volume and geometric design. The important junctions leading to settlements have been identified and proper junction layouts (including road marking, and traffic signs) shall be applied as per IRC-SP: 41-1994.

G. Traffic Control and Road Safety Features

Traffic control devices and road safety features, including Traffic Signs, Road Markings, Road lighting & Crash Barriers are proposed and designed as per relevant IRC codes and standards.

7.5 LEGISLATIVE FRAMEWORK

7.5.1 Introduction

Project road under study is mostly lies in hilly region and has been upgraded for development. Any developmental activity has both adverse as well as beneficial impact on surrounding environment. The present report is an effort for scrutinised the applicable environmental laws

and legislative framework under Ministry of Environment Forests & Climate Change, Govt. of India. This section elaborates on the various clearance requirements for the project from the State Government and MoEF&CC, GoI.

7.5.2 Environment Legislation- India

The Government of India has formulated various policy guidelines; acts and regulations aimed at protection and enhancement of environmental resources. The following **Table 7.7** surmises the existing legislations pertaining to the project, the various clearances required for the project.

Table 7.5: Environment Laws and their Applicability

S. No.	Law / Regulation / Guidelines	Relevance	Applicability Yes / No	Reason for Application	Implementing / Responsible Agency
1	The Environmental (Protection) Act, 1986, and the Environmental (Protection) Rules, 1987-2002 (various amendments)	Umbrella Act. Protection and improvement of the environment	Yes	All environmental notifications, rules and schedules are issued under the act	MoEF&CC, State Department of Environment & Forest, CPCB and SPCB
2	The EIA Notification, 14th September 2006 & subsequent amendments	Identifies expansion of National highways projects greater than 100 Km involving additional ROW and land acquisition greater than 40m on existing alignments and 60m on re-alignments or by-passes and All new state highway projects & SH expansion projects in hilly terrain (above 1000 MSL) and or ecological sensitive areas	Yes	Project road from Numaligarh – Khatkhati (NH-129) is an Upgradation/expansion of greater than 100 km of road packages. Hence the EIA Notification 2006 and its subsequent amendments shall be applied. For other road stretches EIA Notification shall not be attracted as the road length is less than 100 km.	MoEF&CC/ SEIAA
3	Notification for use of Fly ash, 3 rd November 2009 and subsequent amendment in 25 th January 2016	Reuse fly ash discharged from Thermal Power Station to minimize land use for dispersal and minimized borrow area material	No	The project road is traversing through the mountainous region of Assam where No coal based thermal power project in 300 km form the project road.	MoEF&CC, SPCB
4	The Water (Prevention and Control of Pollution) Act, 1974	Central and State Pollution Control Board to establish / enforce water quality and effluent standards, monitor water quality, prosecute offenders, and issue licenses for	Yes	Consent required for not polluting ground and surface water during construction	State Pollution Control Board

S. No.	Law / Regulation / Guidelines	Relevance	Applicability Yes / No	Reason for Application	Implementing / Responsible Agency
		construction / operation of certain facilities.			
5	The Air (Prevention and Control of Pollution) Act. 1981	Empowers SPCB to set and monitor air quality standards and to prosecute offenders, excluding vehicular air and noise emission.	Yes	Consent required for establishing and operation of batching, hot mix plants and crushers	State Pollution Control Board
6	Noise Pollution (Regulation And Control) Act, 1990	Standards for noise emission for various land uses	Yes	Construction machineries and vehicles to conform to the standards for construction	State Pollution Control Board
7	Forest (Conservation) Act, 1980	Conservation and definition of forest areas. Diversion of forest land follows the process as laid by the Forest conservation Act.	Yes	Part of road packages passes through the Daboka, Sildhampur, Longhit and Nambor Reserve Forests	Forest Department, MoEF&CC
8	Coastal Regulatory Zone Notification, 1991	Protect and manage coastal areas	No	The project area is located in landlocked region and there is no designated coastal zone.	MoEF&CC, State Department of Environment
9	Wild Life Protection Act, 1972	Protection of wild life in sanctuaries and National Park	No	-	NBWL, SBWL & Chief Wild Life Warden
10	Ancient Monuments and Archaeological sites & Remains Act 1958	To protect and conserve cultural and historical remains found.	No	Nonotified archaeological monument is located in the proximity of the planned project road	Archaeological Survey of India, State Dept. of Archaeology
11	The Motor Vehicle Act, 1988	Empowers State Transport Authority to enforce standards for vehicular pollution.	Yes	All vehicles used for construction will need to comply with the provisions of this act.	State Motor Vehicles Department
12	The Explosives Act (& Rules) 1884 (1983)	Sets out the regulations as to regards the use of explosives and	Yes	New quarrying operation may require blasting	Chief Controller of Explosives

S. No.	Law / Regulation / Guidelines	Relevance	Applicability Yes / No	Reason for Application	Implementing / Responsible Agency
		precautionary measures while blasting & quarrying			
13	Public Liability and Insurance Act, 1991	Protection to the general public from accidents due to hazardous materials	Yes	Hazardous materials like Bitumen shall be used for road construction	State Pollution Control Board
14	Hazardous Wastes (Management, Handling and Trans-boundary Movement) Rules, 2008	Protection to the general public against improper handling and disposal of hazardous wastes	Yes	Hazardous wastes shall be generated due to activities like of maintenance and repair work of vehicles	State Pollution Control Board
15	Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996	Protection against chemical accident while handling any hazardous chemicals resulting	Yes	Handling of hazardous (flammable, toxic and explosive) chemicals during road construction	District & Local Crisis Group headed by the DM and SDM
16	Mines & Minerals (Regulation & Development) Act, 1957 as amended in 1972	Permission of Mining of aggregates and sand from river bed & aggregates	Yes	Mining of sand or aggregates	State Department of Mining
17	The Building & Other Construction Workers (Regulation of Employment & Conditions of Service) BOCW Act, 1996	Employing Lab our / workers	Yes	Employment of labors	District labor Commissioner

7.5.3 International Agreements

Key international agreements that India is signatory to and relevant for the project are provided below:

- Convention Relative to the conservation of Flora and Fauna in their Natural State (1933)
- International Plan Protection Convention (1951)
- Convention on Wetlands of International Importance, Especially as Waterfowl Habitat (Ramsar, 1971)
- Convention concerning the Protection of the World Cultural and Natural Heritage (Paris, 1972)
- Convention in International Trade in Endangered Species of Wild Fauna and Flora (Washington, 1973)
- Convention on Migratory Species of Wild Animals (Bonn, 1979)
- Convention on the Prior Informed Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (PIC or Rotterdam, 1990)
- United Nations Framework Convention on Climate Change (Rio De Janeiro, 1992)
- Convention on Biological Diversity (Rio De Janeiro, 1992)
- Protocol to the United Nations Convention on Climate Change (Kyoto, 1997)
- United Nations Convention on the law of sea (Jamaica, 1982)
- Convention concerning the Protection of the World's Cultural and Natural Heritage (1975)

The above list of international conventions served as requirements for the project to comply.

7.5.4 Environment and Social Safeguard Policies

A. ASIAN DEVELOPMENT BANK (ADB) SAFEGUARD POLICIES

Environmental and social safeguards are a cornerstone of ADBs support for environmentally sustainable economic growth. The Safeguard Policy Statement builds upon the three safeguard policies on the environment, involuntary resettlement, and indigenous people, and brings them into a consolidated policy framework to enhance effectiveness and relevance. The Safeguard Policy Statements, lays out Policy Principles and outlines a set of specific safeguard requirements that ADB supported projects are expected to meet. The ADB Safeguard Policies cover the following aspects.

- Environmental assessment;
- Environmental planning, and management;
- Information disclosure;

- Consultation and participation;
- Grievance Redress mechanisms;
- Monitoring and Reporting;
- Unanticipated Environment Impacts;
- Biodiversity and sustainable natural resources management;
- Pollution prevention and abatement;
- Health and safety;
- Physical cultural resources; and
- Involuntary resettlement;
- Indigenous peoples

Applicability analysis of the ADBs in reference to proposed project is tabulated below

Table 7.6: Application of ADB Safeguard Policies to the Project

ADB Safeguard Policy statement	Requirements	Project Information/ Application
1. Environmental assessment	Environmental assessment term is used to identify potential direct, indirect, cumulative, and induced impacts and risks at an early stage of the project	The assessment is made in reference to the ADB standard checklist
2. Environmental planning and management	As per this requirement, borrower should prepare an environmental management plan (EMP) that addresses the potential impacts and risks identified by the environmental assessment. The EMP should include the proposed mitigation measures, environmental monitoring and reporting requirements, emergency response procedures, related institutional or organizational arrangements, capacity development and training measures, implementation schedule, cost estimates, and performance indicators.	Management and monitoring plan for the project is based on the Impact Intensity in a particular aspect of environment. Performance Indicators are established for post project monitoring.
3. Information Disclosure	Under this requirement borrower should establish regular interaction with the affected populations and stakeholders	Regular interaction with affected population and stakeholders are being made.
4. Consultation and Participation	The borrower / client should carry out meaningful consultation with affected people and other concerned stakeholders, including civil society, and facilitate their informed participation.	Consultation is a regular practice at the project site. NHIDCL should keep regular interaction with all the stakeholders.
5. Grievance Redress Mechanism	The borrower / client should establish a mechanism to receive and facilitate	Grievance Redressal Mechanism of NHIDCL, MoRTH, Govt. of

ADB Safeguard Policy statement	Requirements	Project Information/ Application
	resolution of affected peoples' concerns, complaints and grievances about the project's environmental performance.	India shall be followed.
6. Monitoring and Reporting	The borrower / client should monitor and measure the progress of implementation of the EMP. The extent of monitoring activities should be commensurate with the project's risks and impacts. The borrower / client should prepare periodic monitoring reports that describe progress with implementation of the EMP and compliance issues and corrective actions, if any.	Monitoring plan is defined in this report and same shall be followed during operation of the project.
7. Unanticipated Environmental Impacts	Where unanticipated environmental impacts become apparent during project implementation, the borrower / client should update the environmental assessment and EMP or prepare a new environmental assessment and EMP to assess the potential impacts, evaluate the alternatives, and outline mitigation measures and resources to address those impacts.	At this stage no such unanticipated impact is expected. However, If any unforeseen circumstance takes place, corrective action shall be taken by NHIDCL.
8. Biodiversity and sustainable natural resources management;	NHIDCL should follow and need to identify measures to avoid, minimize, or mitigate potentially adverse impacts and risks and, as a last resort, propose compensatory measures, such as biodiversity offsets, to achieve no net loss or a net gain of the affected biodiversity.	The project road packages are traversing through Eco-sensitive locations such as Daboka, Sildharampur Reserve Forests. Hence the project requires Forest Clearance from the MoEF&CC under the Forest (Conservation) Act, 1980 and Wildlife Clearance from NBWL under Wildlife (Protection) Act, 1972.
9. Pollution prevention and abatement;	During the design, construction, and operation of the project the borrower/ client should apply pollution prevention and control technologies and practices consistent with international good practice, as reflected in internationally recognized standards such as the World Bank Group's Environment, Health and Safety (EHS) Guidelines.	NHIDCL shall ensure that any pollution during design, construction, and operation of the project shall be minimal and at any cost should not exceed the permissible limit of CPCB/SPCB.

ADB Safeguard Policy statement	Requirements	Project Information/ Application
10. Health and safety;	<p>NHIDCL should provide workers with a safe and healthy working environment, taking into account risks inherent to the particular sector and specific classes of hazards in the work areas, including physical, chemical, biological, and radiological hazards.</p> <p>Borrower / client should take steps to prevent accidents, injury, and disease arising from, associated with, or occurring during the course of work by (i) identifying and minimizing, so far as reasonably practicable, the causes of potential hazards to workers; (ii) providing preventive and protective measures, including modification, substitution, or elimination of hazardous conditions or substances; (iii) providing appropriate equipment to minimize risks and requiring and enforcing its use; (iv) training workers and providing them with appropriate incentives to use and comply with health and safety procedures and protective equipment; (v) documenting and reporting occupational accidents, diseases, and incidents; and (vi) having emergency prevention, preparedness, and response arrangements in place.</p>	NHIDCL shall abide with National and International Safety Standards. Labour laws shall be followed in specific reference to Highways and Infrastructure Development Projects.
11. Physical cultural resources	The borrower / client is responsible for siting and designing the project to avoid significant damage to physical cultural resources (Defined as movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance).	NHIDCL shall ensure that the project will not have any impact on any structure(s) of archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance.
12. Involuntary resettlement;	Borrower / client should provide adequate and appropriate replacement land and structures or cash compensation at full replacement cost for lost land and	Land for the project shall be acquired from the public/Govt. and local inhabitants following the Govt. of India/State of

ADB Safeguard Policy statement	Requirements	Project Information/ Application
	structures, adequate compensation for partially damaged structures, and relocation assistance. The rate of compensation for acquired housing, land and other assets should be calculated at full replacement costs. The calculation of full replacement cost should be based on the following elements: (i) fair market value; (ii) transaction costs; (iii) interest accrued, (iv) transitional and restoration costs; and (v) other applicable payments.	Assam and NHIDCL/MoRTH Guidelines.
13. Indigenous peoples;	Borrower / client should explore to the maximum extent possible alternative project designs to avoid physical relocation of Indigenous People that shall result in adverse impacts on their identity, culture, and customary livelihoods. If avoidance is impossible, in consultation with ADB, a combined Indigenous Peoples plan and resettlement plan could be formulated to address both involuntary resettlement and Indigenous Peoples issues.	Land for the project shall be acquired from the public/Govt. and local inhabitants following the Govt. of India/State of Assam and NHIDCL/MoRTH Guidelines.

B. WORLD BANK (WB) SAFEGUARD POLICIES

The World Bank has 10 operational safeguard policies for the development projects that are funded by the Bank. The purpose of these policies is to ensure that social and environmental risks are prevented or at least minimized while increasing socio-economic benefits of approved projects in addition to preserving the environment.

These policies have been a means to increase the effectiveness and positive impacts of development projects and programs supported by the Bank.

The Bank's 10 safeguard policies are:

- OP/BP 4.01 Environmental Assessment
- OP/BP 4.04 Natural Habitats
- OP/BP 4.09 Pest Management
- OP/BP 4.10 Indigenous Peoples
- OP/BP 4.11 Physical Cultural Resources
- OP/BP 4.12 Involuntary Resettlement
- OP/BP 4.36 Forests

- OP/BP 4.37 Safety of Dams
- OP/BP 7.50 Projects on International Waterways
- OP/BP 7.60 Projects in Disputed Areas

With respect to this project, three key policies are being triggered. These are Environmental Assessment (OP/BP 4.01), Involuntary Resettlement (OP/BP 4.12) and Physical Cultural Resources (OP/BP 4.11)

i) OP/BP 4.01 Environmental Assessment

This policy is triggered if a project is likely to have significant adverse environmental impacts in its area of influence. For Category A projects, such as this project, a comprehensive Environmental and Social Impact Assessment and the resultant Environmental and Social Management Plan are required, with emphasis on integrating environmental measures in project planning, design, implementation and operation, in addition to ensuring the environmental soundness and sustainability of investment projects.

The project's ESIA and ESMP take into account the natural environment (air, water, and land); human health and safety; and social aspects (involuntary resettlement, physical cultural resources, etc.) in addition to trans-boundary and global environmental aspects. The policy requires consultations with potentially affected persons and analysis of alternatives as key parts of the process and documentation. The OP 4.01 is applicable to all components of Bank financed projects.

ii) OP/BP 4.12 Involuntary Resettlement

This policy requires that adverse social impacts of projects it supports be mitigated, including when land or property is acquired or its use modified under a project so that Project-affected Persons (PAPs) suffer loss of income, residence, livelihoods or access to resources, either permanent or temporary, whether the land occupation/use is legal or illegal. Resettlement or relocation of PAPs adversely affected by project activities must be undertaken in accordance with laws, regulations and guidelines for Resettlement/Land Acquisition in Govt. of India/State of Assam Resettlement & Rehabilitation Policy and OP 4.12. If there is a gap between Govt. of India/State of Assam Resettlement & Rehabilitation Policy and the Bank's OP 4.12 then the Bank's provisions must apply.

According to OP 4.12, the main objectives of this policy are:

- Involuntary resettlement should be avoided where feasible, or minimized, exploring all viable alternative project designs.

- Where it is not feasible to avoid resettlement, resettlement activities should be conceived and executed as sustainable development programs, providing sufficient investment resources to enable the persons displaced by the project to share in project benefits.
- Displaced persons should be assisted in their efforts to improve their livelihoods and standards of living or at least to restore them, in real terms, to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher.
- This policy covers direct economic and social impacts that both result from Banks assisted investment projects, and are caused by:
- The Involuntary taking of land resulting in:
 - Relocation or loss of shelter
 - Loss of assets or access to assets; or
 - Loss of income sources or means of livelihood, whether or not the affected persons must move to another location; or
- The involuntary restriction of access to legally designated parks and protected areas resulting in adverse impacts on the livelihoods of the displaced persons.

Furthermore, the Bank requires that appropriate and accessible grievance mechanisms are established for project affected persons. A Resettlement Action Plan (RAP) for the project shall be prepared as a separate document.

iii) OP/BP 4.11 – Physical Cultural Resources

The Policy triggered if there are physical cultural resources will be affected due to proposed development. Procedures to deal with such instances in line with the Govt. of India/State of Assam law and OP 4.11 will need to be integrated into the civil works contract documents, through the ESMP.

iv) Mandatory Policies – BP 17.50 Bank Disclosure Policies

This Bank Policy supports decision making process by the Borrower and Bank through allowing public access to information on environmental and social aspects of projects. Disclosure of key project documents, including Executive summaries in English and in the local language, is mandated:

- In Country – prior to project appraisal in the local language and in English

- In the World Bank Info Shop before project appraisal, in English with the Executive Summary in English and in the local language (documents can be in draft but must meet World Bank standards).

C. OTHER WB GUIDELINES

Other useful guidelines and manuals that have been considered during the ESIA phase of the project include:

- The World Bank Participation Source book
- IFC Involuntary Resettlement Guide book
- Safeguards Policy Basics – Red book
- Environmental, Health and Safety (EHS) General Guidelines of the World Bank Group
- Roads and the Environment. A Handbook. World Bank Technical Paper 376.
- Doing Better Business through Effective Public Consultation and Disclosure – A good Practice Manual, issued by IFC.
- Handbook for Preparing a Resettlement Action Plan, issued by IFC.

7.6 ENVIRONMENT SCREENING

7.6.1 Introduction

The collection of baseline information on biophysical, social and economic aspects of the project area is the most important reference for conducting environment study. Social and Environment team have visited the site to collect environment and socio-economic data pertaining to the planned road project. The outcome of the findings is discussed in this section of the report.

7.6.2 Study Area

Details of affected structures were collected for 22.5 m on either side from the center line of the road. Details of sensitive receptors, those are located beyond 22.5 m were also collected as the noise and air pollution may take place beyond direct area (approximately 500 meters) of impact.

7.6.3 Data Collection

Efforts have been made to collect the latest information both at regional as well as local level especially along the project roads alignment.

A. Secondary Data

Data collection from the secondary sources has been done from various authentic and published sources. Following are some important information available from secondary sources.

- Project objectives, technical information on existing road features from Contract

Document

- Climatic condition & long-term meteorological data from Indian Meteorological Department and government websites
- Geology, seismicity, soil and topography from government websites & district groundwater brochure of CGWB
- Land Use from Google Earth and observation during surveys
- Survey of India Topo-sheet, Google Earth & field observation

B. Primary Data

Field study / monitoring have been carried out to generate and collect primary data in the study corridor, which involves:

- Inventory of road features like drinking water source, water bodies, community structures, environmentally sensitive locations areas, congested locations etc. from physical surveys
- Enumeration of roadside trees by Contractor
- Biological Diversity Data
- Environment Monitoring
- Forest Data from the concerned forest Department.

7.6.4 Location

A. The State- Assam

Assam is a state in Northeast India, situated south of the eastern Himalayas along the Brahmaputra and Barak River valleys. Assam covers an area of 78,438 km² (30,285 sq mi). The state is bordered by Bhutan and the state of Arunachal Pradesh to the north; Nagaland and Manipur to the east; Meghalaya, Tripura, Mizoram and Bangladesh to the south; and West Bengal to the west via the Siliguri Corridor, a 22 kilometres (14 mi) strip of land that connects the state to the rest of India.

The indigenous people traditionally include ethnic groups like Assamese Brahmins (including Ganaks), Koch Rajbongshi, Ahom, Bodo, Mishings, Sonowal Kacharis, Rabha, Hajong, Karbi, Rengma Naga, Chutias, Kalitas, Keot (Kaibarta), Tiwa, Mech Kachari, Thengal-Kacharis, Sarania Kacharis, Dimasas, Tea Tribes, Tai Phake and other Tai groups, indigenous ethnic groups of other neighbouring North-East states, Deoris, Doms/Nadiyals, Assamese Muslims (particularly Gorias, Morias, Deshi communities), Assamese Sikhs and Assamese Christians speaking Assamese or any other tribal dialect of Assam as their mother tongue.

Assam is known for Assam tea and Assam silk. The state has conserved the one-horned Indian rhinoceros from near extinction, along with the wild water buffalo, pygmy hog, tiger and various

species of Asiatic birds, and provides one of the last wild habitats for the Asian elephant. The Assamese economy is aided by wildlife tourism to Kaziranga National Park and Manas National Park, which are World Heritage Sites. Sal tree forests are found in the state which, as a result of abundant rainfall, look green all year round. Assam receives more rainfall than most parts of India; this rain feeds the Brahmaputra River, whose tributaries and oxbow lakes provide the region with a hydro-geomorphic environment.

A. District of project Road Stretches in Assam

In Assam, the project stretchroad stretches under Nagaon – Dimapur Economic Corridor traverses through Hojai and Karbi Anglong districts.

- a. Hojai District:** Hojai is a new district in the state of Assam, in India. It was formed on 15 August 2015. Hojai is the Headquarter of the new district. Hojai district is formed with three tehsils of Nagaon district named Hojai, Doboka and Lanka. As per Indian census 2011, those three tehsils together had a population of 931,218. So, newly formed Hojai district had a population of 931,218 in 2011. Among those 499,565 are Muslim & 424,065 are Hindu. Muslims constitute 53.65% of district population, Hindu constitute 45.53% of district population.
- b. Karbi Anglong District:** Karbi Anglong district is one of the 33 administrative districts of Assam state in Northeastern India. The district is bounded by Golaghat district on the east, Morigaon district on the west, Nagaon and Golaghat districts on the north and Dima Hasao district and Nagaland state on the south. The district is located between 25° 33' and 26° 35' North latitude and from 92° 10' to 93° 50' East longitude. Diphu is the administrative headquarter of the district. Indigenous tribal communities particularly Karbi people form the majority of the population. According to the 2011 census Karbi Anglong District has a population of 965,280. This gives it a ranking of 451st in India (out of a total of 640). The district has a population density of 93 inhabitants per square kilometre (240/sq mi). Its population growth rate over the decade 2001-2011 was 17.58%. Karbi Anglong has a sex ratio of 951 females for every 1000 males and a literacy rate of 74%. With Male and Female constituting 82% and 65% respectively.

7.6.5 Topography, Geology, Seismicity and Soil

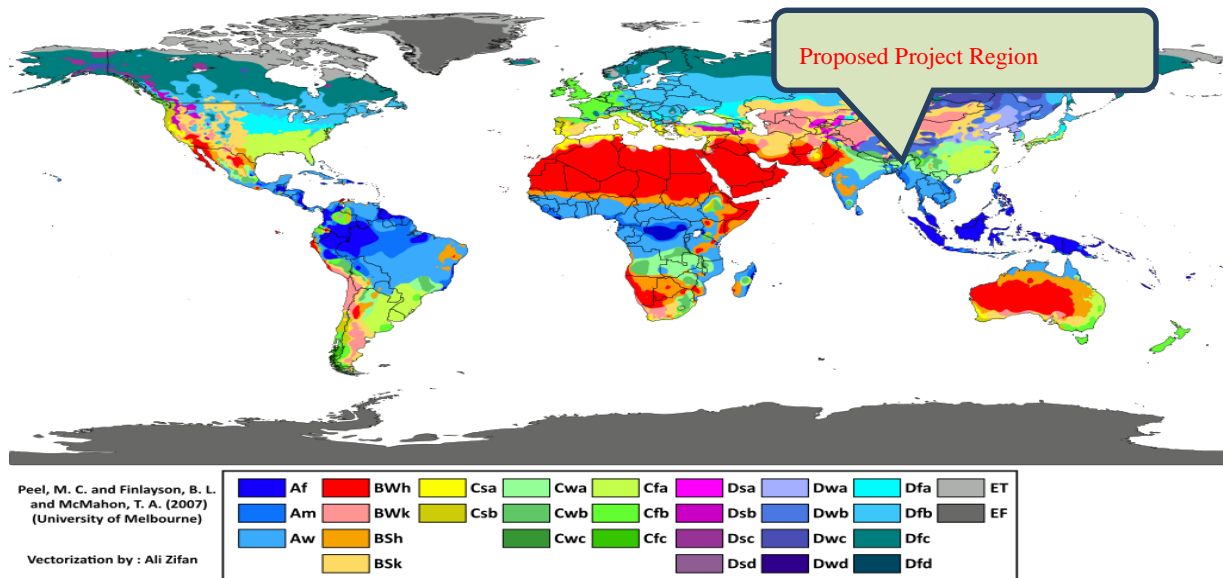
The topography, geology, seismicity and Soil of the project districts is detailed in **Table 7.9a** as follows:

Table 7.7: Topography, Geology, Seismicity and Soil of the project districts

Factors	Assam	
	Hojai District	Karbi Anglong District
Topography	Hojai is a newly formed district which is carved out from Nagaon district on 15 th August, 2015. Hojai is located at 26.0°N 92.87°E. It has an average elevation of 59 metres (193 feet).	The Karbi Anglong district covered total geographical area of 10434 Sq Km which accounts for 13.3% total geographical area of Assam State. It is almost consisting of undulating and hilly terrain with numerous rivers and streams. The altitude of Karbi Anglong district varies from 600 meters in the North range to 900 meters on south range, while that of the valley area range from 75 meters to 150 meters.
Geology	The geological formations of the Sub-division as seen from the outcrop ping rocks are confined mainly to three geological periods viz. Pre-cambrian, Tertiary and quaternary ages. Maximum areas of Hojai Sub-division are mostly covered by recent alluvium formed by the Brahmaputra tributaries.	The geological setting of the hill districts of Karbi Anglong is a complex one. The western part of Karbi Anglong physically attached with Meghalaya lying mainly north of the Mynriang and Amring rivers. Granite, gneiss and the Shillong group of rocks are predominant.
Seismicity	As per the seismic zoning map of India, as incorporated in Indian Standard Criteria for earthquake Resistant Design of Structure IS:1893-(Part I) 2002: General Provisions and Buildings; the entire state of Assam has been assigned to seismic zone V, which is the most seismotectonically active zones on the map.	As per the seismic zoning map of India, as incorporated in Indian Standard Criteria for earthquake Resistant Design of Structure IS:1893-(Part I) 2002: General Provisions and Buildings; the entire state of Assam has been assigned to seismic zone V, which is the most seismotectonically active zones on the map.
Soil	The soil of Hojai district is mainly Alluvium. From physical and chemical characteristics, alluvial soil can be classified into two classes, viz., Residual and transported soil. Residual soils are found Mainly near the foothills of the districts. Alluvial soil is The main transported soil in the plain area.	Two types of soils are mainly observed in the district. These are (1) Brown to pale brown soil developed on the top of the hills, lateritic in places and (2) the alluvial soil, sandy loam or clayey developed on the low lying terrain.

7.6.6 Climatology

In accordance to ²Köppen–Geiger Climate Classification system, The project districts i.e. Hojai, Karbi Anglong in Assam falls under³Humid subtropical climate (Cwa).



**Source: Peel, M. C., Finlayson, B. L., and McMahon, T. A. (University of Melbourne) Enhanced, modified, and vectorized by Ali Zifan. - Hydrology and Earth System Sciences: "Updated world map of the Köppen-Geiger climate classification"*

Figure 7.3: World Map of Köppen–Geiger Climate Classification

- a) **Hojai District:** The climate in Hojai is warm and temperate. In winter, there is much less rainfall in Hojai than in summer. The Köppen-Geiger climate classification is Cwa. In Hojai, the average annual temperature is 24.4 °C. Precipitation here averages 1562 mm. The driest month is January, with 9 mm of rain. With an average of 295 mm, the most precipitation falls in July. The driest month is January, with 9 mm of rain. With an average of 295 mm, the most precipitation falls in July.

² Köppen-Geiger Climate Classification is one of the most widely used climate classification systems. The system is based on the concept that native vegetation is the best expression of climate. Thus, climate zone boundaries have been selected with vegetation distribution in mind. It combines average annual and monthly temperatures and precipitation, and the seasonality of precipitation.

³A humid subtropical climate is a zone of climate characterized by hot and humid summers, and mild to cool winters. These climates normally lie on the southeast side of all continents, generally between latitudes 25° and 35° and are located poleward from adjacent tropical climates.

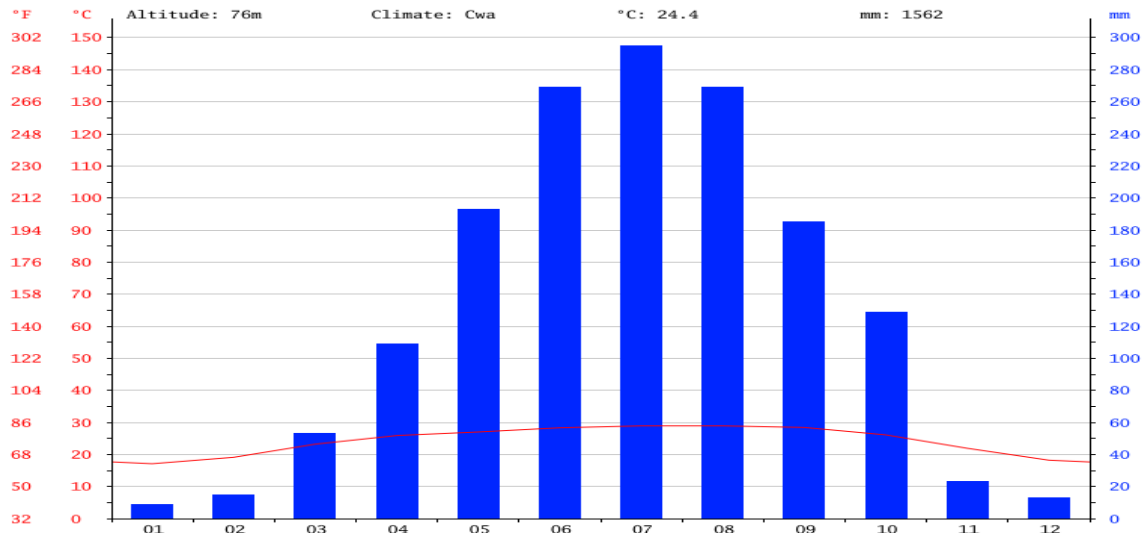


Figure 7.4: Climograph of Hojai District

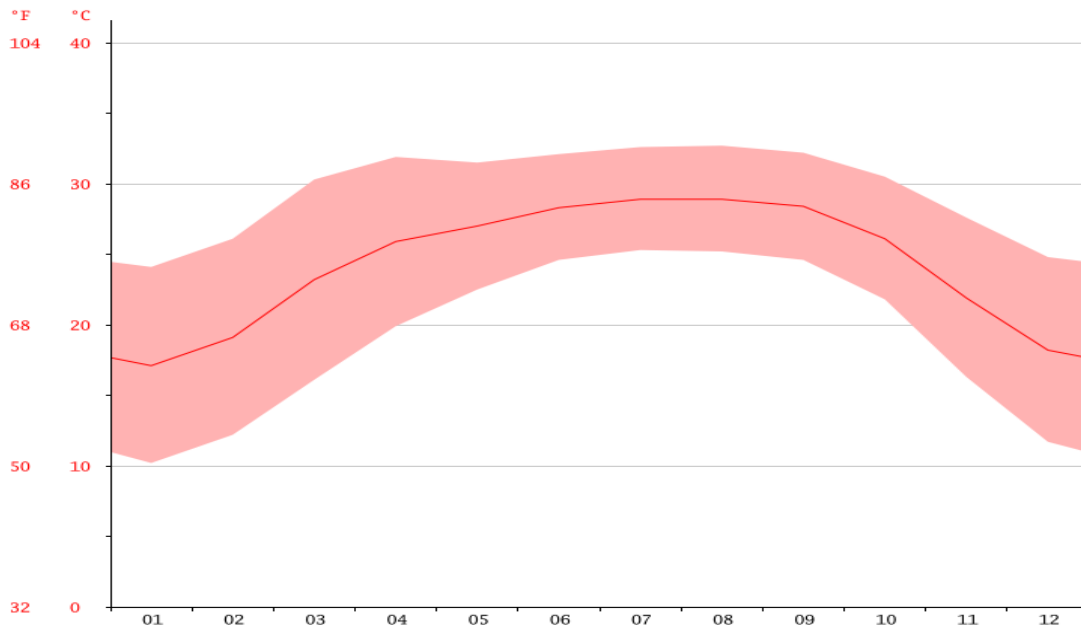


Figure 7.4: Temperature Graph of Hojai District

*Source: <https://en.climate-data.org/location/767206/>

- b) **Karbi Anglong District:** The climate is warm and temperate in ⁴Diphu. When compared with winter, the summers have much more rainfall. The Köppen-Geiger climate classification is Cwa. The average temperature in Diphu is 24.0 °C. In a year, the average rainfall is 1453 mm. The driest

⁴ Diphu is the headquarter of Karbi Anglong district in the state of Assam in India.

month is January, with 17 mm of rainfall. In July, the precipitation reaches its peak, with an average of 247 mm. The warmest month of the year is July, with an average temperature of 28.6 °C. At 16.5 °C on average, January is the coldest month of the year. The difference in precipitation between the driest month and the wettest month is 230 mm. The variation in annual temperature is around 12.1 °C.

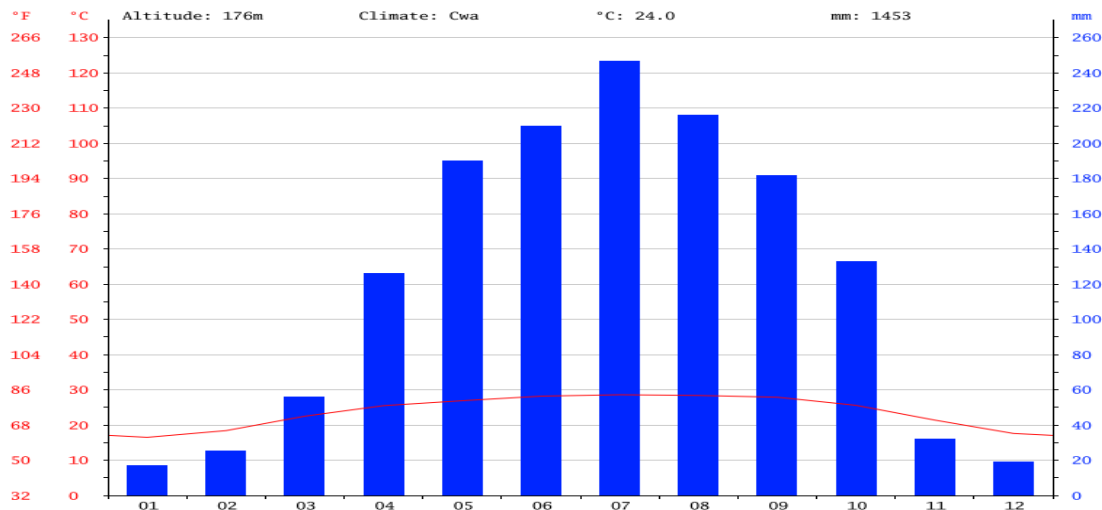


Figure 7.5: Climograph of Karbi Anglong District

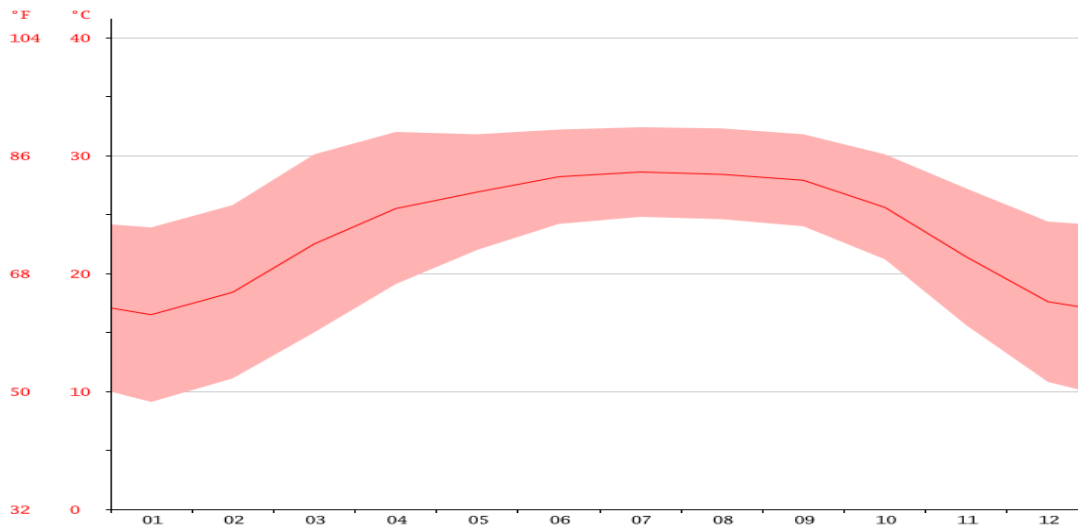


Figure 7.6: Temperature Graph of Karbi Anglong District

*Source: <https://en.climate-data.org/location/24634/>

7.6.7 Drainage Pattern

Two main rivers of the **Hojai** district are Kopili and Jamuna. After entering Assam, the Kopili

separates the Karbi Anglong district from the Dima Hasao North Cachar Hills district and flows into the Nagaon district in a north-westerly direction. While Jamuna River with a catchment of 3960 km² flows to the Kopili at Jamunamukh. The Kopili River finally flows to Kalang, a spill channel of Brahmaputra, near Hatimukh after traversing a distance of 290 km². The total catchment of Kopili River is about 16,421 km²

The drainage network of **Karbi Anglong** District forms the upper catchment of Dhansiri River, Jamuna and Kopili rivers. The drainage pattern is dendritic to sub-parallel and is controlled by structural features and underlying lithology.

7.6.8 Surface Water Resources in the Project Area

The project road stretches are traversing through various surface water bodies (Ponds/rivers etc.). **Table 7.10** as follows:

Table 7.8: List of Major Surface-Water Resources observed in NH-29 (Section 6 in Daboka To Lahorijan Section)

S.No.	Features	Existing Chainage (km)	Side	Dist from C/W edge (m)
1.	Pond	121+050	LHS	2.5
2.	Pond	144+600	RHS	4.0

7.6.9 Air Quality

Air quality along the project stretch is observed healthy and clean in the study area. No major dust emitting activities was observed along the project road. Ambient air quality monitoring for various parameters like PM₁₀, PM_{2.5}, SO_x, NO_x, CO shall be started at project site and surrounding area.

However, during detailed EIA & EMP study, air quality monitoring will be carried out along the road to understand the actual baseline condition.

Central and State Pollution Control Board guidelines shall be followed for sampling and analysis. The data will be compared with the National Ambient Air Quality Standard of CPCB as given in **Table 7.11** below.

Table 7.11: National Ambient Air Quality Standards

S. No.	Pollutants	Time Weighted Average	Concentration in Ambient Air		
			Industrial, Residential, Rural and Other areas	Ecological Sensitive Area (notified by Central Government)	Methods of Measurement
(1)	(2)	(3)	(4)	(5)	(6)
1.	Particulate Matter (size less than 10 μ m) or PM ₁₀ μ g/m ³	Annual* 24 hours**	60 100	60 100	Gravimetric TOEM Beta attenuation
2.	Particulate Matter (size less than 2.5 μ m) or PM _{2.5} μ g/m ³	Annual* 24 hours**	40 60	40 60	Gravimetric TOEM Beta attenuation
3.	Sulphur Dioxide (SO ₂), μ g/m ³	Annual* 24 hours**	50 80	20 80	Improved West and Gaeke Ultraviolet Fluorescence
4.	Nitrogen Dioxide (NO _x), μ g/m ³	Annual* 24 hours**	40 80	30 80	Modified Jacob & Hochheiser (Na-Arsenite) Chemiluminescence
5.	Carbon Monoxide (CO), μ g/m ³	8 hours** 1 hour**	02 04	02 04	Non Dispersive Infra-Red (NDIR)

***Source:** Central Pollution Control Board

Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform interval.

***24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be compiled with 98% time in a year. 2 % of the time, they may exceed the limits but not on two consecutive days of monitoring.*

7.6.10 Noise Level

The noise level on road side was found low on the stretch except the market area that has some traffic during day time otherwise the noise level is normal as observed during consultation. Day and night time ambient noise levels will be determined based on monitored data. Monitoring

location shall be finalized based on the sensitive receptors and source of noise pollution. The data will be compared with Ambient Noise level standards as given in **Table 7.12** below:

Table 7.12: Ambient Noise Monitoring Standards

Area/Class	Noise Level (Leq dB (A))*	
	Day Time	Night Time
Industrial	75	70
Commercial/Mixed	65	55
Residential/Rural	55	45
Sensitive	50	40

Note:-

1. Day time shall mean from 6 a.m. to 10 p.m. and Night time shall mean from 10 p.m. to 6 a.m.
2. Silence Zone is an area comprising not less than 100 meters around hospitals, education institutions, courts, religious places or any other area, which is declared as such by Competent Authority.
3. Mixed categories of areas may be declared as one of the four above-mentioned categories by the Competent Authority.
4. * dB(A) Leq denotes the time weighted average of the level of decibels on scale A which is related to Human Beings
5. A “decibel” is the unit in which noise is measured
6. “A” in dB (A) Leq, denotes the frequency weighted in the measurement of the noise corresponds to frequency response characteristics of the human ear.
7. Leq: It is an energy means of the noise level over a specified period.

7.6.11 Forest & Biodiversity

a) Assam

In the “Revised Survey of Forest Types in India”, Champion and Seth categorized as many as fifty-one different forest types/ sub types for this region. But, the species diversity is so spectacular that it becomes often difficult to clearly identify separate rich to existing plant formations. However, broadly speaking the forest in Assam can be described into following types/ sub types.

- Tropical Wet Evergreen Forests.
- Tropical Semi Evergreen Forests.
- Tropical Moist Deciduous Forests.
- Sub-Tropical Broadleaf Hill Forests.
- Sub-Tropical Pine Forests.
- Littoral and Swamp Forests.
- Grassland and Savannahs.

Important Tree Species along the project road: Hollong (*Dipterocarpus macrocarpus*),

Dipterocarpus terbinatus (Garjan) *Michelia glabra* (Champ), *Palaquium polyanthum* (Kathalua) etc. *Sal (Shora robusta)* *Adina cordifolia* (Haldu), *Ficus species* (Bor, Dimoru, Dhupbor, Bot, Athabor, tengabor, Lotadioru, Khongaldimoru), *Michelia champaca* (Teeta champa), *Terminalia species* (Hilikha, Bhomora, Bohera). *Toona ciliate* (Poma) etc. *Adina cordifolia* (Haldu), *Albizia species* (Siris, *Alstonia scholaris* (Satiana), *Dalbergia species* (Sissoo, Medelua), *Ficus species* (Bot, Bor, Dimoru), *Aegle marmelos* (Bel), *Albizia species* (Siris), *Cassia fistula* (Sonaru), *Bombaxciba* (Simul), *Melia azedarach* (Neem), *Moringa oleifera* (Sajana) and *Terminalia species* (Hilikha, Bhomora) etc.

7.6.12 Reserved Forest and Eco sensitive Locations along the Project Road

List showing the forest stretches is presented in **Table 7.13**.

Table 7.13: List of Forest Stretches

Sl No.	Design Chainage (km)		Length (m)	Forest Name
	From	To		
Daboka – Lahorijan (Section 6)				
Nil				

7.6.13 Social and Cultural Feature

Table 7.14: Built-up locations along the planned project road

Sl No.	Design Chainage (km)		Length (m)	Village
	From	To		
Daboka – Lahorijan Road (NH 29)				
Section 6+7				
Nil				

**Note: These lengths are exclusive of structures*

7.6.14 Historical/ Archaeological Sites

No archeological site listed under Archeological Survey of India, has been identified in close vicinity of the project road.

7.6.15 Educational Facilities

About 7 education facilities are likely to be affected by the proposed improvement. The details of facilities are given in **Table 7.15** below.

Table 7.15: Education facilities along Section-6 Daboka To Lahorijan Section of NH-29

S.No.	Features	Existing Chainage (km)	Road Segment	Side	Dist from C/W edge (m)
Section 6+7					
1.	Primary School	114+950	NH29	RHS	20.0

S.No.	Features	Existing Chainage (km)	Road Segment	Side	Dist from C/W edge (m)
2.	Rangsina M.E .School	121+380	NH29	LHS	9.0
3.	Mohongijua M.E. School	124+220	NH29	LHS	10.0
4.	Kohongojur H.S.School	126+300	NH29	LHS	14.0
5.	Primary School	127+420	NH29	LHS	13.0
6.	Oxford School	128+480	NH29	LHS	5.0
7.	Primary School	128+530	NH29	LHS	5.0
8.	School	135+020	NH29	LHS	35.0
9.	School	138+600	NH29	LHS	14.0

7.6.16 Medical Facilities

2 nos Hospitals/Health Centers located on (Daboka to Lahorijan) Section6of NH-29. Details of these hospital is given in **Table7.16**below.

Table 7.16: Medical Facilities along Daboka To Lahorijan Section of NH-29

S.No.	Features	Existing Chainage (km)	Road Segment	Side	Dist from C/W edge (m)
Section 6					
1.	Mohongijua Hospital	124+300	NH29	LHS	11.0
2.	Vetenary Hospital	129+400	NH29	RHS	6.0

7.6.17 Religious & Cultural Structures

6Religious structure (Temples/Church & Mosque) are likely to be impacted in Section-6 of the stretch due to the proposed 4-lane widening Daboka to Lahorijan Sectionof NH-29. Details of these hospitals are given in **Table 7.17** below.

Table 7.17: Religious & Cultural Structures along Daboka To Lahorijan Section of NH-29

S.No.	Features	Existing Chainage (km)	Road Segment	Side	Dist from C/W edge (m)
Section 6					
1.	Temple	128+010	NH29	LHS	1.5
2.	Temple	128+180	NH29	LHS	1.3
3.	Temple	128+330	NH29	LHS	1.5
4.	Church	128+900	NH29	LHS	20.0
5.	Church	129+040	NH29	LHS	4.5
6.	Temple	129+120	NH29	LHS	10.0

S.No.	Features	Existing Chainage (km)	Road Segment	Side	Dist from C/W edge (m)
7.	Temple	134+530	NH29	LHS	10.0
8.	Temple	145+400	NH29	LHS	0.5

7.7 STAKEHOLDER CONSULTATION

7.7.1 Process and Methodology

As a part of the project preparation and to ensure that the community support is obtained and the project supports the felt needs of the people; stakeholder consultations were carried out as an integral component. A continuous involvement of the stakeholders and the affected community was obtained.

Individual interviews, field level observations, transect walk, community consultations & meetings were used to collect stakeholders input on the project. Meetings with community were conducted in both ways i.e. formal as well as informal.

Detailed Stakeholder consultation and socio-economic surveys shall be carried out during the EIA stage.

7.8 SCREENING OF POTENTIAL ENVIRONMENTAL & SOCIAL IMPACTS

7.8.1 Analysis of Data and Environmental & Social Screening

Based on the collected site data and field investigations, the critical sections have been recognized for further detailed Environmental Impact Assessment study. For convenience, the road has been divided into different segments and was screened with respect to sensitive environment features as mentioned in **Table 7.18**

Table 7.18: Road Segments with Preliminary Findings

Road Segment	Road Section	Description
NH-29	Daboka To Lahorijan Section	<ul style="list-style-type: none"> ■ Daboka Reserve Forest is located from Km 41+970 to Km 49+270 with a total length of 7.300 km. ■ Sildharampur Reserve Forest is located from Km 58+280 to Km 63+550 with a total length of 5.270 km. ■ Presence of waterbodies (ponds & rivers) at several locations as detailed out in Table 7.14. ■ Presence of Educational Facilities at several locations as detailed out in Table 7.15. ■ Presence of Medical Facilities at several locations as detailed out in Table 7.16. ■ Presence of religious structures at several locations as detailed out in Table 7.17.

As the number of environmental features in a particular section increases, the project road section becomes more sensitive. Special care will be needed for the sensitive zones during designing and construction phase as well. Formulation of specific mitigation measures has to be done for adverse impacts in those sections during the detailed environmental assessment study.

7.8.2 Identification of Critical Sections

All the road sections were subjected to screening considering the major environmental indicators within area of influence, their importance and their presence in the section and their degree of sensitivity.

- Water resources
- Major Settlement/ built-up area
- Religious structures
- Road side tree cutting
- Forest Area
- Environmentally Protected Area

The road sections with more than one environmental feature have been designated as sensitive section. All the sensitive section shall be carefully analyzed during Environmental Impact Assessment study and accordingly safeguard measures will be provided in Environmental Management Plan.

7.8.2.1 Water Resources

River/ pond / lake has major environmental significance in the project area as they are being utilized by the nearby villagers. The details of water resources in the project road are listed in **Table 7.14**.

7.8.2.2 Settlement / Built-up Areas

The road section with high settlement area has been considered as sensitive zone. The widening process will involve loss of public properties, resettlement and rehabilitation problem. The people residing at roadside are exposed to the emissions and are vulnerable to health problems. During construction phase, they will be directly exposed to additional emissions and noise pollution. The sensitive receptors are located mainly in the settlement area. Thus, the area without any settlement or low built-up area is likely to be affected less. Some section of road is passing through populated area along the road. During detailed study, impacts will be identified on the structures falling within ROW and rehabilitation and resettlement plan will be prepared as per the requirement. Thus, these sections have importance both from environmental and social aspects.

7.8.2.3 Religious/ Cultural Features

A number of religious structures are located both sides along the project corridor. These structures are socially critical issue and hence make the section containing them as high sensitive impact zones. All these sites are critical and proper attention shall be given during detailed Environmental Impact Assessment study.

7.8.2.4 Roadside Tree Cutting

Tree cutting is a critical environmental issue but the cutting of roadside trees is inevitable during the widening process. Road side trees present throughout length of the project road will be counted during detailed study. Species wise and girth wise details of trees within ROW will be provided in EIA & EMP report.

7.8.3 Potential Environmental Impacts and Mitigation

Attempt has been made to identify and assess the probable impacts on different environmental parameters due to planning, construction and the operation of the proposed development. After studying the existing baseline environmental scenario, initial field surveys, reviewing the process and related statutory norms, the major impacts can be identified and assessed during the design, construction and the operation phases.

Road construction related impacts occur at three stages of the project:

- i) Design and Pre-construction
- ii) Construction
- iii) Operation

The major impacts during Planning and designing phase is related with the land acquisition, since widening needs land area throughout the corridor. The impacts during construction phase, in general, have adverse influence on all the components of environment. Most of these impacts are short lived and reversible in nature. A proper care is must to minimize the negative impacts, which can facilitate the restoration. Operation phase impacts are continuous in nature. To identify these impacts broadly on physical, ecological and social environment Impact Identification Matrix of potential environmental impacts due to the project and preliminary mitigation measures has been developed and is presented in **Table 7.19**.

Table 7.19: Matrix of Potential Environmental Impacts due to the Project and Preliminary Mitigation Measures

Environmental Components	Impacts	Direct/ Indirect	Significance (High/ Medium/Low)	Duration of Impacts	Mitigation
Preconstruction	Land Acquisition	D	H	L	The alignment selection should be in such manner to minimize the acquisition of land. As far as possible the productive land area should be avoided to acquire.
Construction					
Physical Resources					
Soil	Loss of top soil due to site clearance, excavation, Hill cutting	D	H	L	Top soil should be removed & stored separately during excavation. Re-vegetate the disturbed slope as early as possible
	Soil compaction due to storage of quarry materials and other heavy equipment's, movements of heavy vehicles at the site	D	H	L	Regulation of movement and parking of vehicles and equipment outside ROW. Storage of materials should be allowed only at wasteland or barren area.
Air Quality	Reduced buffering of air pollutants, hotter, drier microclimate due to tree felling and vegetation loss during site clearance	I	L	L	Tree plantation
	Localized increase in pollutants due to increase in number of construction vehicles and equipment's.	D	L	S	Vehicles should be maintained such that exhaust emissions are minimum.
	Dust generation due to earth excavation, transportation & heavy vehicles maintenance or operation, Construction of structures and earth works, asphalt & crusher plants	I	L	S	<ul style="list-style-type: none"> Vehicles delivering materials should be covered. Regular water sprinkling over exposed surfaces.
	Toxic gas emissions during asphalt preparation, bituminous heating	D	M	S	<ul style="list-style-type: none"> The asphalt mixing plant should be located in conformity with the statutory requirements. Consent to Establish and Consent to Operate from SPCB should be obtained prior to operation of plant.

Environmental Components	Impacts	Direct/ Indirect	Significance (High/ Medium/Low)	Duration of Impacts	Mitigation
Noise Quality	Increased noise level due to excavators/ machinery etc., operation and maintenance of heavy vehicles and equipment's, Asphalt preparation and crushing	D	M	S	Noise standards of industrial enterprises shall be strictly enforced. Proper scheduling of the operation of these equipment's. The stationary noise generating equipment's should be installed sufficiently away from habitation area.
Surface Water	Additional pressure on water demand due to the water requirement for construction works	D	M	S	Alternative water supply system for construction should be ensured in such a way to prevent the additional pressure on public water supply system
	Damage to streams, springs, from excavation, cutting of hill, spoil disposal	D	H	L	Prohibit activities which cause blockage or otherwise impede water flow Suitable measures should be taken to avoid any damage to springs.
	Blockage of water flow channels due to unmanaged excavation and earth filling	D	M	S	Proper excavation and disposal of the extra fill material away from stream. Provision of cross drainage during construction along the stream and springs.
	Contamination of water due to spillage, construction wastes	I	M	S	Strict regulation of traffic flow, waste disposals, bunding around fuel storage site, proper disposal system at equipment and vehicle service stations
	Impairment of surface water bodies, new water bodies due to Quarries/ borrow pits	I	H	L	Controlled quarrying and borrowing
Ground water	Ground water exploitation for construction works and workforce camp	I	L	S	Regulation of ground water extraction Surface water should be used for construction

Environmental Components	Impacts	Direct/ Indirect	Significance (High/ Medium/Low)	Duration of Impacts	Mitigation
Drainage Pattern	Interference with natural drainage flow due to earth excavation dumping, disposal of wastes and surplus earth materials, and construction of structures and earthworks	D	M	S	Regulation of dumping of waste materials and proper care should be taken at the site of construction to minimize the wastage. Clean fill material devoid of soil particles to prevent siltation and deposition on the way of natural drainage.
Ecological Resources					
Vegetation	• Impacts on forests from land take and loss of trees.	D/I	H	L	Cut only those trees affected by permanent works; specify non-timber construction materials Strengthen forest protection and management.
	• Fire risks during vegetation clearance and asphalt preparation	I	H	L	
	• Encroachment on to forest for construction camps and loss of forest resources due to demands for fuel woods of workforce and incomers	D/I	M	L	Camp should be established away from forest area Prohibition of clearing of trees for firewood, prohibiting on trapping and killing of wild life Kerosene or gas cylinders should be supplied to campsite to avoid use of firewood.
Wild Animals	Disturbance or hunting of wild animals	I	H	S	Control workforce, awareness programme for the workforce, strict enforcement of Wildlife (Protection) Act,1972. No camp site near forest area. Prohibition of hunting of wild animals
Social Environment					
Resettlement and Rehabilitation	Problem of Resettlement and Rehabilitation	D	H	L	Adjustment in alignment to avoid displacement Early identification and entitlement of the project affected people Early planning of rehabilitation and resettlement
Livelihood	Economic losses as a result of property loss due to land take for widening	D	M	L	The alignment selection should be done in a way to minimize the land acquisition

Environmental Components	Impacts	Direct/ Indirect	Significance (High/ Medium/Low)	Duration of Impacts	Mitigation
Employment	Employment on road construction, and resultant flow	D	H	S	Encourage local recruitment
Religious / Cultural feature	Impact on religious/ cultural structure	D	H	L	Shifting and restoration of structures through public consultation.
Health	<ul style="list-style-type: none"> Health problems to the local people settled near the construction sites because of toxic gaseous emissions due to asphalt preparation and crushing Asphalt odor and dust due to asphalt and crusher plant and laying of pavement. 	D	M	S	Appropriate siting of plant establishment. Strict adherence to the emission standards laid by the Central Pollution Control Board, regular monitoring of emissions.
		D	M	S	Provision of emergency medical facility.
Sanitation	Insanitation condition at Campsite	D	H	S	Suitable medical facilities for workers First Aid facilities at camp/ construction site
Safety at Work site	Accidents at work and on the road	D/I	M/H	S	Safe working techniques; safety clothing; proper training to workers and drivers
Operational Phase					
Natural Resources	Long term stability problems along some sections of the road	D	M	L	Provide adequate resources for effective maintenance programme
Air Quality	Increase in air quality due to stimulation of traffic flow, intense human activity, congestion	D	L	L	Providing lateral buffer zones in design, regular Regulation of air pollution by legislation and public awareness Regulate development activities along the corridor
Forests	<ul style="list-style-type: none"> Increased exposure to anthropogenic activities due to better access Forest cutting and poaching due to induced development 	D	M	L	Enactment and enforcement of laws regulating human intrusions, implementation of traffic control measures such as low speed limits near the forest Better forest management
		I	M	L	

7.9 ENVIRONMENTAL MANAGEMENT PLAN

A site-specific Environmental Management Plan (EMP) will be prepared for avoiding, mitigating, checking the adverse impacts envisaged during EIA studies on various environmental components during construction and operational phase of the project. This Environmental Management Plan will include brief description about the project, EMP for construction and operation phase, tree plantation strategy and environmental monitoring plans.

7.10 STRUCTURE OF THE EIA & EMP REPORT

The EIA & EMP report will be prepared as per MoEF&CC EIA Notification 2006 and amendments thereafter and chapters will also be structured accordingly. Structure of EIA & EMP report is provided in **Table 7.20**.

Table 7.20: Structure of EIA & EMP Report

Chapter No.	Report Structure	Content Description
1.	Introduction	<ul style="list-style-type: none"> ■ Purpose of the report ■ Identification of project & project proponent ■ Brief description of nature, size, location of the project and its importance to the country, region ■ Scope of the study – details of regulatory scoping carried out (As per Terms of Reference)
2.	Project Description	<ul style="list-style-type: none"> ■ Condensed description of those aspects of the project (based on project feasibility study), likely to cause environmental effects. Details should be provided to give clear picture of the following: <ul style="list-style-type: none"> ■ Type of project ■ Need for the project ■ Location (maps showing general location, specific location, project boundary & project site layout) ■ Size or magnitude of operation (incl. Associated activities required by or for the project) ■ Proposed schedule for approval and implementation ■ Technology and process description ■ Project description. Including drawings showing project layout, components of project etc. Schematic representations of the feasibility drawings which give information important for EIA purpose
3.	Description of the Environment	<ul style="list-style-type: none"> ■ Study area, period, components & methodology ■ Establishment of baseline for valued environmental components, as identified in the scope ■ Base maps of all environmental components
4.	Anticipated Environmental Impacts & Mitigation Measures	<ul style="list-style-type: none"> ■ Details of Investigated Environmental impacts due to project location, possible accidents, project design, project construction, regular operations, final decommissioning or rehabilitation of a completed project ■ Measures for minimizing and / or offsetting adverse impacts identified

Chapter No.	Report Structure	Content Description
		<ul style="list-style-type: none"> Irreversible and Irretrievable commitments of environmental components Assessment of significance of impacts (Criteria for determining significance, Assigning significance) Mitigation measures
5.	Environmental Monitoring Program	<ul style="list-style-type: none"> Technical aspects of monitoring the effectiveness of mitigation measures (incl. Measurement methodologies, frequency, location, data analysis, reporting schedules, emergency procedures, detailed budget & procurement schedules)
6.	Additional Studies	<ul style="list-style-type: none"> Public Consultation Risk assessment Social Impact Assessment. R&R Action Plans
7.	Project Benefits	<ul style="list-style-type: none"> Improvements in the physical infrastructure Improvements in the social infrastructure Employment potential –skilled; semi-skilled and unskilled Other tangible benefits
8.	EMP	<ul style="list-style-type: none"> Description of the administrative aspects of ensuring that mitigative measures are implemented and their effectiveness monitored, after approval of the EIA
9.	Summary & Conclusion	<ul style="list-style-type: none"> Overall justification for implementation of the project Explanation of how, adverse effects have been mitigated
10.	Disclosure of Consultants engaged	<ul style="list-style-type: none"> The names of the Consultants engaged with their brief profile

ANNEXURE-I: PHOTO-LOG OF THE ENVIRONMENTAL AND SOCIAL SCREENING FIELD VISIT

	
Daboka Reserve Forest in Daboka to Lahorijan Section of NH-29	Longhit Reserve Forest in Daboka to Lahorijan Section of NH-29
	
River at Km 40+100 in Dabokato Lahorijan Section of NH-29	River at Km 108+800 in Daboka to Lahorijan Section of NH-29
	
Temple at Km 128+010 in Daboka to Lahorijan Section of NH-29	Forest office on either side of the road at Km 157+300 in Daboka to Lahorijan Section of NH-29

Chapter 8 : Social Impact Assessment

CHAPTER 8

PRELIMINARY SOCIAL IMPACT ASSESSMENT

8.0 SOCIAL SCREENING

8.1 Introduction

The proposed project of the Nagaon – Dimapur Economic Corridor, have three stretches viz., 1) Daboka – Manja, 2) Manja – Lahorijan, & 3) Numaligarh – Khatkhati, in the state of Assam has been specified in Chapter 1. **The Section-6 under Daboka-Manja stretch**, has the project influence area (PIA) of the project has been identified in Chapter 3 Socio-economic profile as (1) Direct PIA as the vicinity on both sides of the project road, (2) Indirect PIA of the districts of Hojai, East Karbi Anglong and Golaghat and (3) Tertiary PIA as the state of Assam as a whole.

The socio-economic profile of the indirect and tertiary project influence area has been prepared based on secondary official sources of information and discussed in Chapter 3 Socio-economic profile. The present chapter provides with a screening report on possible social impacts of the vicinity of the project based on an initial assessment from the reconnaissance survey and further field investigations.

8.2 Social Screening

The project is expected to bring quite a few benefits, viz.

- Improved connectivity with Daboka, Manja, Dimapur, Ranjgajan, Silonijan, Sariajan, Bokajan and Numaligarh
- Take care of traffic from Dimapur side towards north and north-west;
- Connectivity with Dimapur of Nagaland
- The proposed road will share the load of NH37 traffic also;
- Lower transport costs for freight and passengers of motorised and non-motorised vehicles;
- Improved Road network connectivity to the villages in the vicinity of the road;
- Enhanced traffic facilities and volume in the project road;
- Enhancement in economic opportunities/activities of the local people;
- Enhanced basic amenities to the villages along the proposed road;
- Rural prosperity of the project influence area;

Although such benefits were not quantified, the project is also expected to help alleviate development constraints in agriculture, commerce, education, health, social welfare, and public safety and contribute to general expansion and diversification of development activities.

Preliminary survey activities have been carried out to assess the potential impacts of the proposed project for the direct influence area. Features and properties along the Corridor of Impact (COI) and Right of Way (ROW) and distance from the road to habitations and their distance from the center line were observed, recorded and analyzed and presented.

8.3 Existing Road Width

The average carriageway width of the existing road is 7 - 10 m and the width of the earthen shoulder varies from 1 m to 2.0m on both sides. Details of the existing carriageway width is presented in Appendices Volume (under Volume-IA).

8.4 Existing Right of Way (ROW)

As per investigation with sample measurements at site the existing total ROW at built up area and forest area are found to vary between 10.0m-45.0m in total. It appears from the first impression that the improved facility can be accommodated with acquisition of lower order structures except at Dokmoka and Manja where provision of bypass is thought off.

Existing ROW information needs to be verified upon receipt of revenue maps. The collection of Revenue Maps for verification of the official record is in process. A statement of existing ROW is provided in Chapter-2.

8.5 Terrain and Land Use

The project road is passing mainly through plain & rolling terrain.

Daboka, Sildhampur, Patradisa and Longnit Reserve Forests are involved for Section-1, 2 & 5 of the road stretches.

8.6 Built up Areas

The settlements along the existing road is given in **Table 8.1** and pictures in **Plate 8.1**.

Table 8.1: Settlements of Villages/Towns along the Existing Road

Design Chainage (km)		Length (m)	TCS	Remarks
From	To			
Daboka – Lahorijan Road (NH 29)				
Section 6+7				
NIL				

Source: Reconnaissance Survey by Consultant, July&Aug 2018

Plate 8.1: Roadside Settlements



Source: Reconnaissance Survey by Consultant, July & Aug 2018

In addition to the above, a few clusters of habitation were also found at many locations along the project road in scattered manner. These are mainly comprised of kutcha type structures.

8.7 Project Impacts

The assessment of potential positive externalities and negative impacts of the project is identified preliminarily. The assessment of impacts is being covered under following variables: number of structures likely to be impacted, number of religious structures likely to be impacted, number of community property and resources likely to be impacted, built up sections along the corridor etc. The project may trigger the following categories of loss:

- Loss of Agricultural/ homestead Land and other Properties
- Loss of Residential Properties
- Loss of Commercial Properties
- Families losing Residential cum Commercial Structures
- Loss of economic/ livelihoods

The project affected families may be categorized in following three broad categories:

- Title holders: People who are losing land, land & structures, only part of structures, which are under legal ownership of the incumbent
- Non-Titleholders: People who are losing structures/ part of structures, which were erected/ extended on the land not under his legal ownership, and
- Livelihoods Losers: Any person from the previous categories, Kiosks operators, tenants of the affected structures and employees of the affected Business are likely to be affected with existing economic/ physical livelihood losses.

The details of land acquisition and quantum of loss under each category will be given in DPR stage.

8.7.1 Impacts on Land

Proposed ROW of 42m is considered for the road sections in rural area. In built-up area 47m PROW is considered. In forest area, to minimize the land acquisition, 35.5m PROW and at the approach of elephant underpasses, 42.5m PROW are considered. In Manja Bypass 60m ROW is considered.

As per assessment at this stage tentative land acquisition is assessed as below:

- **For Section 6+7: 84.20 Ha**

8.7.2 Impacts on Structures

The impacts on structures on the both sides of the existing road have been preliminarily estimated within PROW. All the structures mentioned in the list may not necessarily be affected. The list of likely affected structures is presented in **Table 8.2**.

Table 8.2: Likely Affected Structures

Sl.	Type of Structure	No of Likely Affected Structures			
		Pucca	Semi-Pucca	Katcha	Total
Section 6+7					
1	Residential Structure	4	10	59	73
2	Commercial Structure	12	15	5	32
3	Other structure	5	-	-	1
	Total	21	25	64	106

Source: Reconnaissance Survey by Consultant, July&Aug 2018

8.7.3 Impacts on Community Structures

The impacts on community structures on the both sides of the existing road have also been estimated within PROW. The final design will avoid the community structures as much as possible. The list of likely affected community structures is presented in **Table 8.3** and pictures in **Plate 8.2**.

Table 8.3: Likely Affected Community Structures

Sl.	Type of Structure	No of Likely Affected Structures
		Section-6+7
1	Religious Structure	5
2	Schools/ Educational Institutes	-
3	Health Centre/ Hospitals	-
4	Government Offices	-
5	Factory, Godowns etc.	-
6	Passenger Shelter	-
7	Boundaries	-
8	Other Structures	-
	Total	5

Source: Reconnaissance Survey by Consultant, Aug & Sep 2017

Plate 8.2: Roadside Community Structures



Source: Reconnaissance Survey by Consultant, July&Aug 2018

8.8 Community Perceptions about the Project

Consultation with Project Affected Persons (PAPs) is the starting point to address involuntary resettlement issues, concerning land acquisition and rehabilitation. People affected by resettlement may be apprehensive that they will lose their livelihoods and communities. Information dissemination of the project is the first principle of consultation. Participation in planning and managing resettlement helps to reduce their fears and gives PAPs an opportunity to participate in key decisions that affect their lives.

8.9 Further Detailed Social & Resettlement Assessment

The detailed Social & Resettlement Assessment will be conducted after the road alignment and development schemes are being finalized. The consultant will undertake census (100%) and socio-economic surveys (25%) of the affected persons, as per the proposed development. In addition to the census and socio-economic surveys, public consultations with the stakeholders including the communities and affected persons will be conducted.

The objective is to establish a base line profile of population which includes data on gender, ethnicity, social structure, employment and labour patterns, sources of income (including production and marketing activities), local tenure and property rights arrangements, access to social services and facilities (including health, education, and agricultural extension and credit); use of community and natural resources relevant to formulation of development strategies in order to assist in determining project impacts on the social, economic, cultural, and livelihood activities of affected communities.

All untitled occupants will be recorded at the initial stages and identify cards will be issued to ensure there is no further influx of people into the project area. All consultations with affected persons should be fully documented

The consultant would prepare Resettlement and Rehabilitation Plan; assess feasibility and effectiveness of income restoration strategies and suitability and availability to relocation sites as per procedures of NH Act 1956 and the compensation and assistance will be guided through Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCTLARR 2013), and/ or guidelines set by Govt. of Assam.

8.10 Conclusions/Recommendations

The people were generally enthusiastic towards the project and believed that it will bring social and economic development in the region. People believed that the development of road will improve connectivity for the local people. Agriculture is the main economic activity in the project area. The farmers believe the road will improve their accessibility with the nearby market places by reducing the travel time. They anticipate better income as the cost of travel will be reduced and access to socio-economic facilities will be enhanced. People wanted that the payment of compensation and other rehabilitation measures be completed before the start of construction work. People were particularly concerned about the road safety issues

and expressed the need of proper signage, speed breakers and pedestrian crossings to minimize the risk of accidents. They even demanded facilities like bus stops, public toilets etc. Apprehensions raised by the community include more accidents, houses coming closer to the proposed alignment, more noise pollution, agriculture loss, effect on livelihood, and dug well loss.

The community perceives that the project will help in increasing road safety, promote more business, better service facilities, and better conveyance and promote local employment opportunities. They consider that it would lead to increase in land rates and smooth traffic.

Chapter 9 : Cost Estimates

CHAPTER 9

COST ESTIMATES

9.0 COST ESTIMATES

9.1 General

Cost estimate has been prepared for the total project in four sections considering the various items of works associated with identified improvement proposals using unit rates prevailing currently in order to assess the updated cost structures in general.

9.2 Methodology

9.2.1 Estimation of Quantities

Quantities of different items of work have been calculated on the basis of typical existing cross-sections as developed from the information obtained through inventory/reconnaissance survey and typical proposed cross-sections. Quantities for other work items have also been computed based on proposed improvement, road alignment and widening proposals as recommended. The major items of work considered are:

- Site Clearance and Dismantling
- Earthwork
- Granular Sub Base and Base Courses
- Bituminous Courses (Flexible Pavement)
- Culverts
- Bridges, EUP, VUP, VOP
- Drainage and Protection Works
- Junctions
- Traffic Signs, Marking and Appurtenances
- Bus-bay and Truck Lay byes
- Repair and Rehabilitation
- Road Maintenance

9.2.2 Unit Rates of Civil Works

Unit rates are primarily estimated by using the SOR of NH (Roads), Govt. of Assam for National Highway Roads for 2013-14. Proper escalation as per circular has been added to the base rate in order to derive the current rate. Carriage of aggregates for road works from Quarry to Plant and Plant to Site exceeding the one considered in the SOR are added to the Base rate to obtain the final rate of the items of works. Unit rates for other items of work were finalized after considering the current market rates or from information or other major projects of similar standards.

9.2.3 Civil Cost and TPC

Considering various items of works associated with identified improvements and current unit rates, cost estimate has been prepared. Summary Civil cost and TPC is provided in **Table 9.1**.

Table 9.1: Summary of Civil Cost and TPC

Section No.		Sec-6+7
Civil Cost	(Rs.)	3,53,57,50,594
Total cost including GST, Contingency, Administration, Supervision, Maintenance etc.	(Rs.)	2,78,28,65,295
Cost for LA, R&R, Utility and Environment Mitigation	(Rs.)	18,64,61,937
Total Project Cost (Rs.)		6,31,86,15,889
Cost per km (Rs. Crore)		19.82

9.2.4 Other Costs

Costs against various pre-construction activities (asunder listed below) have been assessed on the basis of available information and included in **Table 9.1** above.

- Environmental Monitoring and Mitigation Cost
- Land Acquisition Cost
- Social Cost (R&R)
- Utility Shifting Cost
- Tree Cutting Cost

The backup of estimate and detail of rate are provided in cost estimate volume.

Abstract of cost is provided in **Table 9.2**.

Table 9.2: Abstract of Cost

Item	Bill Description	Rate (Rs.)	Amount(Rs)
BILL# 01	Site Clearance & Dismantling	Rs.	6,576,533
BILL# 02	Earthwork	Rs.	301,628,743
BILL# 03	Base & Sub Base	Rs.	643,699,514
BILL# 04	Pavement (Flexible)	Rs.	781,807,863
BILL# 05	Drainage & Protection	Rs.	348,142,758
BILL# 06	Landscaping	Rs.	30,426,007
BILL# 07	Junction	Rs.	83,165,606
BILL# 08	Bus Bay	Rs.	16,660,528
BILL# 09	Truck Lay Bye	Rs.	9,806,517
BILL# 10	Illumination	Rs.	3,611,368
BILL# 11	Road Furniture	Rs.	208,250,102
A.	Civil Cost for Highways	Rs.	2,43,37,75,539
	Culvert	Rs.	32,435,128
	Bridge (Major)	Rs.	320,885,332
	Bridge (Minor)	Rs.	289,113,215

Item	Bill Description	Rate (Rs.)	Amount(Rs)
	VOP	Rs.	60,741,266
B.	Civil Cost for Structures	Rs.	703,174,941
C.	Total Civil Cost (A+B)	Rs.	3,136,950,480
D.	Area weightage @10% of civil cost		313,695,048
E.	Total Civil Cost including area weightage (D+E)		3,450,645,528
	Civil cost per Km (in Cr.)		10.82
F.	GST @ 12% of civil cost	Rs.	414,077,463
G.	Contingency Charges @ 2.8% of civil cost	Rs.	96,618,075
H.	Supervision Charges @ 3% of civil cost	Rs.	103,519,366
I.	Administrative charges @3% of civil cost	Rs.	103,519,366
J.	Maintenance charge @ 2.5% of Civil cost	Rs.	86,266,138
K.	Escalation cost @5% per annum of Civil cost during construction period	Rs.	86,266,138
L.	Total Cost (E+F+G+H+I+J)		4,34,09,12,074
M.	Electrical Utility -HT/LT Line and Crossings		
	Civil items cost (Civil Works)-Electrical	Rs.	62,799,897
	GST @ 18% of civil works cost	Rs.	11,303,981
	Supervision Charges @ 15% of civil works cost	Rs.	9,419,985
	Contingency Charges @ 3% of civil works cost	Rs.	1,883,997
	Total Cost of Electrical including GST and supervision etc.	Rs.	8,54,07,860
N.	Water Pipeline Utility -Water pipe line (PHE)		
	Civil items cost (Civil Works)-Water pipeline (Urban)	Rs.	21,239,356
	Addition of GST @ 18%	Rs.	3,823,084
	Sub total	Rs.	25,062,440
	Addition of Supervision Charges @ 10%	Rs.	2,506,244
	Total Cost of water pipeline (Urban) including GST and supervision etc.	Rs.	27,568,684
	Civil items cost (Civil Works)-Water pipeline (Rural)	Rs.	1,065,814
	Addition of 1% contingency and 5% Supervision charge	Rs.	63,949
	Sub total	Rs.	1,129,763
	Addition 12% GST	Rs.	135,572
	Total Cost of water pipeline (Rural) including GST and supervision etc.	Rs.	12,65,334
	Total Civil item Cost (Road, Structure and Utility-Electric & Water pipe line)	Rs.	3,53,57,50,594
	Total Cost including GST, supervision etc. (Road, Structure and Utility)	Rs.	4,45,51,53,952
O.	Cost for Pre Construction Activities		
1	Cost of Land Acquisition	Rs	1,427,735,297
2	Cost of Assets (Structure, Zeerat, horticulture, fishery etc)	Rs	295,726,640
A.	Total Cost of LA &Cost of Assets	Rs	1,723,461,937
3	Tree Cutting Cost and Afforestation Cost	Rs	140,000,000
P.	Total Project Cost	Rs	6,31,86,15,889
	Total project cost per Km (in Cr.)		19.82

Chapter 10 : Economic Analysis

CHAPTER 10

ECONOMIC ANALYSIS

10.1 INTRODUCTION

The economic analysis covers the following aspects:

- (i) Assess the capacity of existing roads and the effects of capacity constraints on vehicle operation costs (VOC).
- (ii) Calculate VOCs for the existing road situation and those for the project.
- (iii) Quantify all economic benefits, including those from reduced congestion, travel distance, road maintenance cost savings and reduced incidences of road accidents.
- (iv) Estimate the economic internal rate of return (EIRR) for the project over 30 year period.
- (v) Saving in time value.

The economic evaluation has been carried out within the broad framework of social cost benefit. The economic analysis has been taken into account all on-going and future road and transport infrastructure projects and future development plans in the project area.

The objective is to determine the economic viability of the project as well as sections with respect to proposed improvement schemes that leads to minimizing total transport costs and maximizing benefits to the road users. The indicators for economic viability analysis are Economic Internal Rate of Return (EIRR), Net Present Value (NPV) and NPV/Cost Ratio.

The costs considered comprise agency costs and costs to road users as follows.

Road Agency costs:

- Construction Cost
- Maintenance Cost

Costs of Toll Plazas have been excluded from road agency costs.

Road Users Costs:

- Vehicle Operating Cost
- Travel Time Costs
- Congestion Costs
- Accident Costs.

The benefits accruing to society from the proposed improvement are as follows:

Road User Benefits:

- Vehicle Operating Cost Savings
- Value of Travel Time Savings
- Value of Savings in Accident Costs
- Savings in Maintenance Costs

Social Benefits:

- Improvements in administration, Law and order
- Improvements in health and education
- Improvements in agriculture, Industry, trade and mining
- Improvements in environmental standards
- Appreciation in value of Land adjacent to roads.

At the present state of knowledge in the country, it is possible to monetarily quantify only the direct road user benefits. This report, therefore, restricts itself to only the direct road user benefits.

Road users experience different costs in the “With Project” and “Without Project (Base Option)” conditions. The benefits to road users are constituted by the savings in costs. Increasing traffic volumes as a result of the project implies more vehicle kilometres and hence more vehicles operating costs and, possibly showing more saving in with project conditions viz. benefits as a result of the project.

Based on traffic, Road network and Socio-economic characteristics of the project road, improvement option (with project) have been considered by the consultants with proposed up-gradation / improvement Option (4-Lane) of the project road. The Economic analysis is carried out for the following improvement options

- “Without project/ Do minimum” - Routine maintenance of the existing road (Base option)
- “With Project”- Four laning of Project Road as per warrant.

The total transport costs for both the Options have been worked out on yearly basis for the entire analysis period of 30 Years. All costs and benefits considered in the study have been valued in monetary terms and expressed in economic prices for avoiding distortion in the input prices of labor, materials, equipment and foreign exchange due to market imperfections. The ratio of Economic and Financial costs is taken as 0.85.

Economic analysis is carried out with help of HDM-4 (version 1.1) developed by the World Bank. This is the updated version of HDM-III which incorporates up to date State of Art and the research findings in road user and road deterioration related studies carried out in a number of developed and developing countries including India over the last few decades. The HDM-4 Road User Effects (RUE) sub-model uses mechanistic principles for the modeling of fuel and tyre consumption. The mechanistic forces are comprised of the aerodynamic, gradient, rolling and inverted resistance. It calculates vehicle speeds and operating costs taking into account of road roughness and geometry, together with the characteristics of representative vehicles and also the traffic flow. Although the latest version of HDM III (HDM Manager, 1995) includes congestion analysis, the HDM IV model more accurately represents the prediction of vehicle operating components under congested conditions. The HDM-4 also makes use of the CRRI deterioration models for Indian asphalt mixes such as semi dense carpet and premix carpet and gives accurate predictions of roughness for various road maintenance work components.

This model provides for calibration of crucial input parameters to suit the local condition and analysis of a number of alternatives and sections at relatively greater speed than is possible with HDM III. The Road user cost streams generated by HDM-4 are extracted and Economic Internal Rate of Return (EIRR), Net Present Value (NPV) and sensitivity analysis have been carried out.

10.2 MEASURES OF PROJECT ANALYSIS

In order to quantify the economic viability of a project or projects three measures can be used. All of these use a discounting approach. These are:

- Net Present Value (NPR)
- Benefit Cost Ratio (BCR)
- Internal Rate of Return (IRR)

(1) Net Present Value (NPV)

NPV = Discounted Benefit – Discounted Cost

$$\sum_{i=1}^n \frac{B_i}{[1+r]^i} - \sum_{i=1}^n \frac{C_i}{[1+r]^i}$$

Where B_i = Benefit in the i^{th} year

C_i = Cost of the i^{th} year

(2) Benefit Cost Ratio (BCR)

$$BCR = \frac{\text{Present Value of benefits}}{\text{Present value of costs}}$$

(3) Internal Rate of Return (IRR)

The IRR is that discount rate r which makes $NPV = 0$

$$\text{or, } \sum_{i=1}^n \frac{B_i - C_i}{[1 + r]^i} = 0$$

IRR represents average earning power of the money used in the project over the project life.

10.3 DECISION CRITERIA

The formal decision criterion is to accept all projects with a BCR of one or greater than one, NPV greater than Zero or IRR greater than opportunity cost of capital, since primary tangible returns are greater than primary tangible costs. If funds are limited, the magnitude of IRR or BCR can be used in ranking the order of priority of undertaking projects whose ratios are more than one. This assumes, of course, that the indirect tangible and intangible benefits and costs are of minor importance or are approximately the same for the various projects under consideration. Sometimes, however, the indirect tangible and intangible benefits may dictate over direct tangible benefits and so the projects with even less than one BCR may be selected for the overall intangible benefits of the society. In practice, there is really no single yardstick to measure the economic and financial viability of the project.

10.4 PRICE ELASTICITY OF DEMAND AND TRAFFIC FORECASTING

An important benefit of a capacity expansion project is the reduction in travel times for highway users. Travel time is a major component in overall price or cost to the user, which includes time as well as out-of-pocket costs. As with most goods and services, a lower price can be expected to lead to more quantity demanded - in this case, some additional travel.

Price elasticity of demand is an economic concept used to summarize how much more or less of something people will consume if its price changes. From the standpoint of estimating future traffic levels, elasticity represents how a change in the cost of driving, due to a reduction in travel time or implementation of a toll, may affect the volume of travel that will take place. These changes in volume result from some drivers' decisions to make more or fewer trips than they otherwise would have made.

Elasticity is stated in percentage change terms, e.g., an "X" percent reduction in travel time leads to a "Y" percent increase in travel Km or trips. An elasticity of zero implies that travel is unresponsive to a time change, no matter how large, while an infinite elasticity implies that even a one-second decrease in travel time will cause all capacity to be completely absorbed. While price elasticity is a generally accepted tool in economics, there are differing opinions about how to apply it in a transportation context. The transportation economics literature reveals a wide range of

measured elasticity values, reflecting different study methods, data, time periods, and locations. No studies, however, suggest that travel demand elasticity is either zero or infinite. When measured on a given facility, observed elasticity includes the effects of both diverted trips, which represent existing traffic that has simply shifted from other routes or time periods, and new travel taken as a consequence of the lower user cost. Additional research is needed to narrow the range of elasticity values that are applicable to a given set of circumstances - whether facility, corridor, or region - and to develop methods for better incorporating demand elasticity into traffic forecasting.

10.5 ROAD USER COSTS (RUC) COMPONENTS

RUC consists of following three components:

- Vehicle operating costs (VOC), that is, the physical costs of operating a vehicle such as fuel, spare parts, depreciation, crew costs, etc;
- Travel time costs (TTC), that is, the value of time spent in travelling that could be used in other activities;
- Accident costs (ACC), that is, the physical costs of an accident and the value of injuries and fatalities.

The financial price is the retail market price to the consumer of the product. The economic price reflects the true value (that is, the real worth) as well as the scarcity premium of the resource to the economy. In the economic jargon, this is termed as a “shadow” or “accounting” price of the resource in the economy. The shadow price of unskilled labor, for instance, may well be lower than the wage to reflect its abundant supply, while that of a skilled professional may be higher than the salary given to him, if his opportunity cost is considered. The economic price of a factor or a product also excludes all tax elements as they reflect mostly a transfer of resources from one sector of the economy to another. On the other hand, subsidy elements, if any, are included with the economic price. Furthermore, market distortion or imperfection and government regulations or interventions are also taken into consideration while shadow-pricing a factor or a product. In case of imported inputs, economic costs were based on the border prices plus port handling, transportation, assembling and retail cost (profit margin) duly shadow priced. Local inputs of labor and materials were shadow priced using the Standard Conversion Factor of 0.85.

10.6 INPUTS TO THE HDM-4 MODEL

(A) Project Road Inputs

Based on the existing traffic and pavement conditions, the project road has been divided into 3 (three) homogeneous Sections. Details are given in **Table 10.1**.

Table 10.1: Project Length Details

Section	Description	Type	Length (km)	Remarks
6	From Km 113+830 to Km 145+712	NH-29	31.88	

(B) General Inputs

Analysis period	-	30 years
Discount rate	-	12 %
Construction Period	-	2 Years
Construction Beginning Year	-	2020
Opening year to Traffic	-	2022
Standard Conversion factor	-	0.85
Salvage value	-	15 %
Construction Phasing	-	60% 1 st Year
		40% 2 nd Year

(C) Pavement Characteristics

Road and pavement characteristics obtained from the Road Inventory Survey have been used as Model input. These include road length, carriageway width, width of paved shoulders, existing pavement composition, sub-grade CBR, roughness of the existing road (IRI), structural number, FWD and cracking area.

The details of model inputs for road and pavement characteristics are presented in **Table 10.2**. For the flexible pavement, opening year roughness has been taken as 2.5 IRI.

Table 10.2: Details of Existing Pavement Conditions

S.no.	DESCRIPTION	Section-6
1	Roughness IRI (m/km)	3.89
2	Area of Cracking (%)	11.41
3	Area of Raveling (%)	4.28
4	Number of Potholes (no./km)	43
5	Mean Rut Depth (mm)	4
6	Edge Brake area (m/km)	259.5
7	Average FWD reading (MPa)	
	Moduli BT	1120.5
	Moduli Granular	254.75
	Moduli SG	110.8

(D) Traffic Composition and Growth Rates

The classified Traffic Volume data obtained from IHMCL. The estimated ADT has been converted in to AADT, by applying the seasonal factor as applicable to the area. The traffic data is given below in **Table 10.3**.

At km 127 of NH-29 - Motorized = 6,208 nos. and Non-motorized = 1,080 nos.

Table 10.3: Traffic Composition (%) in AADT

Vehicle Type	At km 127 of NH-29	At km 138.45 of NH-29
Car	1691	1301
2 Wheeler	2455	1894
3 Wheeler	921	710
Bus	308	235
LCV	483	373
2 Axle	182	137
3 Axle	83	62
MAV	72	54
Tractor	7	5
Tractor with Trailer	5	4
Cycle	1063	820
Cycle Rickshaw	4	4
Others	13	9

(E) Road Side Friction

Roadside friction has to be computed for each project road package considering the following:

- The road width
- Total traffic Volume and its Composition (Slow, Two & Three wheelers Traffic)
- Settlement pattern along the road side
- Percentage of Built-up Area
- Number and location of Dhabas and Fuel Stations

The number of settlements along the roadside and especially the extensive ribbon development that take place is a major factor influencing road performance. The maximum friction factor for the existing condition is taken as 0.9 and the minimum 0.8 amongst different sub projects.

Following the improvements of package the roadside friction factor for the two lanes has to be taken as 1.0.

Roadside friction factors have been incorporated into VOC as well as vehicle speeds for the given volumes and composition of traffic. It is considered that the creation of free flow conditions will be a more important yardstick with which to measure the success of any project improvement rather than increase in vehicle speeds.

(F) Base Vehicle Characteristics and Utilization Data

Base vehicle characteristics and its utilization data has been obtained from manufacturer's literature and various literatures. The same has been used as Vehicle input data for HDM-4.

10.7 CAPITAL COST OF THE PROJECT

The capital costs (financial) of the project road have been converted into economic cost by using a standard conversion factor of 0.85, as suggested by the World Bank for highway projects in India. The conversion factor of 0.85 has been applied to all cost items except land acquisition cost and R&R cost. The economic cost excludes the cost of toll plazas. A salvage value of 15% of capital cost has been considered in the terminal year for flexible pavements. The project costs in financial and economic terms for different schemes are presented in **Table 10.4**.

Table 10.4: Summary of Capital Cost

Section	Financial Cost (Rs. Crores)	Economic Cost (Rs. Crores)
From Km 113+830 to Km 131+152	345.06	293.30

10.8 ROUTINE AND PERIODIC MAINTENANCE COST

Routine maintenance, Periodic maintenance costs have been considered as per latest MORT&H guidelines. The details of the maintenance costs and administration charges are given in **Table 10.5**.

Table 10.5: Routine and Periodic Maintenance Cost

Sl No.	Description	Amount (Rs/km)
1	Routine maintenance in every year cost per km for the two lane road with unpaved shoulders	93,800
2	Routine maintenance in every year cost per km for the two lane road with paved shoulders	1,14,300
3	Periodic maintenance in every 5 th year cost per km for the two lane road with unpaved shoulders.	23,76,000
4	Periodic maintenance in every 5 th year cost per km for the two lane road with paved shoulders.	34,32,000

10.9 PROJECT BENEFITS

The direct benefits of road improvement considered in the study include vehicle operating cost (VOC) savings for vehicular traffic using the project road and time savings for passengers and goods (carried) in transit. The benefit streams have been computed annually over the 30 year benefit period for all the sections.

VOC Savings

The unit Vehicle Operating Cost (VOC) by vehicle type and VOC savings section-wise has been computed by the HDM model. The VOC computation takes into account capacity augmentation, pavement characteristics, roughness progression vis-à-vis intervening surface treatment and strengthening policies, traffic characteristics, geometric conditions and vehicle characteristics.

Time Savings

The HDM Model has generated average speeds in km/hr by vehicle type, in the existing (without project) and the improved (with project) road conditions. The time savings for passengers and goods (in transit) vehicles have been derived separately. For computing time saving for passengers of cars and buses, a weighted average occupancy was used viz. Car – 4 persons and Bus – 30 persons. The average payloads considered for goods vehicles are: LCV – 6 tonnes, Truck-16.2 tonnes and MAV – 24 tonnes.

The value of time (VOT) for passengers and goods considered in this analysis has been based on earlier studies carried out in recent years. For the average car passenger, VOT has been taken as Rs. 51 per hour, and for the average bus passenger it was Rs. 35 per hour. The value placed on time is rather on the conservative side. For goods in transit, time value has been worked out using the inventory cost method, with a 15% interest rate considered as the opportunity cost of capital. The VOT for goods (Cargo) vehicle worked out to Rs. 2.56 per hour for LCV, Rs. 7.87 per hour for 2-axle trucks and Rs. 14.72 per hour for multi-axle vehicles. All above said values are based on Road User Cost Study Report by CRRI.

Accident Cost Savings

A distinction made between main cause of accident and the contributory factors of accident. It is usually difficult to identify the main cause of accidents; whereas several factors which could have contributed to accidents can be identified.

Contributory factors of Accidents:

Human Factors: Manner of executions (Deficiency in actions & behavior)

Perceptual errors

Impairment

Lack of Skill

Road Factors: Adverse Road Design

Adverse Environment

Inadequate Furniture or Markings

Obstacles

Vehicle Factors: Tyres

Brakes

Other defects due to poor maintenance

Unsuitable Designs

It is possible to predict the reduction in accidents on account of road improvements. The accidents costs collected from IRC-SP-30 (the values are in the year 1990 and escalated @ 5% per year to get the values in the year 2020 are given in **Table 10.6**.

Table 10.6: Accident Cost Savings

Accident Costs	1990	2020
Cost of fatal accident	2,10,000	952,988
Cost of a serious injury accident	32,000	145,217
Cost of a minor injury accident	1,100	4,992
Cost of damages to a car	4,700	21,329
Cost of damages to 2-wheeler	1,100	4,992
Cost of damages to a bus	15,800	71,701
Cost of damages to a trucks	18,100	82,139

**Source SP: 30 - 1993*

10.10 ECONOMIC VIABILITY

The annual cost and benefit streams are used to derive the net cash flow for the project. The EIRR and NPV @ 12% discount rate are determined using the discounted cash flow technique for all the Sections. The EIRR found is 15.45% (which is > the Discount Rate of 12%). Hence the project is economically viable.

10.11 SENSITIVITY ANALYSIS

Sensitivity analysis has been carried out for the below mentioned three variations and compared with base case results in costs and benefits. The sensitivity scenarios take into account possible construction delays, construction costs overrun, traffic volume, revenue shortfalls, operating costs, exchange rate variations, convertibility of foreign exchange, interest rate volatility, non-compliance or default by contractors, political risks and force majeure.

Scenario-I	Base Costs and Base Benefits
Scenario-II	Base Costs plus 15% and Base Benefits
Case-III	Base Costs and Base Benefits minus 15%
Case-IV	Base Costs plus 15% and Base Benefits minus 15%

Results of sensitivity analysis also show that the project is economically viable for 30 years analysis period.

10.12 CONCLUSIONS

The project road is being developed to improve the connectivity of the surrounding area and connectivity is the guiding factor for developing this section. The surrounding areas of the road stretches from Daboka to Lahorijan will be improved manifold if the project road is developed.

So it can be concluded that the project of up gradation to Four Lanes is economically viable and recommended for implementation for Section-6+7 [from Km 113+830 to Km 145+712].

Chapter 11 : Financial Analysis

CHAPTER 11

FINANCIAL ANALYSIS

11.0 FINANCIAL ANALYSIS

11.1 Background

The main objective of financial analysis is to assess the likely returns to the investors under realistic conditions. In the present studies the financial viability of the project is assessed on the basis of project's financial internal rate of return on investments and Rate of Return on Equity, which is estimated on the basis of cash flow analysis.

11.2 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 than on any other way of financing the project, in this case the other alternative we are considering is 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 Assam in the form of Grant. 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 (FIRR) 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. Details of the project road are given in **Table 11.1**.

Table 11.1: Details of Project Road

Sr. No.	Description	Design Length (Km)
1	Kwaram Taro Village to Dilai	31.882

11.3 Cost of the Project

The total cost of the project includes cost of civil works involved in the widening of the roads, Flyover. 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 2019-2020 prices and escalated by 5% for subsequent years. The annual phasing of capital cost is made as per the work schedule. Construction cost is phased over a period of 18 months from Oct 2020 to Mar 2022 as 60% in the first year and 40% in the second year. Cost of civil works is provided in **Table 11.2**.

Table11.2: Cost of Civil Works (as on 2019-2020)

Description	Cost of Civil Works Rs.crore
Project cost for 31.882km	345.06

11.4 Cost Escalation and Total Project Cost

The base costs have been escalated at a rate of 5% per annum to obtain the actual costs in the year of expenditure. This is in line with long-term inflation rates of major materials utilized for construction.

However total project cost has been arrived at by adding Cost towards cost of financing, interest during construction and escalation.

11.5 Toll Rates

Tolls can be set either to maximize revenue or maximize the utilization of the project without causing congestion. However, in no case, tolls are set at a level higher than the perceived benefits of using the facility. Toll rates are calculated as per NHAI notification no. NHAI/11033/CGM (Fin)/2011. This is shown in the **Table 11.3**. The detailed year wise cost is given in **Annexure 11.1**

Table11.3: Toll Rates as per NHAI Notification

Sl No.	Description	Toll Rates per Vehicle / per km
1.	Car, Jeep, Van or Light Motor Vehicle	0.65
2	Light commercial Vehicle (L.C.V.), Light Goods Vehicle or Mini Bus	1.05
3	Bus or Trucks (2 axle)	2.20
4	Heavy Construction Machinery (H.C.M.) or Earth Moving Equipment (E.M.E.) or Multi Axle Vehicles (3 to 6 axles)	3.45
5	Oversized Vehicle (seven or more axles)	4.20

Note: - above mentioned toll rates is for four & six Lane projects. For two laning 60% of the above rates shall be applicable.

11.6 Traffic

Traffic volume count (TVC) surveys for seven days have been carried out at 1 location along the project road. For financial analysis atoll plaza is considered. For the BOT analysis, considering all future growth predicted average tollable traffic counts (AADT) for project road is considered based on the homogeneity of the road is given in **Table 11.4**. Traffic projection

for financial analysis is given in **Annexure 11.2**

Table11.4: AADT (Vehicles) for Financial Analysis (Base year 2018)

SI No.	Chainage	Car/ Jeep/Van/LMV	Taxi/ Tata Magic/ LMV	Minibus	Std. Bus	LCV	2-Axle	3-Axle	4-Axle and 6 Axle	7 Axle Above	Total Vehicles (No.)
1		1467.5	28.5	42	229.5	428	159.5	72.5	63	-	2490

11.7 Toll Revenue

The toll revenue is the product of the forecast traffic expected to use the road and the toll fee for the vehicle category. Toll revenues have been calculated by collected toll at two toll plaza of the indicative traffic for the project road length. The computed toll revenues for various years are given below in **Table 11.5**. Year wise toll revenue is given in **Annexure 11.4**.

Table11.5: Net Toll Net Revenue for the Various Years

Sr. no.	Year	Toll Revenue (Rs. crore)
1	Apr2022 to Mar 2023	2.72
2	Apr 2030 to Mar 2031	7.15
3	Apr 2040 to Mar 2041	18.97
4	Apr 2050 to Sep 2050	26.29

11.8 Tax Calculation Module

The tax rate adopted for this study is 25.17% as proposed under Taxation Laws (Amendment) Act, 2019 with no applicability of MAT.

11.9 Proposed Sources of Finance

In general, the developer shall crystallize the sources of finance by optimizing his equity returns keeping in view the project cash flows, terms, and conditions of various financing options available. Further the market standing and financial strength of the Developer would largely determine the terms and conditions of finance offered to the Developer by various lending agencies. For the purpose of the study, following sources of finance have been taken:

- Equity: To be provided by the Developer
- Subsidy / Grant for viability of funding, to be provided by Government of Assam.
- Debt: To be arranged by the Developer / Concessionaire

11.10 Expenses

Expenses can broadly be classified based on the phases in which these are incurred, viz. construction period expenses and operation & maintenance period expenses.

Operation and Maintenance Period Expenses

- Administrative expenses for day-to-day operation.
- Maintenance expenses, which include routine and periodic maintenance.
- Interest expenses incurred for servicing term loans.
- Lighting expenses.
- Patrolling Expenses.
- Insurance.
- Office Expenses.

11.11 Operation and Maintenance Cost

Routine maintenance costs comprise of maintenance of the pavement, collection of litter, lighting, traffic management (policing), accident repairs and all ancillary works including beautification.

Routine maintenance/ Periodic maintenance costs have been considered as per new circular of NHAI (letter no. RW/NH-37044/67/2011/PPP dated 16.11.2011). The details of the maintenance costs and administration charges are given below in **Table 11.6**.

Table 11.6: Routine & Periodic Maintenance (Base Year 2011-2012)

Sl. No	Description	Amount
1	Routine maintenance in every year cost per km for two lanes with paved shoulder.	2.16 Lakhs/km/annum
2	Periodic maintenance in every 6th year cost per km for the two lanes with paved shoulder.	37.70 Lakhs/km

11.12 Resources Mobilization

In the present study, the project is envisaged to be funded through equity and debt components. Since the Project revenues are not able to sustain the capital structure, option such as capital grant / subsidy utilization in the developmental charges method of financing shall be explored.

11.13 Resource Mobilization Schedule

In general, the duration of construction for similar size road projects ranges between 12-24 months. Since the proposed Project is to 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 18 months. Based on the implementation period, the project cost has been phased as mentioned in **Table 11.7**.

Table 11.7: Project Cost Phasing

Description	1st year	2nd year
Percentage of total cost incurred	60%	40%

11.14 Minimum Return Criteria

The minimum return criteria for the B.O.T project is considered as follows: -

The return on project investment (Post Tax FIRR) should be between 12% to 14% while the return on equity (Post Tax Equity IRR) ranges from 14% - 16%. The minimum average DSCR is taken as 1.25.

11.15 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
- Concession period (Including 18months construction period) – 30 Years
- Escalation – 5%
- Interest on Debt – 10.00% (SBI One Year MCLR Rate + 3% Premium)
- Project Phasing: First year – 60%, Second year – 40%
- Loan Repayment period – 12 years (incl Moratorium Period)
- Moratorium – 1 year
- Depreciation by Straight line method - 100% in 27 years.
- Depreciation by Written down value method – 10%

11.16 Results 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.

Financial study is done considering project stretch two lane project of 17.322 Km. The details following Financial Statements and Analysis is given in

- **Profit and Loss**
 - **BOT:** Annexure 11.4
 - **Annuity with Grant:** Annexure 11.8
 - **Annuity without Grant:** Annexure 11.12
 - **HAM:** Annexure 11.16
- **Balance Sheet**
 - **BOT:** Annexure 11.5
 - **Annuity with Grant:** Annexure 11.9
 - **Annuity without Grant:** Annexure 11.13
 - **HAM:** Annexure 11.17
- **Cash Flow Statement**
 - **BOT:** Annexure 11.6
 - **Annuity with Grant:** Annexure 11.10
 - **Annuity without Grant:** Annexure 11.14
 - **HAM:** Annexure 11.18
- **Financial Analysis**
 - **BOT:** Annexure 11.7
 - **Annuity with Grant:** Annexure 11.11
 - **Annuity without Grant:** Annexure 11.15
 - **HAM:** Annexure 11.19

11.17 Conclusions and Recommendations

11.17.1 Conclusions

- (i) The road is divided in a toll section of 31.882 Km
- (ii) Concession period of the road project is 30years including 18monthsconstruction period.
- (iii) All the traffic moving on the project road is through traffic.
- (iv) It is clear from Financial Analysis read with Profit & Loss Statement, Balance Sheet and Cash Flow Statement that the project is not financially viable under BOT even on 40%

grant with 30years concession period (including the Construction Period of 18 months).

11.17.2 Recommendations

The proposed project road being developed as two lane carriageway configuration for 17.322 Km is recommended under

- EPC Construction
- Annuity for 28.5 years with Government Grant at INR 25.50 crore per annum
- Annuity for 28.5 years without Government Grant at INR 40.40 crore per annum
- Hybrid Annuity at Bid Project Cost of INR 221.20 crore and First Year O&M Quote of INR 1 crore

Chapter 12 : Road Safety Audit

CHAPTER 12

ROAD SAFETY AUDIT

12.0 ROAD SAFETY AUDIT

12.1 Introduction

Road safety is now recognized as a major socioeconomic concern in India. Increasing traffic volumes, the rapid growth in two and three wheeled traffic, higher speeds due to construction improvement / rehabilitation of roads has increased safety problem. A Road Safety Audit (RSA) is the safety performance examination of a road section through experienced road safety expert. It qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements in safety for all road users. The road safety audit investigates general safety conditions, focuses on specific concerns or users. This also includes pedestrian safety as well as safety of bus users.

12.2 Stages of Road Safety Audit (RSA)

As per the scope of works RSA needs to be performed in the following stages:

- During Feasibility Study Stage (planning stage)
- On completion of Preliminary Design Stage
- On completion of Detailed Design Stage

This chapter is related to safety audit report at detailed design stage. The audit team reviewed proposed design from road safety perspective and checked the following aspects. RSA related to construction stage and monitoring existing road stage is not discussed here.

12.3 Aspects to be Checked

Broadly following items have been checked or reviewed during the feasibility study stage based on site data, existing road and proposed designs.

- Safety and operational implications of proposed alignment and junction strategy with particular references to expected road users and vehicle types likely to use the road.
- Width options considered for various sections.
- Departures from standards, if any and accordingly actions taken.
- Provisions of pedestrians, cyclists and intermediate transport.
- Safety implications of the schemes beyond its physical limits, i.e., how the scheme fits into its environs and road hierarchy.

Road Safety Audit is a formal procedure that uses extensive safety engineering knowledge to

identify safety deficiencies in road sections. A broad experience in road, traffic and safety engineering needs to be acquired to ensure that a Road Safety Auditor has the knowledge and ability to refer back to the basic principles in road safety, and propose appropriate mitigation measures. Following points are generally adequately clarified during a road safety audit.

- Confusion or ambiguity due to design layout for road users that could lead to potential road traffic accidents
- Insufficient information for road users
- Improper visibility, or an obstruction to road views of road users
- Hazards in layout create or obstacles to road users that could contribute to an increased risk of injuries

In the above cases safety of the scheme may be compromised and remedial measures may be required to remove this potential or actual deficiency. Road users need to perceive and process vast amounts of sensory and visual information to negotiate a road layout. On the other hand role of designer is to provide a safe road environment that should:

- provide adequate information for road users of the layout and conditions ahead;
- provide adequate warning of hazards or unusual layouts ahead;
- provide positive control of road users passage through conflict points or unusual sections;
- provide a road performance that can nullify road user's errors or inappropriate behavior

Desirable minimum Design Standards should be used wherever possible and advance information and warning should be used to inform road users of the layout ahead. However, driver overload must be avoided as it may cause road users to focus too much on the unimportant data and shed vital information. Conflicting information, an overabundance of road signs or a lack of delineation can cause overload. Therefore a "safer" road environment can be defined as a layout that:

- provides clear, concise and phased release of road user information;
- provides a consistent standard of road design and traffic control;
- Provides adequate warning of hazards.

It is important that a road improvement caters for all road users. Often the needs of the motorist are incorporated within a scheme whilst the needs of the vulnerable user are ignored. The vulnerable road users that need to be considered are: pedestrians – the old, young and those with mobility or sight impairment; cyclists – children, commuters and leisure users; and motorcyclists.

Each vulnerable road user has different needs from the road network. In the habitation environment the pedestrian is likely to be the principal user and designs must incorporate safe crossing locations, adequate visibility to and from the crossings and appropriate lighting. In addition to the needs of vulnerable road users, particular attention should be paid to the

needs of trucks, buses or other specialist vehicles.

Safe road design varies from the urban to the rural road network; and a number of external factors can create a situation in which a safe road in one location becomes unsafe due to external factors. These factors can include traffic volumes, population density, noise, or road user familiarity. The function of a road should be clear to all road users, and a well-planned and defined road hierarchy can assist in providing a safe road network. The design speed can also be an important factor in influencing the safety of a road and should be appropriate to the location, local road users and level of private access control.

One important aspect to the safety of junctions is that layout as well as control method need to be simple and clear, with defined priorities for all road users. The assumption that 'straight on' traffic has priority is widely accepted and it needs to be remembered that alterations to this, despite reinforcement with signs and lines can still be confusing if visual clues such as fences, kerbing or lighting remain unchanged. It is important to attempt to make any minor approach perpendicular to the main road. Y-junctions with acute angles should be avoided. These angled junctions pose problem for road users, including restriction of forward and side visibility. Similarly, it is advisable to avoid intersections on the inside of bends as foliage often encroaches into sight lines after several years. Roundabouts used as a form of junction control have their own rules and design requirements. One of the primary requirements in good roundabout design is that the radius is tighter on the entry than the exit. This ensures a slow entry and lower circulating speed. Visibility is a key requirement for all junction types, all road users need to see and be seen by others. Care should be taken with fixing street furniture and vegetation within visibility splays. Vulnerable road users often experience difficulties during crossing at junctions. It is important that their needs are provided for and that safe crossing places are implemented where required.

The relationship between cross-sectional elements (carriageway, shoulders, etc.) and safety is affected by the type and volume of traffic, and also by the surrounding environment. Lane widths can be critical in affecting safety, where they are too narrow vehicles may collide on horizontal curves, and there may also be inadequate space for two wheeled vehicles. Where lane widths are too wide the alignment may encourage excess speed. On high speed links there is a safety benefit to be gained by the provision of a hard shoulder and central reserve gaps should be of adequate width, depending on the size of vehicles turning. Vehicles parked on the carriageway affect the road environment, layout and consequently safety. Safety problems experienced with parked vehicles are:

- parked vehicles causing physical obstructions which are sideswiped or run into
- parked vehicles causing sudden braking or nose-to-tail shunts
- parked vehicles which deflect oncoming vehicles into adjacent vehicle paths
- parked vehicles blocking visibility for any road user
- parked vehicles between which pedestrians emerge

To reduce the risk of parked vehicles contributing to an accident it is important that designs should minimize parking in main traffic lanes. Trees and foliage can greatly enhance the environmental impact of the street scene. However, left un-maintained, they can also restrict visibility considerably. In addition to this, saplings grow into large trees, which can provide an unforgiving road hazard in the event of a road traffic accident.

With the above discussions and study / analysis of the project road sections safety issues that have been conceived are presented below in **Table 12.1**.

Table 12.1: Road Safety Issues

Content	Items	Observation with respect to Safety		Remarks
		Existing Situation	Proposed Situation	
A1. General	Departure from Standards	The existing geometry of the road is not adequate with presence of sharp curves and steeper gradient in some location	<p>The proposed alignment has been designed based on IRC: 73-1980 and IRC: SP: 84-2019.</p> <p>Realignment has been proposed at several sharp curve locations to improve horizontal geometry.</p>	The design speed to be reduced based on restricted site conditions and non-availability of adequate land
	Cross sectional Variation	The existing carriageway width is 10.0m in general	The Proposed carriageway width of the project road is 2 x 7.5m (including kerb shyness) with 2.5m paved shoulder on either sides having a total roadway width of 27m as per IRC: SP 84-2019. In built up location footpath cum RCC drain of 1.0m is to be provided on both sides along with 7.5m service road on either side.	Extra widening has been provided on the curves having radius less or equal to 300m
	Drainage	Existing drainage condition is poor with improper camber and longitudinal gradient of carriageway and shoulder and absence of roadside drain.	<p>Efficient drainage system is provided along the project road including structure and outfall facility.</p> <p>For quick disposal of precipitations, carriageway and shoulder have the requisite camber and longitudinal gradient.</p> <p>The water from road and adjacent areas to be intercepted and carried through roadside drains to natural outfall.</p> <p>Mostly in rural areas unlined trapezoidal drain shall be provided, whereas in built up</p>	

Content	Items	Observation with respect to Safety		Remarks
		Existing Situation	Proposed Situation	
			stretches Rectangular Stone Masonry drain is proposed both side of Project road.	
	Climatic Conditions	<p>With the "Tropical Monsoon Rainforest Climate", Assam is temperate (summer max. at 35–38 °C and winter min. at 6–8 °C) and experiences heavy rainfall and high humidity. The climate is characterized by heavy monsoon downpours reducing summer temperatures and affecting foggy nights and mornings in winters, frequent during the afternoons. Spring (Mar–Apr) and autumn (Sept–Oct) are usually pleasant with moderate rainfall and temperature. Assam's agriculture usually depends on the south-west monsoon rains</p> <p>The average annual rainfall is 2818mm. The monsoon starts late in June and generally lasts up-to September. 90% of the rainfall received from July to September.</p>		HFL and Pond water level has been considered to fix road top level
	Landscaping	Landscaping on the existing road is not proper due to irregular spacing of trees, absence of proper turfing on embankment slope	<p>Proper Road side Plantation is being provided.</p> <p>Shrubs on median / island are also considered.</p> <p>Turfing is being provided on embankment slope.</p>	<p>Trees and vegetations on the site should be properly trimmed and removed if required so that these should not interfere with the overhead services, clear view of signs and efficiency of roadway lighting. A regular program of pruning of the offending trees shall be under-taken as a part of the maintenance operation. Trees shall be selected based on the soil, temperature, rainfall, water level and should be deep rooted to</p>

Content	Items	Observation with respect to Safety		Remarks
		Existing Situation	Proposed Situation	
				avoid any damage to the pavement crust.
	Service Apparatus	Existing utilities like Electric poles, Transformer, OFC, High Tension Line, Tube well etc. are found along the existing road.	Shifting of existing utilities due to widening of road. Utilities to be relocated at proposed utility corridor within the proposed ROW.	It will be safe during maintenance.
	Lay-byes	No lay-byes are present along the existing road.	In Section-3, 7 No. of Bus bays and 2 Nos. of Truck lay byes are proposed	
	Footpaths	In very few locations, footpaths are observed along the existing road	In built-up areas and major intersections footpaths are provided of width 1.0m	Footpaths are provided for smooth and safe movement of pedestrian
	Pedestrian Crossings	No pedestrian crossings are observed along the existing road.	Pedestrian crossings are provided at major intersections and other locations like schools, religious structure etc. where substantial conflicts exist between Vehicular and Pedestrian movement	Installation of proper traffic sign/ signal near pedestrian crossings is mandatory. Pedestrian guard rails are also required to guide people
	Access	Existing situation shows maximum access to the private property. As such there is no access control.	Private access should be minimized directly from the proposed carriageway by providing service road in either built up locations.	Private access needs be minimized to maintain the design speed of the corridor as well safe passage to traffic and persons.
	Emergency vehicles	No emergency vehicle have been found along the existing corridor.	It is proposed to provide Emergency vehicles to operate within a certain time frame along the project road.	
	Public Transport	Existing traffic survey shows that 2 wheeler and car/Jeep/Taxi/Van are act	After improvement of road surface to 4-lane with paved shoulder public transport like	Traffic report shows increase in public transport along the

Content	Items	Observation with respect to Safety		Remarks
		Existing Situation	Proposed Situation	
		major public transport compare to bus and minibus along the existing track	bus and minibus will be increased	project road
	Future Widening	Existing ROW is around 18m to 45m which can accommodate to four lanes with land acquisition.	Proposed road is of 4-lane configuration which cannot be accommodated within existing ROW for the stretches under these Sections. Land acquisition is required where sufficient EROW is not available.	The road section needs to be improved to 4-lane with paved shoulder configuration.
	Staging of Contracts	Length of the project Road section is; Section-6: 31.882 Km	Contract for construction can be made for these sections separately in individual packages.	
	Adjacent Development	Existing shoulders are generally damaged throughout the road Footpaths are not found in the built up stretches Insufficient traffic signs observed along the corridor.	Proposed shoulder on both sides of the carriageway can be used for the movement of slow moving vehicle during emergency as well as parking for stalled vehicle. Footpaths cum RCC drains have been proposed in built up areas for safe movement of pedestrians. Installation of traffic sign (for example- horn prohibited in front of school, health centers, religious structure etc.) is being proposed. Improvement of roads will help in development of new industry along project road	
A2. Local Alignment	Visibility	Visibility is not proper in many places as the existing profile of the road not does not follow required sight distances (horizontal as well as vertical)	For proposed 4-lane roads Intermediate Sight distance is being taken throughout.	At only a very few stretches where intermediate sight distance is not available the profile shall be designed with

Content	Items	Observation with respect to Safety		Remarks
		Existing Situation	Proposed Situation	
				safe stopping sight distance and overtaking prohibited traffic shall be installed in the location.
	Safety Aids on hilly terrain	No such stretch present	NA	
	New/ Existing Road Interface	Existing site shows that new/existing road interface are not smooth with improper horizontal and vertical profile	New/ Existing road interface is designed with proper geometry and vertical profile so that riding quality of the vehicle should be smooth	
A3. Junction	Minimize potential conflicts	Existing junctions are not properly developed with insufficient turning radius and absence of road signage as well as markings	In Section-6, 36 Minor Junctions are to be developed with proper turning radius, signage and markings to minimize potential conflict between pedestrians and vehicles	Provide pedestrian guard rail on Footpath, median for the safety of pedestrians. Pedestrian crossings shall be provided in proper places in the junctions with signage and markings.
	Layout	Layout of the junctions are not proper	Layout of the proposed junctions are to be made with proper turning radius, acceleration /deceleration lane, island and median etc.	These are designed as per respective IRC guidelines and land acquisition to be kept absolute minimum
	Visibility	Visibility of the existing junctions are not proper	To improve the visibility of the proposed junction's vertical profile of the road is designed with intermediate sight distance. If it is not found it should be taken care that at least intermediate sight distance should be available throughout	Traffic Sign at junctions should be informative enough

Content	Items	Observation with respect to Safety		Remarks
		Existing Situation	Proposed Situation	
A4. Non-Motorized road users provisions	Adjacent Land	Existing Scenario shows Pedestrians, Cyclists and non motorized vehicles are plying on the existing road due to damage road shoulder and absence of footpath in built-up areas and causing conflicts with fast moving vehicles which decrease the design speed	For smooth movement of non motorized road users, pedestrians and cyclist shoulder having 3.5m width has been proposed on both side of the carriageway. Also in built up stretches 1.0m wide footpath has been proposed for less conflict between fast moving vehicle and pedestrians, cyclists etc.	
	Pedestrians			
	Cyclists			
	Non motorized vehicles			
A5. Signs and Lighting	Lighting	Insufficient Lighting is found in built up areas	Lighting shall be provided on major junctions, bus bays and truck layby locations	
	Signs/ Markings	Insufficient signs found on existing road. Markings are not found in the existing road except some few stretches in the forest area	Traffic Signs and Road Markings are provided on the proposed road for safe guidance of traffic	
A6. Construction and Operation	Build-ability	Guidelines for safety during construction need to be followed as per IRC: SP-55. Traffic control devices have to be provided as per requirements during construction time. Few of these are: barricading, signs and delineators.		
	Operational			
	Network Management			

Chapter 13 : Conclusions and Recommendations

CHAPTER 13

CONCLUSIONS AND RECOMMENDATIONS

13.0 CONCLUSIONS AND RECOMMENDATIONS

13.1 Conclusions

- (i) The road section is from Kwaram Taro Village (Km 113+830) to Dilai (KM 145+712).
- (ii) Concession period of the road project is 30 yrs. including 36 months construction period.
- (iii) All the traffic moving on the project road is through traffic.
- (iv) The project road is being developed to improve the connectivity of the surrounding area and connectivity is the guiding factor for developing this section. The road stretches from Daboka to Dimapur via Dokmoka, Bokalia, Manja and Lahoroijan will be improved manifold if the project road is developed.

13.2 Recommendations

The proposed project road being developed as four lane carriageway configuration for 17.352 Km is not recommended under BOT mode.

The proposed project can, however, be considered under other options as under

➤ EPC Construction

Recommendations for immediate development is provided below:

Recommendation for Immediate Development

Road Section	Recommendation	Remarks
From Kwaram Taro Village (Km 113+830) to Dilai (KM 145+712).	4-Lane with Paved Shoulder from 2024	Traffic of 9438 PCU in the year of opening (2022) is close to 10000 PCU i.e. Design Service Volume Standards for four lane facility. The project is to be taken under EPC mode

Annexures

Annexure 2.1 - GPS Co-ordinates of Various Features

Major Bridges

Sl No.	Road Section	Existing Chainage	Design Chainage	Feature List	Latitude	Longitude
Stretch 1 : Daboka to Lahorijan Section						
1	NH 29	119+500	Realignment	MJB	25.914537°	93.646896°
2	NH 29	127+450	Bypass	MJB	26.023667°	93.389747°
Stretch 2 : Numaligarh to Khatkhathi Section						
3	NH 129	7+500	7+200	MJB	26.581259°	93.760836°
4	NH 129	18+650	17+280	MJB	26.550600°	93.851974°
5	NH 129	46+400	42+830	MJB	26.554680°	93.842391°

Major Junctions

Sl No.	Existing Chainage	Road Segment	Side	Lat	Long	Remarks
Daboka to Lahorijan Section						
1	39+500	NH 29	Both	26.115736°	92.874705°	Daboka Junction
2	85+380	NH 29	RHS	26.090960°	93.139100°	To Howraghat
3	128+350	NH 29	RHS	25.970065°	93.436741°	To Diphu
Numaligarh to Khatkhathi Section						
1	9+250	NH 129	LHS	26.571624°	93.768052°	To NRL
2	16+400	NH 129	LHS	26.553196°	93.829532°	To NRL
3	28+020	NH 129	LHS	26.503455°	93.917874°	To Golaghat
4	51+050	NH 129	LHS	26.332086°	93.865281°	Silanijan
5	83+620	NH 129	RHS	26.070564°	93.778027°	Sariajan
6	89+350	NH 129	LHS	26.024587°	93.763210°	Bokajan Railway Station

Annexure 4.1 : Data Obtained through Falling Weight Deflectometer (FWD)

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
NH 29															
1	39500	LHS	NH 29	40	0.5325	0.3931	0.1635	0.0775	0.0528	0.0436	0.0168	38.1	1067.7	200.6	111
2	39625	RHS	NH 29	40	0.3823	0.2917	0.1453	0.0832	0.0598	0.0476	0.0225	38.6	1064.4	271.1	111
3	39750	LHS	NH 29	40	0.5455	0.4403	0.1991	0.0894	0.0449	0.0376	0.0215	38.6	1067.7	207.9	111
4	39875	RHS	NH 29	40	0.3279	0.2295	0.1036	0.0606	0.0472	0.0262	0.0103	38.6	1061.8	273.7	111
5	40000	LHS	NH 29	40	0.3451	0.2486	0.0966	0.0523	0.0413	0.0338	0.0169	38.6	1041.3	274.5	111
6	40125	RHS	NH 29	40	0.6768	0.5196	0.2092	0.1038	0.0699	0.0632	0.0061	37	1027.9	212.2	111
7	40250	LHS	NH 29	40	0.4946	0.3803	0.1669	0.0756	0.0382	0.0251	0.0064	37	1017	211.9	111
8	40375	RHS	NH 29	40	0.392	0.3097	0.1529	0.0832	0.0586	0.0489	0.0101	37	1040.2	264	112
9	40500	LHS	NH 29	40	0.3634	0.2827	0.1682	0.119	0.086	0.0592	0.0317	39.9	989.6	331.7	113
10	40625	RHS	NH 29	40	0.2464	0.1825	0.0892	0.075	0.0455	0.0326	0.0182	39.9	989.6	331.7	113
11	40750	LHS	NH 29	40	0.2944	0.2076	0.0846	0.0462	0.032	0.0229	0.0117	39.4	997.3	272.4	111
12	41000	RHS	NH 29	40	0.4102	0.3084	0.1435	0.0912	0.067	0.0528	0.0311	37.9	1255.533	240.7	96.9
13	41250	LHS	NH 29	40	0.279	0.1836	0.0506	0.0334	0.0245	0.0127	0.0095	34.1	1336.242	207.9	94
14	41500	RHS	NH 29	40	0.47	0.3503	0.1548	0.0856	0.0635	0.0554	0.0276	37.9	1267.166	239.3	97
15	41750	LHS	NH 29	40	0.2828	0.2211	0.1187	0.072	0.054	0.0356	0.0185	37	1219.554	328.6	111
16	42000	RHS	NH 29	40	0.3799	0.2369	0.0768	0.0439	0.0318	0.0232	0.0116	34.1	1318.555	211.6	94
17	42125	LHS	NH 29	40	0.3938	0.2912	0.1255	0.0846	0.0562	0.0373	0.0143	39.4	1002	271.9	111
18	42250	RHS	NH 29	40	0.3611	0.2684	0.1334	0.0768	0.048	0.0394	0.0128	39.4	994.9	215.8	94
19	42375	LHS	NH 29	40	0.4761	0.368	0.1784	0.0973	0.0659	0.0558	0.0111	39.4	983.1	213.7	94
20	42500	RHS	NH 29	40	0.4285	0.2932	0.156	0.0979	0.056	0.0395	0.0184	39.4	984.3	215.1	94
21	42625	LHS	NH 29	40	0.4129	0.3146	0.1372	0.0739	0.0532	0.0264	0.0133	37.9	1073.5	240.7	97
22	42750	RHS	NH 29	40	0.4599	0.3748	0.1772	0.1142	0.0805	0.0404	0.014	37.9	895.5	240.7	97
23	42875	LHS	NH 29	40	0.3729	0.2988	0.1404	0.0861	0.0533	0.0347	0.0172	37.9	1080	240.6	97
24	43000	RHS	NH 29	40	0.455	0.2969	0.1284	0.0908	0.0703	0.0485	0.018	40.7	902.5	240.4	97
25	43125	LHS	NH 29	40	0.3922	0.2994	0.1326	0.0787	0.0514	0.0342	0.0149	37.9	1092.3	240.3	97
26	43250	RHS	NH 29	40	0.36	0.2733	0.1345	0.0781	0.0568	0.0436	0.0213	37.9	1009.1	240.6	97
27	43375	LHS	NH 29	40	0.3443	0.2614	0.1265	0.0736	0.0525	0.0392	0.0135	37.9	1078.5	238.1	97

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
28	43500	RHS	NH 29	40	0.3432	0.252	0.1173	0.0643	0.0487	0.039	0.0083	37.9	923.7	239.3	97
29	43625	LHS	NH 29	40	0.4071	0.2537	0.0823	0.0474	0.0343	0.0248	0.0124	40.7	907.8	239.2	97
30	43750	RHS	NH 29	40	0.5752	0.4129	0.1717	0.0748	0.0538	0.0471	0.0229	40.7	934.7	234.1	110
31	43875	LHS	NH 29	40	0.4648	0.3556	0.1727	0.0924	0.0649	0.0512	0.0193	39.5	984.9	270.7	110
32	44000	RHS	NH 29	40	0.3358	0.2482	0.1249	0.073	0.0413	0.02	0.01	39.5	933.4	268.5	110
33	44125	LHS	NH 29	40	0.2602	0.1857	0.0859	0.0482	0.0377	0.0299	0.007	38.6	988.6	270.6	110
34	44250	RHS	NH 29	40	0.3724	0.2736	0.1205	0.0735	0.0548	0.0424	0.0095	39.5	989	268.5	110
35	44375	LHS	NH 29	40	0.4963	0.3443	0.1344	0.0693	0.0474	0.0401	0.0184	39.1	999.1	260.2	110
36	44500	RHS	NH 29	40	0.3705	0.2627	0.0978	0.0711	0.0335	0.0272	0.0093	39.1	955.9	272.1	110
37	44625	LHS	NH 29	40	0.4239	0.2874	0.1168	0.0555	0.0381	0.0298	0.0089	39.1	997.9	258	110
38	44750	RHS	NH 29	40	0.2169	0.1404	0.0677	0.0353	0.0248	0.0201	0.0077	39.1	966	270.6	110
39	44875	LHS	NH 29	40	0.3346	0.227	0.0864	0.045	0.0275	0.0135	0.0068	40.3	928.4	230.7	110
40	45000	RHS	NH 29	40	0.3674	0.2619	0.1064	0.0536	0.0371	0.0285	0.0139	39.1	962.4	271.9	110
41	45125	LHS	NH 29	40	0.4079	0.3025	0.1385	0.0697	0.0447	0.0322	0.01	40.3	935.2	271.5	110
42	45250	RHS	NH 29	40	0.3636	0.2606	0.118	0.0674	0.0546	0.0484	0.0068	39.1	960.6	271.9	110
43	45375	LHS	NH 29	40	0.3612	0.2646	0.1154	0.0599	0.05	0.0373	0.0174	39.1	982.5	272.6	110
44	45500	RHS	NH 29	40	0.3569	0.2614	0.1092	0.0538	0.0399	0.0352	0.0099	40.3	926.3	269.7	110
45	45625	LHS	NH 29	40	0.3388	0.2561	0.127	0.0717	0.0452	0.0369	0.0123	39.1	994.4	272.1	110
46	45750	RHS	NH 29	40	0.3783	0.2953	0.1398	0.0657	0.0426	0.0235	0.0131	40.3	933.7	269.2	110
47	45875	LHS	NH 29	40	0.3702	0.2739	0.1415	0.0837	0.0606	0.0499	0.0211	39.1	997.9	271.1	110
48	46000	RHS	NH 29	40	0.3428	0.2612	0.1064	0.059	0.0334	0.021	0.0076	40.3	924.2	273	110
49	46125	LHS	NH 29	40	0.3342	0.254	0.1162	0.0689	0.0524	0.043	0.0148	39.1	951.2	272.5	110
50	46250	RHS	NH 29	40	0.4884	0.334	0.1413	0.0776	0.0589	0.0404	0.0216	40.3	904.6	272.9	110
51	46375	LHS	NH 29	40	0.3796	0.2806	0.1242	0.064	0.0533	0.0394	0.0187	40.6	937.9	325.8	115
52	46500	RHS	NH 29	40	0.3244	0.2118	0.067	0.0445	0.0338	0.023	0.0114	40.6	909.9	284.8	115
53	46625	LHS	NH 29	40	0.5765	0.4151	0.1822	0.1068	0.071	0.0539	0.0269	40.3	893.5	221.9	115
54	46750	RHS	NH 29	40	0.5431	0.3923	0.1639	0.0867	0.0547	0.0428	0.0226	40.6	892.5	221.9	115
55	46875	LHS	NH 29	40	0.583	0.4696	0.1859	0.0928	0.0655	0.048	0.0243	40.3	917.3	222.6	115
56	47000	RHS	NH 29	40	0.3517	0.2662	0.1293	0.0781	0.0427	0.022	0.0108	40.6	917.3	244.6	115
57	47125	LHS	NH 29	40	0.4376	0.3141	0.1353	0.0742	0.0444	0.0288	0.0128	40.6	900.9	223.4	115

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
58	47250	RHS	NH 29	40	0.4191	0.3202	0.1436	0.0845	0.0551	0.0366	0.0158	40.6	933.7	248.7	115
59	47375	LHS	NH 29	40	0.278	0.2098	0.106	0.0629	0.0458	0.0375	0.0184	39.9	984.3	338.5	113
60	47500	RHS	NH 29	40	0.3049	0.2455	0.1009	0.056	0.0388	0.0304	0.0084	39.9	1001.5	214	112.9
61	47625	LHS	NH 29	40	0.2431	0.1787	0.0877	0.0737	0.0445	0.0314	0.0179	39.9	1001.5	214	112.9
62	47750	RHS	NH 29	40	0.3374	0.2546	0.1406	0.0847	0.0597	0.051	0.0251	39.9	1002.6	336.2	113
63	47875	LHS	NH 29	40	0.2228	0.1677	0.0927	0.0629	0.044	0.0316	0.0185	39.9	974.8	335.4	113
64	48000	RHS	NH 29	40	0.3435	0.2629	0.1276	0.0856	0.063	0.0449	0.0045	39.9	950.6	213	113
65	48125	LHS	NH 29	40	0.3153	0.2314	0.1431	0.0743	0.0628	0.035	0.0195	39.9	1000.3	324.2	113
66	48250	RHS	NH 29	40	0.3587	0.2747	0.139	0.086	0.068	0.0494	0.0179	39.9	998.5	270.8	113
67	48375	LHS	NH 29	40	0.3957	0.3025	0.1644	0.1028	0.0707	0.0495	0.0225	39.9	993.8	268.3	113
68	48500	RHS	NH 29	40	0.3554	0.2764	0.1453	0.095	0.0684	0.0484	0.0241	39.9	988.4	337.5	113
69	48625	LHS	NH 29	40	0.3004	0.2329	0.1185	0.0738	0.0518	0.0376	0.0161	39.9	1003.8	299.7	113
70	48750	RHS	NH 29	40	0.3361	0.2598	0.143	0.0883	0.0613	0.0513	0.0249	39.9	990.2	325.3	113
71	48875	LHS	NH 29	40	0.3177	0.2314	0.139	0.0738	0.0611	0.0336	0.0186	39.9	992.6	307.1	113
72	49000	RHS	NH 29	40	0.3721	0.2907	0.1459	0.0903	0.0663	0.0476	0.0188	40.4	931.6	238.5	113
73	49125	LHS	NH 29	40	0.2757	0.1963	0.0753	0.0524	0.0352	0.0304	0.0158	40.6	909.9	337.5	113
74	49250	RHS	NH 29	40	0.272	0.1983	0.0795	0.0527	0.037	0.0305	0.0168	40.6	932.6	302.6	99
75	49375	LHS	NH 29	40	0.2824	0.1924	0.1038	0.062	0.0298	0.0219	0.0112	40.6	909.9	198	99
76	49500	RHS	NH 29	40	0.2529	0.1869	0.1015	0.0756	0.0552	0.033	0.0176	40.6	938.4	318.7	99
77	49625	LHS	NH 29	40	0.317	0.2268	0.1219	0.0891	0.0591	0.045	0.0129	40.6	938.4	200.2	99
78	49750	RHS	NH 29	40	0.3534	0.2658	0.1462	0.0949	0.0705	0.0521	0.01	38.4	1027.5	198.4	99
79	49875	LHS	NH 29	40	0.2753	0.1963	0.1263	0.067	0.042	0.024	0.0055	38.4	1025.5	198.7	99
80	50000	RHS	NH 29	40	0.4018	0.304	0.149	0.0917	0.0663	0.0477	0.023	38.4	1042	199.1	99
81	50125	LHS	NH 29	40	0.2857	0.2142	0.1063	0.0634	0.0459	0.0381	0.0189	38.4	1007	199.6	99
82	50250	RHS	NH 29	40	0.2193	0.1467	0.0572	0.0406	0.0142	0.0071	0.0035	38.4	1007	199.6	99
83	50375	LHS	NH 29	40	0.2969	0.2181	0.1342	0.0883	0.064	0.0544	0.0232	39.5	1002.6	316.3	99
84	50500	RHS	NH 29	40	0.1858	0.1454	0.0783	0.0595	0.0448	0.0348	0.0123	39.5	987.3	315.8	101
85	50625	LHS	NH 29	40	0.1718	0.1366	0.0747	0.0548	0.041	0.0326	0.0115	39.5	937	316	101
86	50750	RHS	NH 29	40	0.2953	0.215	0.1269	0.0772	0.0592	0.0344	0.0124	39.5	997.3	293.4	101
87	50875	LHS	NH 29	40	0.293	0.2152	0.119	0.0809	0.0621	0.0462	0.0135	40.6	938.4	200.2	99

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
88	51000	RHS	NH 29	40	0.2643	0.2036	0.1197	0.0819	0.059	0.0402	0.0208	40.6	933.1	315.1	101
89	51125	LHS	NH 29	40	0.2655	0.1879	0.1103	0.0737	0.0613	0.0366	0.0157	40.6	931	315	101
90	51250	RHS	NH 29	40	0.2713	0.1969	0.0961	0.055	0.0463	0.0352	0.013	40.6	931.6	310.2	101
91	51375	LHS	NH 29	40	0.2416	0.173	0.1009	0.0671	0.0568	0.0447	0.0183	40.6	927.3	315.3	100.9
92	51500	RHS	NH 29	40	0.3441	0.2584	0.1466	0.0907	0.0681	0.0531	0.0275	40.6	928.9	315.2	101
93	51625	LHS	NH 29	40	0.2725	0.2038	0.1262	0.0817	0.0596	0.0509	0.0216	40.6	933.7	315.8	101
94	51750	RHS	NH 29	40	0.3024	0.2266	0.1132	0.0769	0.0504	0.0375	0.0157	40.6	889.9	313	101
95	51875	LHS	NH 29	40	0.258	0.182	0.0875	0.0736	0.0459	0.0329	0.0178	40.6	919.4	315.7	101
96	52000	RHS	NH 29	40	0.3096	0.2407	0.1296	0.0924	0.061	0.0478	0.0109	40.6	937.4	245.2	101
97	52125	LHS	NH 29	40	0.2459	0.1762	0.0942	0.0712	0.0514	0.0314	0.0164	40.6	912	314.7	101
98	52250	RHS	NH 29	40	0.3082	0.2209	0.1158	0.0804	0.0612	0.0456	0.0231	40.6	889.9	315.2	101
99	52375	LHS	NH 29	40	0.2869	0.2083	0.1093	0.0754	0.0591	0.0442	0.0216	40.6	930	314.8	101
100	52500	RHS	NH 29	40	0.213	0.1508	0.0811	0.0547	0.031	0.0211	0.0116	40.6	930	314.8	101
101	52625	LHS	NH 29	40	0.3434	0.2318	0.1241	0.0845	0.0617	0.0364	0.0148	40.6	931.6	276.9	101
102	52750	RHS	NH 29	40	0.3167	0.2605	0.1304	0.0871	0.0637	0.0559	0.0279	40.6	930.5	315.4	101
103	52875	LHS	NH 29	40	0.6089	0.4571	0.1884	0.0844	0.0502	0.0356	0.0173	40.6	915.7	221.2	115
104	53000	RHS	NH 29	40	0.2975	0.2262	0.1148	0.0716	0.0509	0.0372	0.0156	37.9	1101.7	240.7	96.9
105	53250	LHS	NH 29	40	0.42	0.3337	0.1638	0.0905	0.0606	0.0456	0.0183	37.9	1050.3	239.5	97
106	53500	RHS	NH 29	40	0.3891	0.2839	0.1255	0.0786	0.0596	0.0442	0.0102	35.5	1128.7	243.9	102
107	53750	LHS	NH 29	40	0.2291	0.1654	0.0744	0.0463	0.0351	0.0237	0.0089	37.9	1136.4	239.1	97
108	54000	RHS	NH 29	40	0.4795	0.3658	0.1599	0.0908	0.0692	0.0451	0.0082	35.5	1271.6	212	102
109	54125	LHS	NH 29	40	0.3589	0.2651	0.1197	0.0707	0.0497	0.0326	0.0176	41.6	924.2	238.7	110
110	54250	RHS	NH 29	40	0.2583	0.1951	0.0867	0.0498	0.031	0.0274	0.0094	41.6	931	235.9	110
111	54375	LHS	NH 29	40	0.2615	0.188	0.0951	0.0589	0.0365	0.0248	0.0093	41.6	930.5	238.3	110
112	54500	RHS	NH 29	40	0.461	0.3439	0.1617	0.0877	0.0547	0.0441	0.0224	40.3	932.1	267.3	115
113	54625	LHS	NH 29	40	0.539	0.4254	0.179	0.0903	0.0657	0.0445	0.0159	40.6	915.2	222.5	115
114	54750	RHS	NH 29	40	0.5196	0.3878	0.1743	0.0909	0.0661	0.0476	0.0123	40.3	911.5	223.2	115
115	54875	LHS	NH 29	40	0.2929	0.2134	0.1129	0.085	0.0538	0.041	0.012	40.6	931	297.6	101
116	55000	RHS	NH 29	40	0.3722	0.295	0.1458	0.0904	0.0669	0.0465	0.0187	40	931	301.5	101
117	55125	LHS	NH 29	40	0.2084	0.1507	0.0855	0.0587	0.0414	0.0296	0.0171	40	934.7	312.6	101

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
118	55250	RHS	NH 29	40	0.3443	0.2601	0.1408	0.0922	0.0685	0.0508	0.0098	40	934.7	202	101
119	55375	LHS	NH 29	40	0.4017	0.3067	0.155	0.0984	0.0677	0.0573	0.0193	40	936.3	275.3	101
120	55500	RHS	NH 29	40	0.2372	0.1504	0.0674	0.041	0.0211	0.0098	0.0032	40	924.2	197.9	101
121	55625	LHS	NH 29	40	0.298	0.2322	0.1208	0.0873	0.06	0.0419	0.0193	40	913.6	312.3	101
122	55750	RHS	NH 29	40	0.1945	0.1533	0.0988	0.0631	0.0582	0.0389	0.013	40	933.1	316	101
123	55875	LHS	NH 29	40	0.458	0.3426	0.1626	0.0945	0.0637	0.051	0.0176	40.6	940	266.8	115
124	56000	RHS	NH 29	40	0.229	0.1399	0.0632	0.0429	0.0327	0.0217	0.0057	37.9	1139.3	240.8	97
125	56250	LHS	NH 29	40	0.3651	0.2751	0.1161	0.0788	0.0522	0.0346	0.0133	37.9	1009.8	271.8	110
126	56500	RHS	NH 29	40	0.375	0.2936	0.1329	0.0765	0.0513	0.0403	0.0104	37.9	1094.4	270.6	110
127	56625	LHS	NH 29	40	0.407	0.2946	0.123	0.0708	0.0574	0.043	0.0112	40.6	930	222.5	115
128	56750	RHS	NH 29	40	0.4195	0.3253	0.165	0.0903	0.0584	0.0412	0.0138	41.5	934.7	240.9	115
129	56875	LHS	NH 29	40	0.2385	0.1705	0.0819	0.069	0.0422	0.0307	0.0169	40	892	314.7	101
130	57000	RHS	NH 29	40	0.3053	0.2229	0.125	0.0865	0.0654	0.049	0.0146	40	926.3	310.4	101
131	57125	LHS	NH 29	40	0.2872	0.1998	0.118	0.0705	0.0478	0.0357	0.0156	40	928.4	314.3	101
132	57250	RHS	NH 29	40	0.2989	0.2242	0.1126	0.0778	0.0623	0.0462	0.0226	40	930.5	313.6	101
133	57375	LHS	NH 29	40	0.2332	0.1651	0.0785	0.0501	0.0303	0.0127	0.0058	40.6	934.7	231.6	115
134	57500	RHS	NH 29	40	0.4604	0.3508	0.143	0.0825	0.0504	0.0428	0.0077	37.9	1273.78	225.3	110
135	57750	LHS	NH 29	40	0.2912	0.2129	0.0944	0.0584	0.045	0.0361	0.0181	37.9	1246.523	271.8	110
136	58000	RHS	NH 29	40	0.3788	0.2767	0.1257	0.074	0.058	0.0516	0.0074	37	1177.542	214.4	111
137	58125	LHS	NH 29	40	0.433	0.3061	0.1361	0.0717	0.0478	0.0378	0.0136	41.5	913.6	224.7	115
138	58250	RHS	NH 29	40	0.5055	0.3868	0.1581	0.0887	0.0586	0.0478	0.0178	41.5	921.5	222.2	115
139	58375	LHS	NH 29	40	0.4266	0.34	0.1407	0.0862	0.0456	0.0322	0.0164	41.5	932.6	241.1	115
140	58500	RHS	NH 29	40	0.3867	0.3029	0.1434	0.0799	0.0573	0.0479	0.0097	40.6	931	223.6	115
141	58625	LHS	NH 29	40	0.4937	0.3852	0.1583	0.0929	0.0604	0.0478	0.0185	41.5	896.7	221.2	115
142	58750	RHS	NH 29	40	0.4584	0.3272	0.1419	0.0763	0.05	0.0406	0.0145	41.5	936.8	224.7	115
143	58875	LHS	NH 29	40	0.5516	0.4034	0.1872	0.1043	0.0641	0.0508	0.0186	40.7	932.1	221.7	115
144	59000	RHS	NH 29	40	0.3529	0.2204	0.0945	0.0532	0.0289	0.0147	0.0038	40.7	920.5	227.5	103
145	59125	LHS	NH 29	40	0.6156	0.4386	0.1907	0.1095	0.0744	0.0551	0.0279	42.2	898.3	227.4	103
146	59250	RHS	NH 29	40	0.4446	0.3046	0.1457	0.0871	0.0714	0.0542	0.0151	41.2	913.1	228	103
147	59375	LHS	NH 29	40	0.652	0.5056	0.2221	0.1123	0.0734	0.0572	0.0194	42.2	912	227.7	103

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
148	59500	RHS	NH 29	40	0.6187	0.4399	0.1634	0.0714	0.0493	0.0414	0.0078	41.2	916.2	221.7	103
149	59625	LHS	NH 29	40	0.5623	0.4274	0.1422	0.0574	0.0347	0.0216	0.0053	42.2	922.6	226.4	103
150	59750	RHS	NH 29	40	0.3748	0.2987	0.1261	0.073	0.0491	0.0274	0.0129	41.2	893.5	228	103
151	59875	LHS	NH 29	40	0.3076	0.2282	0.0956	0.0535	0.0385	0.0317	0.0074	42.2	893.5	227.3	103
152	60000	RHS	NH 29	40	0.4909	0.3623	0.1746	0.1005	0.0681	0.0546	0.0187	41.2	928.4	227.1	103
153	60125	LHS	NH 29	40	0.4682	0.3094	0.1338	0.0624	0.0401	0.0236	0.0114	41.2	932.1	227.4	103
154	60250	RHS	NH 29	40	0.3127	0.2034	0.0881	0.0517	0.0429	0.0286	0.013	42.2	905.2	225.9	103
155	60375	LHS	NH 29	40	0.6034	0.4566	0.1988	0.1012	0.0664	0.0546	0.0037	42.2	933.1	227.7	103
156	60500	RHS	NH 29	40	0.4622	0.3454	0.1765	0.101	0.0597	0.0458	0.0202	42.2	925.7	226.7	103
157	60625	LHS	NH 29	40	0.5118	0.4018	0.1597	0.09	0.0593	0.0479	0.0176	41.2	937.4	226.9	103
158	60750	RHS	NH 29	40	0.5631	0.4347	0.1902	0.0889	0.047	0.0397	0.0146	42.2	915.7	222.1	103
159	60875	LHS	NH 29	40	0.6683	0.5129	0.2158	0.1003	0.0684	0.048	0.0173	41.2	909.9	225.9	103
160	61000	RHS	NH 29	40	0.4845	0.365	0.166	0.089	0.0628	0.0457	0.0113	42.2	892.5	224.9	103
161	61125	LHS	NH 29	40	0.445	0.3341	0.1581	0.0927	0.0641	0.0522	0.0215	41.2	927.9	227	103
162	61250	RHS	NH 29	40	0.4933	0.3876	0.1875	0.1085	0.0604	0.0563	0.0044	42.2	923.6	221.8	103
163	61375	LHS	NH 29	40	0.4033	0.3114	0.1514	0.0816	0.0527	0.0359	0.0207	41.2	912.6	227.8	102.9
164	61500	RHS	NH 29	40	0.3433	0.2661	0.115	0.0538	0.0348	0.0233	0.0082	42.2	897.8	227.2	103
165	61625	LHS	NH 29	40	0.4133	0.2904	0.1355	0.0806	0.0644	0.051	0.0144	42.2	906.7	227.9	103
166	61750	RHS	NH 29	40	0.4765	0.3659	0.1559	0.0854	0.0613	0.0342	0.0175	42.2	930	226.7	103
167	61875	LHS	NH 29	40	0.2761	0.1742	0.1103	0.0869	0.0456	0.0279	0.0099	40	928.9	250.9	98
168	62000	RHS	NH 29	40	0.2815	0.2064	0.1039	0.0626	0.0453	0.0378	0.0183	40	937.9	250.7	98
169	62125	LHS	NH 29	40	0.263	0.1786	0.0946	0.0577	0.0276	0.0206	0.0106	40	931.6	249.2	98
170	62250	RHS	NH 29	40	0.2313	0.172	0.0886	0.056	0.0368	0.0301	0.0107	40	914.1	247.7	98
171	62375	LHS	NH 29	40	0.2701	0.2276	0.1144	0.0819	0.0581	0.0359	0.0191	40	931.6	249.2	98
172	62500	RHS	NH 29	40	0.2923	0.217	0.1218	0.0842	0.0608	0.0548	0.0274	40	940	249	98
173	62625	LHS	NH 29	40	0.2016	0.1361	0.0747	0.0501	0.0287	0.0192	0.0108	40	939.5	250.4	98
174	62750	RHS	NH 29	40	0.1959	0.1372	0.0732	0.0479	0.0416	0.0296	0.0121	40	911	250.2	98
175	62875	LHS	NH 29	40	0.2546	0.1885	0.1038	0.0575	0.0424	0.0294	0.0145	40	939.5	249.3	98
176	63000	RHS	NH 29	40	0.191	0.1551	0.0978	0.0613	0.0515	0.0398	0.0167	40	935.2	249.4	98
177	63125	LHS	NH 29	40	0.428	0.3254	0.1569	0.1	0.0684	0.0576	0.0199	39.5	987.3	249.3	98

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
178	63250	RHS	NH 29	40	0.3389	0.2558	0.1389	0.0876	0.0598	0.0506	0.0252	39.5	1000.9	250.3	98
179	63375	LHS	NH 29	40	0.2962	0.2423	0.122	0.0811	0.0597	0.0528	0.0263	39.5	972.5	250.9	98
180	63500	RHS	NH 29	40	0.2932	0.2178	0.1349	0.0876	0.0629	0.0532	0.023	39.5	977.2	185.7	111.9
181	63625	LHS	NH 29	40	0.3552	0.2795	0.146	0.0963	0.0682	0.0478	0.0242	39.5	977.2	185.7	111.9
182	63750	RHS	NH 29	40	0.319	0.2261	0.1564	0.1175	0.0886	0.0555	0.0219	39.5	983.1	185.8	112
183	63875	LHS	NH 29	40	0.3722	0.2481	0.1303	0.0907	0.0651	0.0388	0.0158	39.5	898	185.9	111.9
184	64000	RHS	NH 29	40	0.3301	0.2508	0.1146	0.0729	0.0589	0.0263	0.0131	39.5	973.1	184.1	112
185	64125	LHS	NH 29	40	0.3688	0.2333	0.1065	0.0821	0.0592	0.0423	0.0108	39.5	983.1	185.9	112
186	64250	RHS	NH 29	40	0.229	0.1759	0.0914	0.0565	0.0477	0.0301	0.0056	39.5	972.5	185.7	112
187	64375	LHS	NH 29	40	0.2905	0.2269	0.115	0.0755	0.0557	0.0372	0.0235	39.5	1002.6	185.7	111.9
188	64500	RHS	NH 29	40	0.4157	0.316	0.1557	0.0967	0.0694	0.0564	0.0199	39.5	958.3	185.2	112
189	64625	LHS	NH 29	40	0.3917	0.2433	0.1102	0.0839	0.0603	0.0434	0.0107	36	1149	223.2	114
190	64750	RHS	NH 29	40	0.2238	0.1406	0.0629	0.0383	0.0193	0.0091	0.003	36.4	966.1	212.1	106
191	64875	LHS	NH 29	40	0.3556	0.2694	0.1453	0.1011	0.0835	0.0618	0.0125	37.8	991.7	256.7	111
192	65000	RHS	NH 29	40	0.2617	0.1988	0.1003	0.0628	0.045	0.0384	0.0081	37.8	1015.6	229	111
193	65125	LHS	NH 29	40	0.2918	0.2327	0.117	0.0769	0.0487	0.0368	0.0153	38.5	1046.6	247.8	108
194	65250	RHS	NH 29	40	0.3613	0.2753	0.1512	0.0984	0.0788	0.0587	0.0137	38.5	1044.6	249.9	108
195	65375	LHS	NH 29	40	0.3142	0.2428	0.1313	0.0812	0.0578	0.0471	0.0234	38.5	1044.6	249.9	108
196	65500	RHS	NH 29	40	0.2688	0.1725	0.0747	0.0519	0.0371	0.0236	0.0092	39	1000.9	281	112
197	65625	LHS	NH 29	40	0.3161	0.243	0.1256	0.0886	0.0637	0.0499	0.0253	39	1000.9	281	112
198	65750	RHS	NH 29	40	0.3207	0.2475	0.1223	0.0787	0.0659	0.0415	0.0162	39	994.9	292.7	112
199	65875	LHS	NH 29	40	0.3692	0.2348	0.1056	0.0686	0.0483	0.0293	0.0148	41.2	935.8	226.9	103
200	66000	RHS	NH 29	40	0.3113	0.2348	0.1139	0.0642	0.0431	0.0302	0.0139	37.9	1163.156	240.1	97
201	66250	LHS	NH 29	40	0.3245	0.2398	0.1105	0.0621	0.0439	0.0356	0.019	37.9	1153.234	240.4	97
202	66500	RHS	NH 29	40	0.2102	0.1616	0.0706	0.0385	0.0278	0.0201	0.0059	37.9	1258.84	240.5	97
203	67000	LHS	NH 29	40	0.4228	0.2872	0.1217	0.0826	0.064	0.046	0.0167	42.5	938.9	267.1	99
204	67125	RHS	NH 29	40	0.4651	0.3467	0.1704	0.0975	0.0612	0.0461	0.0197	42.5	919.4	270.9	99
205	67250	LHS	NH 29	40	0.4654	0.3442	0.1542	0.0821	0.0563	0.0439	0.022	42.5	908.9	265.7	99
206	67375	RHS	NH 29	40	0.2517	0.1804	0.088	0.0543	0.0476	0.0369	0.0098	41.9	937.4	268.7	99
207	67500	LHS	NH 29	40	0.5505	0.4154	0.1677	0.0857	0.0566	0.0437	0.0207	41.9	939.5	222.4	116

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
208	67625	RHS	NH 29	40	0.3845	0.2796	0.1272	0.0767	0.0537	0.0426	0.0101	42.9	934.2	273.7	116
209	67750	LHS	NH 29	40	0.3485	0.2455	0.096	0.0527	0.0411	0.0338	0.0168	41.9	936.3	274.3	116
210	67875	RHS	NH 29	40	0.487	0.3731	0.1798	0.099	0.0707	0.0554	0.0287	42.9	928.9	273.1	116
211	68000	LHS	NH 29	40	0.3598	0.2918	0.1675	0.1152	0.0866	0.0565	0.0225	39	977.2	296	112
212	68125	RHS	NH 29	40	0.3289	0.2577	0.1387	0.0874	0.0631	0.0496	0.0241	39	980.8	295.4	112
213	68250	LHS	NH 29	40	0.4268	0.3384	0.1656	0.1073	0.0756	0.0542	0.0134	39	1004.4	215.8	112
214	68375	RHS	NH 29	40	0.3155	0.2256	0.1201	0.0922	0.0575	0.045	0.0132	39	989.6	293.8	112
215	68500	LHS	NH 29	40	0.3241	0.247	0.1346	0.0874	0.0646	0.0485	0.0093	39	1000.9	231.5	112
216	68625	RHS	NH 29	40	0.2348	0.1797	0.0927	0.0606	0.0411	0.0316	0.0061	39	1000.9	238.1	112
217	68750	LHS	NH 29	40	0.2043	0.1628	0.1046	0.0643	0.0544	0.0426	0.018	39	1000.9	238.1	112
218	68875	RHS	NH 29	40	0.2729	0.2095	0.1108	0.0776	0.0539	0.0471	0.0171	39	1005	292.2	112
219	69000	LHS	NH 29	40	0.4732	0.3608	0.1743	0.0954	0.0686	0.0532	0.0278	41.9	903.6	277.8	116
220	69500	RHS	NH 29	40	0.3961	0.2988	0.1313	0.0782	0.0585	0.0451	0.0104	41.9	927.9	274.6	116
221	69625	LHS	NH 29	40	0.2956	0.188	0.1166	0.0934	0.0481	0.0291	0.0104	39	995.5	289.3	112
222	69750	RHS	NH 29	40	0.3045	0.2288	0.143	0.0726	0.0601	0.0352	0.0194	39	973.7	294.8	112
223	69875	LHS	NH 29	40	0.5397	0.4098	0.1863	0.0877	0.0432	0.0361	0.0203	42.9	935.8	229.8	116
224	70000	RHS	NH 29	40	0.3825	0.2717	0.1134	0.0648	0.0409	0.033	0.0091	34.1	1335.7	215.6	94
225	70250	LHS	NH 29	40	0.4358	0.3073	0.1305	0.0745	0.0604	0.0453	0.0119	32.4	1357.3	221.7	111
226	70500	RHS	NH 29	40	0.3764	0.2714	0.109	0.0582	0.0367	0.0253	0.009	34.1	1392.1	216	94
227	70750	LHS	NH 29	40	0.4679	0.3462	0.1678	0.0857	0.0536	0.0453	0.0218	37	1127.7	228.4	111
228	71000	RHS	NH 29	40	0.4261	0.2808	0.112	0.0632	0.0533	0.034	0.01	34.1	1360	208.1	94
229	71250	LHS	NH 29	40	0.4723	0.3776	0.1662	0.073	0.0365	0.0233	0.0062	37	1114.7	213.6	111
230	71500	RHS	NH 29	40	0.4143	0.2926	0.128	0.0641	0.0487	0.0312	0.0113	34.1	1325	213.4	94
231	71750	LHS	NH 29	40	0.2163	0.1441	0.0517	0.0212	0.0138	0.0071	0.0034	37	1068.4	210	111
232	72000	RHS	NH 29	40	0.4152	0.2772	0.1155	0.049	0.0317	0.0178	0.0088	34.1	1382.4	201.3	94
233	72250	LHS	NH 29	40	0.5478	0.3819	0.1615	0.0857	0.0549	0.0422	0.0235	37	1098.8	215.3	111
234	72500	RHS	NH 29	40	0.4085	0.2685	0.1066	0.0609	0.0508	0.0323	0.0095	34.1	1382.4	203.6	94
235	72750	LHS	NH 29	40	0.4852	0.3647	0.1594	0.0767	0.0561	0.0385	0.0096	37	1130.6	238.2	112
236	73000	RHS	NH 29	40	0.5877	0.4142	0.1531	0.0806	0.0504	0.0265	0.0152	34.1	1394	199.3	94
237	73250	LHS	NH 29	40	0.4267	0.288	0.1131	0.0508	0.0319	0.0176	0.0086	37	1083.6	233.9	112

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
238	73500	RHS	NH 29	40	0.4427	0.3034	0.1153	0.0545	0.0435	0.0254	0.012	35.9	1271.6	215.2	94
239	73750	LHS	NH 29	40	0.3558	0.264	0.1255	0.0693	0.0438	0.0364	0.01	35.9	1141.6	230.8	93
240	74000	RHS	NH 29	40	0.2355	0.1501	0.0695	0.0375	0.0269	0.0216	0.0083	39.9	1002	230.9	93
241	74250	LHS	NH 29	40	0.3459	0.2468	0.0965	0.0506	0.0404	0.034	0.0167	37	1103.8	268.6	112
242	74500	RHS	NH 29	40	0.3676	0.2813	0.1248	0.0755	0.0562	0.046	0.0159	34.7	1305.5	267.1	112
243	74750	LHS	NH 29	40	0.3081	0.2115	0.0918	0.0594	0.0481	0.0346	0.0084	35.9	1220.3	229.2	93
244	75000	RHS	NH 29	40	0.2316	0.1648	0.0735	0.0436	0.0324	0.0227	0.0113	35.9	1184.635	230.1	93
245	75250	LHS	NH 29	40	0.5877	0.4629	0.1885	0.0989	0.0697	0.0485	0.017	34.7	1375.678	221.1	112
246	75500	RHS	NH 29	40	0.3144	0.2108	0.0673	0.0429	0.034	0.0229	0.0113	35.9	1296.01	230.2	93
247	75750	LHS	NH 29	40	0.376	0.2646	0.1278	0.0693	0.0523	0.0426	0.009	34.7	1336.302	265.9	112
248	76000	RHS	NH 29	40	0.2631	0.2065	0.1104	0.0679	0.0506	0.0338	0.0171	35.9	1210.553	230.6	93
249	76250	LHS	NH 29	40	0.4263	0.3259	0.141	0.0831	0.0558	0.0362	0.0161	34.7	1363.243	267.6	112
250	76500	RHS	NH 29	40	0.3696	0.2826	0.1252	0.0781	0.061	0.0441	0.0214	35.9	1288.828	229.6	93
251	76750	LHS	NH 29	40	0.3205	0.2299	0.0915	0.0483	0.0383	0.0316	0.0156	35.9	1324.426	231	93
252	77000	RHS	NH 29	40	0.2124	0.1596	0.0709	0.0431	0.0313	0.0188	0.0094	35.9	1280.813	230.2	93
253	77250	LHS	NH 29	40	0.3295	0.2601	0.1416	0.0809	0.0544	0.0415	0.0165	37.9	1154.944	239.8	97
254	77500	RHS	NH 29	40	0.4374	0.331	0.1569	0.0876	0.0558	0.0398	0.0141	37.9	1248.12	239.3	97
255	77750	LHS	NH 29	40	0.4727	0.3932	0.169	0.0889	0.0595	0.0463	0.0233	37.9	1191.211	240.2	97
256	78000	RHS	NH 29	40	0.4306	0.3095	0.1387	0.0703	0.0439	0.0268	0.0127	34.7	1345.973	266	112
257	78125	LHS	NH 29	40	0.4466	0.3435	0.1525	0.0863	0.0656	0.0433	0.0075	42.3	934.7	201.1	116
258	78250	RHS	NH 29	40	0.3971	0.2709	0.1422	0.0936	0.0538	0.0369	0.0168	42.9	915.7	275.3	116
259	78375	LHS	NH 29	40	0.3296	0.2306	0.1033	0.0619	0.047	0.0276	0.0102	42.3	928.4	274.2	116
260	78500	RHS	NH 29	40	0.3699	0.2722	0.1287	0.0706	0.0512	0.035	0.0061	42.9	924.7	225.1	116
261	78625	LHS	NH 29	40	0.3268	0.2438	0.1217	0.0637	0.0454	0.0238	0.0095	42.3	907.3	276.1	116
262	78750	RHS	NH 29	40	0.5168	0.3704	0.1551	0.0814	0.0522	0.0405	0.0211	42.9	935.2	241.9	116
263	78875	LHS	NH 29	40	0.234	0.1843	0.07	0.041	0.025	0.0216	0.0079	42.9	927.3	274.4	116
264	79000	RHS	NH 29	40	0.391	0.2796	0.1282	0.0736	0.0513	0.0402	0.0177	42.3	932.1	267.9	116
265	79125	LHS	NH 29	40	0.5261	0.3528	0.1382	0.0729	0.0508	0.0418	0.0194	42.9	934.2	218.7	116
266	79250	RHS	NH 29	40	0.4197	0.3043	0.1199	0.0667	0.0393	0.0266	0.0115	42.3	936.3	250.7	116
267	79375	LHS	NH 29	40	0.2708	0.1926	0.0762	0.0526	0.0363	0.0302	0.016	39	981.9	295.8	112

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
268	79500	RHS	NH 29	40	0.3656	0.263	0.1547	0.0953	0.0709	0.0569	0.0276	39	1000.3	294.8	112
269	79625	LHS	NH 29	40	0.2686	0.1868	0.0715	0.0495	0.0417	0.0311	0.0133	39	980.8	291.2	112
270	79750	RHS	NH 29	40	0.4138	0.3006	0.1525	0.0915	0.0668	0.0463	0.0237	39	1002	291.5	112
271	79875	LHS	NH 29	40	0.3757	0.3012	0.1454	0.087	0.0654	0.0494	0.0179	39	1005	287	112
272	80000	RHS	NH 29	40	0.3113	0.2339	0.1243	0.0911	0.0586	0.0449	0.0127	39.5	1001.5	291.7	112
273	80125	LHS	NH 29	40	0.2301	0.1623	0.0857	0.0603	0.0457	0.0378	0.0071	39.5	996.7	279.7	112
274	80250	RHS	NH 29	40	0.319	0.2401	0.1121	0.0715	0.0461	0.0425	0.0193	39.5	991.4	295.9	112
275	80375	LHS	NH 29	40	0.2363	0.1819	0.1017	0.0679	0.0494	0.0377	0.0134	39.5	953	294.9	112
276	80500	RHS	NH 29	40	0.3636	0.2665	0.1535	0.0974	0.0709	0.0566	0.0279	39.5	1001.5	294.8	112
277	80625	LHS	NH 29	40	0.3233	0.2418	0.1294	0.0836	0.0555	0.048	0.0165	39.5	1003.8	264.3	116
278	80750	RHS	NH 29	40	0.3746	0.2809	0.1441	0.0881	0.0627	0.0442	0.0223	39.5	999.7	230.3	116
279	80875	LHS	NH 29	40	0.4626	0.3261	0.1323	0.0885	0.0694	0.0504	0.0182	42.9	929.4	277	116
280	81000	RHS	NH 29	40	0.5775	0.4343	0.2008	0.1131	0.0702	0.0548	0.0198	35.2	1278.572	221.5	105
281	81250	LHS	NH 29	40	0.3403	0.26	0.0953	0.0567	0.0352	0.0272	0.0177	35.2	1275.142	267.1	105
282	81500	RHS	NH 29	40	0.386	0.2762	0.1277	0.0729	0.0442	0.0373	0.0103	35.2	1255.266	263.1	105
283	81750	LHS	NH 29	40	0.3418	0.2562	0.1193	0.066	0.0461	0.0389	0.0202	35.2	1225.908	268.8	105
284	82000	RHS	NH 29	40	0.3252	0.2485	0.1173	0.0689	0.0449	0.0276	0.0127	35.2	1261.32	266.8	105
285	82250	LHS	NH 29	40	0.3686	0.2805	0.1399	0.0795	0.0543	0.0417	0.0146	34.7	1337.289	268.5	112
286	82500	RHS	NH 29	40	0.5569	0.4153	0.1624	0.0817	0.0543	0.0408	0.0235	35.2	1281.195	224.7	105
287	82750	LHS	NH 29	40	0.2796	0.2	0.0849	0.0507	0.0364	0.0272	0.0101	34.7	1350.71	268.4	112
288	83000	RHS	NH 29	40	0.394	0.2895	0.1233	0.0857	0.0566	0.0369	0.0143	39.2	1214.442	268.9	105
289	83250	LHS	NH 29	40	0.3558	0.2317	0.062	0.0392	0.0231	0.0127	0.0055	34.7	1370.941	201.2	112
290	83500	RHS	NH 29	40	0.3602	0.2498	0.091	0.0554	0.0385	0.0309	0.0072	35.2	1284.625	209	105
291	83750	LHS	NH 29	40	0.4138	0.3141	0.1404	0.0843	0.0548	0.0367	0.0158	34.7	1367.092	266.9	112
292	84000	RHS	NH 29	40	0.5761	0.4088	0.1701	0.0753	0.0524	0.0462	0.0225	34.7	1364.23	227	112
293	84250	LHS	NH 29	40	0.3086	0.237	0.1204	0.0752	0.0543	0.0389	0.0165	35.2	1280.287	241.9	101
294	84500	RHS	NH 29	40	0.3232	0.2579	0.1263	0.0792	0.051	0.0416	0.0214	34.5	1360.806	258.1	101
295	84750	LHS	NH 29	40	0.3076	0.2276	0.1013	0.0632	0.0482	0.038	0.019	38.5	1257.072	288.5	101
296	85000	RHS	NH 29	40	0.3451	0.2647	0.1228	0.0711	0.055	0.0452	0.0155	38.5	1235.372	225.6	96
297	85250	LHS	NH 29	40	0.2386	0.1759	0.0804	0.0486	0.0375	0.0255	0.0096	34.5	1348.48	218.3	96

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
298	85500	RHS	NH 29	40	0.4843	0.3706	0.1775	0.0958	0.0709	0.0559	0.0281	38.5	1254.726	222.7	96
299	85750	LHS	NH 29	40	0.2884	0.2107	0.0797	0.0402	0.0343	0.0276	0.0101	38	1201.473	223.2	96
300	86000	RHS	NH 29	40	0.4973	0.3808	0.1825	0.0983	0.0714	0.0553	0.0296	38	1187.838	221.3	96
301	86250	LHS	NH 29	40	0.5071	0.4216	0.1839	0.0927	0.0638	0.0494	0.0247	38	1214.306	221.2	96
302	86500	RHS	NH 29	40	0.3986	0.3008	0.1451	0.0858	0.0621	0.0481	0.0231	33.2	1173.905	314.2	111
303	86750	LHS	NH 29	40	0.3947	0.2915	0.1221	0.0838	0.055	0.0368	0.0144	38	1224.962	248.7	111
304	87000	RHS	NH 29	40	0.5618	0.3593	0.094	0.0441	0.031	0.0266	0.0134	38	1230.232	212.4	111
305	87250	LHS	NH 29	40	0.4996	0.3736	0.1678	0.0933	0.0685	0.058	0.0299	38	1225.649	260.1	111
306	87500	RHS	NH 29	40	0.3617	0.2598	0.1179	0.0711	0.0518	0.0439	0.0164	38	1224.962	309.3	111
307	87750	LHS	NH 29	40	0.403	0.3122	0.1498	0.0835	0.0588	0.0506	0.0103	38	1181.88	215.5	111
308	88000	RHS	NH 29	40	0.4064	0.2965	0.1297	0.0686	0.0417	0.0265	0.0122	33.2	1307.862	214.9	111
309	88250	LHS	NH 29	40	0.3878	0.2734	0.1259	0.0712	0.0584	0.0525	0.0072	38	1165.954	216.9	111
310	88500	RHS	NH 29	40	0.2076	0.1326	0.0513	0.0312	0.0181	0.0094	0.0045	38	1186.349	210.4	111
311	88750	LHS	NH 29	40	0.4759	0.3654	0.1619	0.0915	0.0704	0.0461	0.0079	38	1188.64	212.3	111
312	89000	RHS	NH 29	40	0.2691	0.197	0.0925	0.0531	0.0397	0.0315	0.0073	38	1186.349	245.1	111
313	89250	LHS	NH 29	40	0.3298	0.2028	0.0877	0.0496	0.0278	0.0137	0.0036	33.2	1192.025	212.2	111
314	89500	RHS	NH 29	40	0.4838	0.3798	0.1615	0.0766	0.0359	0.0282	0.0097	38	1156.1	210.4	111
315	89750	LHS	NH 29	40	0.419	0.262	0.083	0.0482	0.0344	0.024	0.0122	38	1207.546	211	111
316	90000	RHS	NH 29	40	0.4727	0.3476	0.1746	0.0978	0.0612	0.0463	0.0201	38	1218.889	236.9	111
317	90250	LHS	NH 29	40	0.5303	0.4134	0.1771	0.0836	0.0604	0.0218	0.0101	37	1221.961	211.1	111
318	90500	RHS	NH 29	40	0.2488	0.1736	0.066	0.0407	0.0265	0.0157	0.0085	34.7	1327.716	264.8	112
319	90625	LHS	NH 29	40	0.5306	0.3921	0.1538	0.0782	0.0526	0.0394	0.0227	42.3	930	239.2	116
320	90750	RHS	NH 29	40	0.5788	0.4408	0.1926	0.0939	0.0567	0.0388	0.0171	42.3	921	204.7	116
321	90875	LHS	NH 29	40	0.3503	0.2795	0.152	0.088	0.0573	0.0441	0.0181	42.3	918.4	277.7	115.9
322	91000	RHS	NH 29	40	0.5536	0.389	0.1634	0.0729	0.0508	0.0446	0.0217	42.9	891.4	212.1	116
323	91125	LHS	NH 29	40	0.4824	0.3731	0.176	0.0933	0.0664	0.0516	0.0192	42.3	923.1	274.1	116
324	91250	RHS	NH 29	40	0.4781	0.3722	0.1803	0.0952	0.0672	0.053	0.02	42.9	933.7	276.9	116
325	91375	LHS	NH 29	40	0.389	0.2532	0.0989	0.0597	0.0393	0.0221	0.0089	42.3	927.3	240.6	116
326	91500	RHS	NH 29	40	0.3374	0.2648	0.1451	0.0988	0.0782	0.0601	0.0226	39.5	999.7	230.3	116
327	91625	LHS	NH 29	40	0.3422	0.2616	0.1411	0.0853	0.0596	0.0507	0.0258	39.5	990.8	299.7	116

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
328	91750	RHS	NH 29	40	0.278	0.2157	0.109	0.0711	0.0468	0.0345	0.0147	39.5	1003.2	283.1	116
329	91875	LHS	NH 29	40	0.294	0.1852	0.1209	0.0919	0.0486	0.0302	0.0104	39.5	981.3	201.4	116
330	92000	RHS	NH 29	40	0.3531	0.2731	0.1481	0.0969	0.0779	0.0558	0.0135	39.5	986.7	200.9	116
331	92125	LHS	NH 29	40	0.3834	0.3049	0.1669	0.0953	0.0803	0.042	0.0216	39.5	999.1	198	116
332	92250	RHS	NH 29	40	0.362	0.2859	0.1469	0.0955	0.069	0.052	0.0164	39.5	992.6	198.4	116
333	92375	LHS	NH 29	40	0.3064	0.2268	0.1306	0.0912	0.065	0.058	0.029	39.5	982.5	306.6	116
334	92500	RHS	NH 29	40	0.4772	0.3572	0.1408	0.0649	0.0347	0.0226	0.0113	42.9	933.7	210.4	113
335	93000	LHS	NH 29	40	0.3904	0.2786	0.1146	0.0658	0.0456	0.0318	0.0163	38.2	1024.9	244.7	102
336	93125	RHS	NH 29	40	0.2723	0.1993	0.0751	0.0376	0.0322	0.0258	0.0095	38.2	1062.5	240.7	102
337	93250	LHS	NH 29	40	0.4216	0.3282	0.1348	0.0692	0.0436	0.029	0.0106	38.2	1040	235.9	102
338	93375	RHS	NH 29	40	0.3427	0.2413	0.1089	0.0652	0.0456	0.0394	0.0154	38.2	1022.9	244.5	102
339	93500	LHS	NH 29	40	0.2883	0.2094	0.1147	0.0796	0.0609	0.0501	0.0177	39.5	994.9	306.8	116
340	93625	RHS	NH 29	40	0.305	0.2228	0.1407	0.0722	0.0609	0.0344	0.0196	39.5	1005	298.8	116
341	93750	LHS	NH 29	40	0.3392	0.2539	0.1331	0.0929	0.0666	0.0533	0.0271	39.5	988.4	307.9	116
342	93875	RHS	NH 29	40	0.3193	0.2492	0.1241	0.0879	0.0609	0.0485	0.0179	39.5	1001.5	330.6	113
343	94000	LHS	NH 29	40	0.2819	0.1958	0.0792	0.0432	0.0299	0.0215	0.0109	38.2	1067.1	244.9	102
344	96000	RHS	NH 29	40	0.3708	0.28	0.1154	0.0573	0.0416	0.0378	0.0104	38.2	1036.1	227.9	108
345	96125	LHS	NH 29	40	0.3715	0.2751	0.1351	0.079	0.0565	0.0414	0.0146	38.2	983.3	228.6	108
346	96250	RHS	NH 29	40	0.4199	0.2781	0.0851	0.0382	0.0286	0.0124	0.0039	38.2	1075	210.9	108
347	96375	LHS	NH 29	40	0.6811	0.5329	0.2233	0.103	0.069	0.0496	0.0181	39.6	970.7	226.3	108
348	96500	RHS	NH 29	40	0.4056	0.3287	0.1419	0.0758	0.0469	0.0364	0.0178	40.3	916.8	226.9	108
349	96625	LHS	NH 29	40	0.3486	0.252	0.1021	0.0603	0.0445	0.0389	0.0147	40.3	905.2	228.3	108
350	96750	RHS	NH 29	40	0.635	0.4579	0.196	0.1039	0.0752	0.058	0.0095	40.3	937.9	226.3	108
351	96875	LHS	NH 29	40	0.4221	0.3121	0.133	0.0724	0.0433	0.0285	0.0128	40.3	927.9	227.3	108
352	97000	RHS	NH 29	40	0.3417	0.2464	0.0957	0.0528	0.0416	0.0334	0.0171	40.3	935.8	225.5	108
353	97125	LHS	NH 29	40	0.4283	0.2912	0.1226	0.0592	0.0418	0.0232	0.0058	40.3	909.9	228.7	108
354	97250	RHS	NH 29	40	0.437	0.3291	0.1533	0.0971	0.0709	0.0563	0.0328	36.5	972.5	297.3	103
355	97375	LHS	NH 29	40	0.3801	0.2731	0.103	0.0608	0.0382	0.0293	0.0191	41.5	931.6	245.6	112
356	97500	RHS	NH 29	40	0.4508	0.3031	0.1326	0.0604	0.0394	0.0232	0.0111	37.9	1071.3	204.7	112
357	97625	LHS	NH 29	40	0.3207	0.213	0.0659	0.0447	0.0332	0.0232	0.0111	41.5	931	234.5	112

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
358	97750	RHS	NH 29	40	0.4779	0.3781	0.176	0.094	0.0676	0.0527	0.0198	41.5	939.5	221.9	112
359	97875	LHS	NH 29	40	0.4385	0.3104	0.1367	0.068	0.0513	0.0337	0.0121	38.3	1049.3	204	112
360	98000	RHS	NH 29	40	0.3117	0.2306	0.1013	0.0625	0.0478	0.038	0.0194	41.5	893	316.8	112
361	98125	LHS	NH 29	40	0.4357	0.3248	0.1483	0.0736	0.0479	0.0349	0.0105	38.3	1057.2	203.2	112
362	98250	RHS	NH 29	40	0.4624	0.3053	0.1302	0.0605	0.0398	0.0233	0.0112	38.3	995.8	208.5	112
363	98375	LHS	NH 29	40	0.5471	0.3993	0.1739	0.0867	0.0589	0.0483	0.0098	41.5	926.8	204.2	112
364	98500	RHS	NH 29	40	0.3858	0.2677	0.1139	0.0652	0.0409	0.0331	0.0091	38.3	1072.4	206.3	112
365	98625	LHS	NH 29	40	0.4914	0.3669	0.1665	0.0935	0.0688	0.0583	0.0293	38.3	1034.8	230.8	112
366	98750	RHS	NH 29	40	0.379	0.2909	0.1438	0.0905	0.067	0.0488	0.0188	39.9	1002	244.9	113
367	98875	LHS	NH 29	40	0.3317	0.2391	0.1189	0.0835	0.0541	0.0366	0.0119	39.9	981.3	221.1	113
368	99000	RHS	NH 29	40	0.5325	0.3931	0.1635	0.0775	0.0528	0.0436	0.0168	38.1	1067.7	200.6	111
369	99125	LHS	NH 29	40	0.3451	0.2486	0.0966	0.0523	0.0413	0.0338	0.0169	38.6	1041.3	274.5	111
370	99250	RHS	NH 29	40	0.2944	0.2076	0.0846	0.0462	0.032	0.0229	0.0117	39.4	997.3	272.4	111
371	99375	LHS	NH 29	40	0.3938	0.2912	0.1255	0.0846	0.0562	0.0373	0.0143	39.4	1002	271.9	111
372	99500	RHS	NH 29	40	0.3611	0.2684	0.1334	0.0768	0.048	0.0394	0.0128	39.4	994.9	215.8	94
373	99625	LHS	NH 29	40	0.4761	0.368	0.1784	0.0973	0.0659	0.0558	0.0111	39.4	983.1	213.7	94
374	99750	RHS	NH 29	40	0.4091	0.2817	0.1131	0.049	0.0313	0.0176	0.0087	39.4	968.9	212.3	94
375	99875	LHS	NH 29	40	0.552	0.3973	0.1751	0.0836	0.0579	0.0478	0.0097	39.4	948.2	211.8	94
376	100000	RHS	NH 29	40	0.2989	0.2173	0.0889	0.0547	0.0396	0.0288	0.0106	39.4	997.3	215.1	94
377	100125	LHS	NH 29	40	0.4285	0.2932	0.156	0.0979	0.056	0.0395	0.0184	39.4	984.3	215.1	94
378	100250	RHS	NH 29	40	0.599	0.465	0.2006	0.0931	0.0501	0.042	0.0157	39.4	969.5	215.8	94
379	100375	LHS	NH 29	40	0.4496	0.3451	0.1471	0.075	0.0456	0.0309	0.0111	39.4	965.4	216.8	94
380	100500	RHS	NH 29	40	0.3342	0.2282	0.0975	0.0616	0.0517	0.0373	0.0088	39.4	900.9	215	94
381	100625	LHS	NH 29	40	0.3949	0.2917	0.1273	0.0782	0.0583	0.0448	0.0102	39.4	970.1	215.9	94
382	100750	RHS	NH 29	40	0.398	0.3231	0.1401	0.0738	0.046	0.0358	0.0177	39.4	990.8	216.1	94
383	100875	LHS	NH 29	40	0.556	0.3433	0.1538	0.0794	0.0461	0.0316	0.0154	39.4	939.4	216.2	94
384	101000	RHS	NH 29	40	0.4821	0.3905	0.1887	0.1179	0.0851	0.0425	0.0145	39.4	980.2	216.1	94
385	101125	LHS	NH 29	40	0.2355	0.1501	0.0695	0.0375	0.0269	0.0216	0.0083	39.9	1002	230.9	93
386	101250	RHS	NH 29	40	0.4124	0.3232	0.1437	0.0742	0.0472	0.0367	0.0179	39.9	929.3	230.1	93
387	101375	LHS	NH 29	40	0.2689	0.1915	0.0945	0.0577	0.0514	0.0393	0.0105	39.9	999.1	230.4	93

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
388	101500	RHS	NH 29	40	0.2321	0.1808	0.0697	0.0432	0.0251	0.0219	0.0079	38.3	1005.1	247.4	112
389	102000	LHS	NH 29	40	0.3269	0.2486	0.0992	0.0604	0.039	0.0228	0.0081	41.5	904.6	210.3	112
390	102125	RHS	NH 29	40	0.2777	0.1896	0.0528	0.0338	0.0241	0.0129	0.0099	38.3	1049.9	203	112
391	102250	LHS	NH 29	40	0.4217	0.3175	0.1419	0.0832	0.056	0.0362	0.016	41.5	922.6	228.3	112
392	102375	RHS	NH 29	40	0.3673	0.255	0.0935	0.0594	0.0375	0.0249	0.01	38.3	1028.8	206	112
393	102500	LHS	NH 29	40	0.6152	0.4754	0.1934	0.0923	0.0584	0.0195	0.0097	41.5	931.6	204.2	112
394	102625	RHS	NH 29	40	0.3101	0.2012	0.0847	0.0516	0.0436	0.0296	0.0126	42	918.9	265.4	111
395	102750	LHS	NH 29	40	0.4372	0.2863	0.1146	0.0647	0.0544	0.034	0.0103	39.7	976.6	261.5	111
396	102875	RHS	NH 29	40	0.3641	0.2796	0.1113	0.0631	0.0367	0.0229	0.008	39.7	996.7	264.2	111
397	103000	LHS	NH 29	40	0.3892	0.286	0.1485	0.0863	0.0631	0.0522	0.0221	39.7	996.7	264.9	111
398	103125	RHS	NH 29	40	0.2118	0.1345	0.0509	0.0311	0.0183	0.0094	0.0045	42	906.7	264.5	111
399	103250	LHS	NH 29	40	0.4046	0.3059	0.1295	0.0731	0.0624	0.0448	0.0116	39.7	940.5	265.2	111
400	103375	RHS	NH 29	40	0.4491	0.3085	0.1323	0.086	0.0673	0.0489	0.0182	42	925.7	264.5	111
401	103500	LHS	NH 29	40	0.2458	0.1797	0.0788	0.046	0.0348	0.0251	0.0121	39.7	966.6	265.9	111
402	103625	RHS	NH 29	40	0.3389	0.2625	0.1241	0.072	0.0479	0.0284	0.014	41.7	926.8	261.3	111
403	103750	LHS	NH 29	40	0.3961	0.3083	0.1333	0.0838	0.0669	0.048	0.0228	41.5	939.5	299	108
404	103875	RHS	NH 29	40	0.3034	0.2049	0.0861	0.0524	0.0429	0.0278	0.0128	39.7	1004.4	299.9	108
405	104000	LHS	NH 29	40	0.3846	0.2829	0.1182	0.0582	0.0427	0.0383	0.0106	40.1	940	246.1	108
406	104125	RHS	NH 29	40	0.3471	0.2514	0.1026	0.0593	0.0425	0.0383	0.0145	41.5	937.4	300.3	108
407	104250	LHS	NH 29	40	0.3842	0.2708	0.1091	0.0547	0.0377	0.0289	0.0144	39.9	990.8	230.9	93
408	104375	RHS	NH 29	40	0.5069	0.421	0.1803	0.093	0.0621	0.0491	0.0248	39.9	997.9	230.8	93
409	104500	LHS	NH 29	40	0.3295	0.2601	0.1416	0.0809	0.0544	0.0415	0.0165	37.9	1012.7	239.8	97
410	104625	RHS	NH 29	40	0.4727	0.3932	0.169	0.0889	0.0595	0.0463	0.0233	37.9	1044.5	240.2	97
411	104750	LHS	NH 29	40	0.3648	0.2774	0.1353	0.0779	0.0573	0.0418	0.0147	40.7	926.3	240	97
412	104875	RHS	NH 29	40	0.4599	0.3748	0.1772	0.1142	0.0805	0.0404	0.014	37.9	895.5	240.7	97
413	105000	LHS	NH 29	40	0.455	0.2969	0.1284	0.0908	0.0703	0.0485	0.018	40.7	902.5	240.4	97
414	105125	RHS	NH 29	40	0.36	0.2733	0.1345	0.0781	0.0568	0.0436	0.0213	37.9	1009.1	240.6	97
415	105250	LHS	NH 29	40	0.3567	0.2644	0.1331	0.0674	0.0488	0.0253	0.0101	40.7	934.7	240.6	97
416	105375	RHS	NH 29	40	0.3034	0.2126	0.0845	0.0467	0.0315	0.0231	0.0116	40.7	935.2	238.1	97
417	105500	LHS	NH 29	40	0.3432	0.252	0.1173	0.0643	0.0487	0.039	0.0083	37.9	923.7	239.3	97

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
418	105625	RHS	NH 29	40	0.3113	0.2348	0.1139	0.0642	0.0431	0.0302	0.0139	37.9	1019.9	240.1	97
419	105750	LHS	NH 29	40	0.3245	0.2398	0.1105	0.0621	0.0439	0.0356	0.019	37.9	1011.2	240.4	97
420	105875	RHS	NH 29	40	0.4071	0.2537	0.0823	0.0474	0.0343	0.0248	0.0124	40.7	907.8	239.2	97
421	106000	LHS	NH 29	40	0.3651	0.2751	0.1161	0.0788	0.0522	0.0346	0.0133	37.9	1009.8	271.8	110
422	106125	RHS	NH 29	40	0.5752	0.4129	0.1717	0.0748	0.0538	0.0471	0.0229	40.7	934.7	234.1	110
423	106250	LHS	NH 29	40	0.4407	0.3311	0.1639	0.0922	0.0567	0.0431	0.0189	37.9	971.5	272.9	110
424	106375	RHS	NH 29	40	0.4648	0.3556	0.1727	0.0924	0.0649	0.0512	0.0193	39.5	984.9	270.7	110
425	106500	LHS	NH 29	40	0.4025	0.2511	0.1129	0.073	0.0533	0.031	0.016	41.5	933.1	297.6	108
426	107000	RHS	NH 29	40	0.4621	0.3273	0.1235	0.0593	0.0467	0.0272	0.0128	40.1	896.2	207.9	108
427	107125	LHS	NH 29	40	0.4726	0.3137	0.1362	0.0621	0.041	0.0238	0.0118	40.1	938.4	203.9	108
428	107250	RHS	NH 29	40	0.3002	0.2145	0.0897	0.0549	0.0414	0.0288	0.0109	41.5	924.7	300.9	108
429	107375	LHS	NH 29	40	0.3794	0.2936	0.1463	0.0835	0.0613	0.0462	0.023	41.5	933.7	300.8	108
430	107500	RHS	NH 29	40	0.2119	0.1345	0.0506	0.0312	0.0184	0.0094	0.0045	40.1	934.2	207.7	108
431	107625	LHS	NH 29	40	0.2309	0.1484	0.0711	0.0372	0.0265	0.0211	0.0081	40.1	917.3	299.9	108
432	107750	RHS	NH 29	40	0.5439	0.4084	0.1731	0.0911	0.0678	0.0465	0.0156	40.1	934.7	206.6	108
433	107875	LHS	NH 29	40	0.3101	0.2018	0.0854	0.0511	0.0424	0.0286	0.013	40.1	928.9	297.3	108
434	108000	RHS	NH 29	40	0.3202	0.2346	0.1135	0.0642	0.0415	0.032	0.0119	41.1	926.8	264.9	101
435	108125	LHS	NH 29	40	0.2729	0.1856	0.1014	0.0626	0.0363	0.0261	0.0127	41.1	917.3	295.3	101
436	108250	RHS	NH 29	40	0.2602	0.1857	0.0859	0.0482	0.0377	0.0299	0.007	38.6	988.6	270.6	110
437	108375	LHS	NH 29	40	0.3724	0.2736	0.1205	0.0735	0.0548	0.0424	0.0095	39.5	989	268.5	110
438	108500	RHS	NH 29	40	0.4963	0.3443	0.1344	0.0693	0.0474	0.0401	0.0184	39.1	999.1	260.2	110
439	108625	LHS	NH 29	40	0.3705	0.2627	0.0978	0.0711	0.0335	0.0272	0.0093	39.1	955.9	272.1	110
440	108750	RHS	NH 29	40	0.4239	0.2874	0.1168	0.0555	0.0381	0.0298	0.0089	39.1	997.9	258	110
441	108875	LHS	NH 29	40	0.2169	0.1404	0.0677	0.0353	0.0248	0.0201	0.0077	39.1	966	270.6	110
442	109000	RHS	NH 29	40	0.3346	0.227	0.0864	0.045	0.0275	0.0135	0.0068	40.3	928.4	230.7	110
443	109125	LHS	NH 29	40	0.3674	0.2619	0.1064	0.0536	0.0371	0.0285	0.0139	39.1	962.4	271.9	110
444	109250	RHS	NH 29	40	0.4079	0.3025	0.1385	0.0697	0.0447	0.0322	0.01	40.3	935.2	271.5	110
445	109375	LHS	NH 29	40	0.3636	0.2606	0.118	0.0674	0.0546	0.0484	0.0068	39.1	960.6	271.9	110
446	109500	RHS	NH 29	40	0.3854	0.289	0.1403	0.0749	0.0494	0.0367	0.013	41.1	911.5	214.3	101
447	112000	LHS	NH 29	40	0.2717	0.2167	0.1133	0.0716	0.041	0.0316	0.0222	40.9	933.1	294.9	100.9

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
448	112125	RHS	NH 29	40	0.2512	0.1892	0.0882	0.051	0.035	0.0217	0.0115	40.9	920.5	292.6	101
449	112250	LHS	NH 29	40	0.3612	0.2646	0.1154	0.0599	0.05	0.0373	0.0174	39.1	982.5	272.6	110
450	112375	RHS	NH 29	40	0.3569	0.2614	0.1092	0.0538	0.0399	0.0352	0.0099	40.3	926.3	269.7	110
451	112500	LHS	NH 29	40	0.2736	0.21	0.0955	0.0539	0.0343	0.0304	0.0118	40.9	927.9	293.3	101
452	113000	RHS	NH 29	40	0.3624	0.2955	0.1325	0.0707	0.0442	0.0324	0.0118	40.9	920.5	204.5	101
453	113125	LHS	NH 29	40	0.2164	0.1465	0.0622	0.0354	0.0216	0.0143	0.0078	40.9	936.3	249.1	101
454	113250	RHS	NH 29	40	0.3388	0.2561	0.127	0.0717	0.0452	0.0369	0.0123	39.1	994.4	272.1	110
455	113375	LHS	NH 29	40	0.3783	0.2953	0.1398	0.0657	0.0426	0.0235	0.0131	40.3	933.7	269.2	110
456	113500	RHS	NH 29	40	0.3387	0.2749	0.1213	0.0846	0.0532	0.0396	0.0309	40.9	940	291.7	101
457	114500	LHS	NH 29	40	0.2816	0.2157	0.1104	0.064	0.044	0.0289	0.0081	40.9	930	221.2	101
458	114625	RHS	NH 29	40	0.2464	0.1982	0.109	0.0745	0.0566	0.0415	0.0278	40.9	934.7	295.5	101
459	114750	LHS	NH 29	40	0.3702	0.2739	0.1415	0.0837	0.0606	0.0499	0.0211	39.1	997.9	271.1	110
460	114875	RHS	NH 29	40	0.3428	0.2612	0.1064	0.059	0.0334	0.021	0.0076	40.3	924.2	273	110
461	115000	LHS	NH 29	40	0.244	0.1937	0.1053	0.0712	0.042	0.0275	0.0099	40.9	923.6	293.9	101
462	117500	RHS	NH 29	40	0.261	0.203	0.1096	0.0637	0.0451	0.0298	0.0189	40.9	909.9	296	101
463	117625	LHS	NH 29	40	0.2248	0.1745	0.0908	0.0531	0.0346	0.0242	0.0062	40.9	926.3	221.1	101
464	117750	RHS	NH 29	40	0.3342	0.254	0.1162	0.0689	0.0524	0.043	0.0148	39.1	951.2	272.5	110
465	117875	LHS	NH 29	40	0.4884	0.334	0.1413	0.0776	0.0589	0.0404	0.0216	40.3	904.6	272.9	110
466	118000	RHS	NH 29	40	0.178	0.131	0.0692	0.041	0.0257	0.0176	0.0073	40.9	930.5	291.3	101
467	119000	LHS	NH 29	40	0.3162	0.2227	0.113	0.0551	0.035	0.0225	0.0143	40.9	935.2	269.5	101
468	119125	RHS	NH 29	40	0.2306	0.1823	0.0841	0.0639	0.0508	0.0347	0.0191	40.9	936.3	346.7	117
469	119250	LHS	NH 29	40	0.4463	0.3177	0.1202	0.0842	0.0608	0.0173	0.0026	40.9	914.7	219.4	117
470	119375	RHS	NH 29	40	0.2372	0.1902	0.1047	0.0656	0.0513	0.0388	0.0341	40.9	938.9	346.6	116.9
471	119500	LHS	NH 29	40	0.1647	0.1161	0.0633	0.0489	0.0263	0.017	0.0079	40.9	925.7	342.5	117
472	119625	RHS	NH 29	40	0.1753	0.1232	0.0679	0.0523	0.0279	0.0186	0.0084	40.1	928.4	345.7	117
473	119750	LHS	NH 29	40	0.3593	0.2859	0.128	0.086	0.0548	0.039	0.0304	40.1	919.9	338.7	117
474	119875	RHS	NH 29	40	0.4053	0.322	0.1213	0.059	0.0393	0.0289	0.0224	40.1	918.9	219.3	117
475	120000	LHS	NH 29	40	0.2116	0.1426	0.0712	0.0469	0.0404	0.0203	0.0177	40.1	933.1	346	117
476	120125	RHS	NH 29	40	0.203	0.1636	0.0774	0.042	0.0159	0.0082	0.004	40.1	900.4	223	117
477	120250	LHS	NH 29	40	0.2289	0.1826	0.0864	0.0524	0.0349	0.027	0.0175	40.1	905.2	346.2	116.9

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
478	120375	RHS	NH 29	40	0.281	0.2257	0.1059	0.067	0.0383	0.0227	0.0108	40.1	913.1	260.4	117
479	120500	LHS	NH 29	40	0.2517	0.1902	0.1023	0.0581	0.0372	0.0226	0.0054	40.1	931.6	219.9	117
480	120625	RHS	NH 29	40	0.2827	0.2086	0.0958	0.0535	0.0371	0.0288	0.0066	40.1	935.8	223	117
481	120750	LHS	NH 29	40	0.2581	0.1959	0.1033	0.0578	0.0374	0.023	0.0054	40.1	909.9	219.4	117
482	120875	RHS	NH 29	40	0.2463	0.1831	0.0924	0.0556	0.0392	0.0261	0.0071	40.1	936.3	235.1	117
483	121000	LHS	NH 29	40	0.2738	0.1997	0.1019	0.0604	0.0429	0.0304	0.0142	40.1	933.7	346.9	117
484	121125	RHS	NH 29	40	0.216	0.1496	0.0627	0.033	0.0225	0.0125	0.0062	39.5	973.1	219	117
485	121250	LHS	NH 29	40	0.2747	0.2006	0.0927	0.0558	0.0365	0.0255	0.0128	39.5	982.5	311.3	117
486	121375	RHS	NH 29	40	0.2573	0.1802	0.0837	0.0488	0.0267	0.018	0.0104	39.5	1003.2	240.8	117
487	121500	LHS	NH 29	40	0.2592	0.1739	0.071	0.0416	0.0282	0.0186	0.0072	39.5	1003.2	221.1	117
488	121625	RHS	NH 29	40	0.3009	0.2158	0.0865	0.0531	0.041	0.0324	0.0178	39.5	999.1	344.4	117
489	121750	LHS	NH 29	40	0.3626	0.2798	0.1342	0.0832	0.0611	0.0486	0.0275	39.5	986.1	242.2	103
490	121875	RHS	NH 29	40	0.239	0.1661	0.0805	0.0521	0.039	0.0284	0.0079	39.5	993.2	242.7	103
491	122000	LHS	NH 29	40	0.2655	0.1989	0.0959	0.0551	0.0372	0.0232	0.0121	39.5	945.3	242.7	103
492	122125	RHS	NH 29	40	0.2596	0.1797	0.0857	0.0599	0.0438	0.0345	0.0172	39.5	967.7	242.8	103
493	122250	LHS	NH 29	40	0.2537	0.1915	0.09	0.0453	0.0277	0.0182	0.0119	39.5	930.5	242.5	103
494	122375	RHS	NH 29	40	0.1424	0.0965	0.0432	0.0225	0.0152	0.0095	0.0062	39.5	998.5	242.3	103
495	122500	LHS	NH 29	40	0.3253	0.2309	0.1045	0.0473	0.0277	0.0183	0.0096	39.5	972.5	240.5	103
496	122625	RHS	NH 29	40	0.2527	0.195	0.0933	0.0463	0.0256	0.0126	0.007	39.5	968.3	242.2	103
497	122750	LHS	NH 29	40	0.2337	0.1603	0.072	0.0467	0.032	0.0173	0.0088	39.5	930.5	242.9	103
498	122875	RHS	NH 29	40	0.2034	0.1303	0.0597	0.0426	0.0342	0.0207	0.009	39.5	966.6	241.3	103
499	123000	LHS	NH 29	40	0.2136	0.1351	0.0629	0.0395	0.0307	0.0219	0.0069	39.5	990.2	240.4	103
500	123125	RHS	NH 29	40	0.2483	0.193	0.0862	0.0506	0.0314	0.0283	0.0109	39.5	1005	242.1	103
501	123250	LHS	NH 29	40	0.2337	0.1785	0.107	0.0688	0.054	0.0413	0.0336	39.5	958.3	243	103
502	123375	RHS	NH 29	40	0.1718	0.1326	0.0643	0.0396	0.0334	0.0096	0.0049	36.4	1094.4	256.3	112
503	123500	LHS	NH 29	40	0.2593	0.1878	0.094	0.0574	0.0394	0.0246	0.0087	36.4	1004.9	303.1	112
504	123625	RHS	NH 29	40	0.2207	0.1673	0.0801	0.0597	0.0468	0.032	0.0178	37.4	1087.2	232.3	96.9
505	123750	LHS	NH 29	40	0.2353	0.1784	0.0949	0.0558	0.0439	0.0364	0.0196	37.4	1095.9	232.7	96.9
506	123875	RHS	NH 29	40	0.185	0.1471	0.0838	0.0538	0.043	0.0332	0.0227	39.2	1000.9	231.9	96.9
507	124000	LHS	NH 29	40	0.1944	0.1508	0.0743	0.0456	0.0325	0.0231	0.0137	39.2	987.3	232.1	97

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
508	124125	RHS	NH 29	40	0.1659	0.1302	0.0786	0.0412	0.0338	0.0206	0.0114	39.2	991.4	232.5	97
509	124250	LHS	NH 29	40	0.1414	0.0978	0.0511	0.0326	0.0268	0.0166	0.008	39.2	978.4	232.4	97
510	124375	RHS	NH 29	40	0.2683	0.2011	0.0937	0.0541	0.0373	0.0231	0.0124	39.2	1005	232.6	96.9
511	124500	LHS	NH 29	40	0.1597	0.1147	0.0602	0.0424	0.0368	0.0251	0.0134	39.2	971.3	314.3	105
512	124625	RHS	NH 29	40	0.225	0.1648	0.0754	0.0462	0.0243	0.0131	0.0045	39.2	999.7	198.9	105
513	124750	LHS	NH 29	40	0.2608	0.199	0.1009	0.0641	0.0473	0.0348	0.0256	39.2	1003.8	314.5	105
514	124875	RHS	NH 29	40	0.3038	0.2418	0.1469	0.0947	0.0631	0.0539	0.0145	39.2	996.1	264.2	105
515	125000	LHS	NH 29	40	0.3796	0.2806	0.1242	0.064	0.0533	0.0394	0.0187	40.6	937.9	325.8	115
516	125125	RHS	NH 29	40	0.3244	0.2118	0.067	0.0445	0.0338	0.023	0.0114	40.6	909.9	284.8	115
517	125250	LHS	NH 29	40	0.5765	0.4151	0.1822	0.1068	0.071	0.0539	0.0269	40.3	893.5	221.9	115
518	125375	RHS	NH 29	40	0.5431	0.3923	0.1639	0.0867	0.0547	0.0428	0.0226	40.6	892.5	221.9	115
519	125500	LHS	NH 29	40	0.583	0.4696	0.1859	0.0928	0.0655	0.048	0.0243	40.3	917.3	222.6	115
520	125625	RHS	NH 29	40	0.3517	0.2662	0.1293	0.0781	0.0427	0.022	0.0108	40.6	917.3	244.6	115
521	125750	LHS	NH 29	40	0.4376	0.3141	0.1353	0.0742	0.0444	0.0288	0.0128	40.6	900.9	223.4	115
522	125875	RHS	NH 29	40	0.4191	0.3202	0.1436	0.0845	0.0551	0.0366	0.0158	40.6	933.7	248.7	115
523	126000	LHS	NH 29	40	0.6089	0.4571	0.1884	0.0844	0.0502	0.0356	0.0173	40.6	915.7	221.2	115
524	126125	RHS	NH 29	40	0.461	0.3439	0.1617	0.0877	0.0547	0.0441	0.0224	40.3	932.1	267.3	115
525	126250	LHS	NH 29	40	0.539	0.4254	0.179	0.0903	0.0657	0.0445	0.0159	40.6	915.2	222.5	115
526	126375	RHS	NH 29	40	0.5196	0.3878	0.1743	0.0909	0.0661	0.0476	0.0123	40.3	911.5	223.2	115
527	126500	LHS	NH 29	40	0.458	0.3426	0.1626	0.0945	0.0637	0.051	0.0176	40.6	940	266.8	115
528	126625	RHS	NH 29	40	0.407	0.2946	0.123	0.0708	0.0574	0.043	0.0112	40.6	930	222.5	115
529	126750	LHS	NH 29	40	0.4195	0.3253	0.165	0.0903	0.0584	0.0412	0.0138	41.5	934.7	240.9	115
530	126875	RHS	NH 29	40	0.2332	0.1651	0.0785	0.0501	0.0303	0.0127	0.0058	40.6	934.7	231.6	115
531	127000	LHS	NH 29	40	0.433	0.3061	0.1361	0.0717	0.0478	0.0378	0.0136	41.5	913.6	224.7	115
532	127125	RHS	NH 29	40	0.5055	0.3868	0.1581	0.0887	0.0586	0.0478	0.0178	41.5	921.5	222.2	115
533	127250	LHS	NH 29	40	0.4266	0.34	0.1407	0.0862	0.0456	0.0322	0.0164	41.5	932.6	241.1	115
534	127375	RHS	NH 29	40	0.3867	0.3029	0.1434	0.0799	0.0573	0.0479	0.0097	40.6	931	223.6	115
535	127500	LHS	NH 29	40	0.4937	0.3852	0.1583	0.0929	0.0604	0.0478	0.0185	41.5	896.7	221.2	115
536	127625	RHS	NH 29	40	0.4584	0.3272	0.1419	0.0763	0.05	0.0406	0.0145	41.5	936.8	224.7	115
537	127750	LHS	NH 29	40	0.5516	0.4034	0.1872	0.1043	0.0641	0.0508	0.0186	40.7	932.1	221.7	115

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
538	127875	RHS	NH 29	40	0.3529	0.2204	0.0945	0.0532	0.0289	0.0147	0.0038	40.7	920.5	227.5	103
539	128000	LHS	NH 29	40	0.6156	0.4386	0.1907	0.1095	0.0744	0.0551	0.0279	42.2	898.3	227.4	103
540	128125	RHS	NH 29	40	0.4446	0.3046	0.1457	0.0871	0.0714	0.0542	0.0151	41.2	913.1	228	103
541	128250	LHS	NH 29	40	0.652	0.5056	0.2221	0.1123	0.0734	0.0572	0.0194	42.2	912	227.7	103
542	128375	RHS	NH 29	40	0.6187	0.4399	0.1634	0.0714	0.0493	0.0414	0.0078	41.2	916.2	221.7	103
543	128500	LHS	NH 29	40	0.5623	0.4274	0.1422	0.0574	0.0347	0.0216	0.0053	42.2	922.6	226.4	103
544	128625	RHS	NH 29	40	0.3748	0.2987	0.1261	0.073	0.0491	0.0274	0.0129	41.2	893.5	228	103
545	128750	LHS	NH 29	40	0.3076	0.2282	0.0956	0.0535	0.0385	0.0317	0.0074	42.2	893.5	227.3	103
546	128875	RHS	NH 29	40	0.4909	0.3623	0.1746	0.1005	0.0681	0.0546	0.0187	41.2	928.4	227.1	103
547	129000	LHS	NH 29	40	0.4682	0.3094	0.1338	0.0624	0.0401	0.0236	0.0114	41.2	932.1	227.4	103
548	129125	RHS	NH 29	40	0.3127	0.2034	0.0881	0.0517	0.0429	0.0286	0.013	42.2	905.2	225.9	103
549	129250	LHS	NH 29	40	0.6034	0.4566	0.1988	0.1012	0.0664	0.0546	0.0037	42.2	933.1	227.7	103
550	129375	RHS	NH 29	40	0.4622	0.3454	0.1765	0.101	0.0597	0.0458	0.0202	42.2	925.7	226.7	103
551	129500	LHS	NH 29	40	0.5118	0.4018	0.1597	0.09	0.0593	0.0479	0.0176	41.2	937.4	226.9	103
552	129625	RHS	NH 29	40	0.5631	0.4347	0.1902	0.0889	0.047	0.0397	0.0146	42.2	915.7	222.1	103
553	129750	LHS	NH 29	40	0.6683	0.5129	0.2158	0.1003	0.0684	0.048	0.0173	41.2	909.9	225.9	103
554	129875	RHS	NH 29	40	0.4845	0.365	0.166	0.089	0.0628	0.0457	0.0113	42.2	892.5	224.9	103
555	130000	LHS	NH 29	40	0.445	0.3341	0.1581	0.0927	0.0641	0.0522	0.0215	41.2	927.9	227	103
556	130125	RHS	NH 29	40	0.4933	0.3876	0.1875	0.1085	0.0604	0.0563	0.0044	42.2	923.6	221.8	103
557	130250	LHS	NH 29	40	0.4033	0.3114	0.1514	0.0816	0.0527	0.0359	0.0207	41.2	912.6	227.8	102.9
558	130375	RHS	NH 29	40	0.3433	0.2661	0.115	0.0538	0.0348	0.0233	0.0082	42.2	897.8	227.2	103
559	130500	LHS	NH 29	40	0.4133	0.2904	0.1355	0.0806	0.0644	0.051	0.0144	42.2	906.7	227.9	103
560	130625	RHS	NH 29	40	0.4765	0.3659	0.1559	0.0854	0.0613	0.0342	0.0175	42.2	930	226.7	103
561	130750	LHS	NH 29	40	0.3692	0.2348	0.1056	0.0686	0.0483	0.0293	0.0148	41.2	935.8	226.9	103
562	130875	RHS	NH 29	40	0.4228	0.2872	0.1217	0.0826	0.064	0.046	0.0167	42.5	938.9	267.1	99
563	131000	LHS	NH 29	40	0.205	0.1687	0.0972	0.0636	0.0468	0.0338	0.0221	39.2	998.5	312.4	104.9
564	145500	RHS	NH 29	40	0.2483	0.1983	0.1083	0.0737	0.0561	0.0428	0.025	39.2	979.6	314.9	104.9
565	145625	LHS	NH 29	40	0.1502	0.1117	0.0621	0.0377	0.0231	0.0183	0.0089	39.2	1002	314.3	105
566	145750	RHS	NH 29	40	0.4654	0.3442	0.1542	0.0821	0.0563	0.0439	0.022	42.5	908.9	265.7	99
567	145875	LHS	NH 29	40	0.2517	0.1804	0.088	0.0543	0.0476	0.0369	0.0098	41.9	937.4	268.7	99

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
568	146000	RHS	NH 29	40	0.2604	0.1822	0.0788	0.0423	0.0284	0.0088	0.0045	39.2	981.3	198.5	105
569	150000	LHS	NH 29	40	0.2307	0.1773	0.0943	0.058	0.0408	0.0259	0.0151	39.2	1005	313.7	105
570	150125	RHS	NH 29	40	0.2204	0.1743	0.0981	0.0591	0.0458	0.0283	0.0087	39.2	1003.2	260.4	105
571	150250	LHS	NH 29	40	0.2218	0.1692	0.0994	0.0646	0.0501	0.0388	0.0314	39.2	994.4	312.7	105
572	150375	RHS	NH 29	40	0.242	0.1926	0.1078	0.0674	0.0507	0.0394	0.0252	39.2	978.4	313.6	105
573	150500	LHS	NH 29	40	0.2668	0.1972	0.0875	0.0532	0.0371	0.0269	0.0111	39.2	999.7	241.9	105
574	150625	RHS	NH 29	40	0.1992	0.1483	0.0813	0.0556	0.0395	0.0292	0.0163	39.2	971.9	314.5	105
575	150750	LHS	NH 29	40	0.2092	0.1652	0.0622	0.0454	0.0244	0.0126	0.0084	39.2	999.1	206.7	104.9
576	150875	RHS	NH 29	40	0.1578	0.1168	0.0657	0.0487	0.036	0.0247	0.0121	39.5	1003.8	313.5	105
577	151000	LHS	NH 29	40	0.2201	0.1587	0.0854	0.0428	0.0257	0.0197	0.007	39.5	1000.3	211.4	105
578	151125	RHS	NH 29	40	0.1366	0.101	0.0606	0.0451	0.0364	0.0263	0.0167	39.5	1003.2	312.9	104.9
579	151250	LHS	NH 29	40	0.2517	0.1657	0.0712	0.0448	0.0275	0.0226	0.0124	39.5	1002.6	298.3	105
580	151375	RHS	NH 29	40	0.2234	0.1705	0.0822	0.0545	0.0396	0.0349	0.0277	39.5	999.1	311.1	105
581	151500	LHS	NH 29	40	0.1603	0.1209	0.0628	0.0431	0.0313	0.0163	0.0116	39.5	996.1	286.8	99
582	151625	RHS	NH 29	40	0.1338	0.0928	0.0522	0.0369	0.0286	0.0166	0.0112	39.5	981.3	285.5	99
583	151750	LHS	NH 29	40	0.2831	0.1954	0.0889	0.0638	0.0477	0.0369	0.0185	38.2	1067.7	280.6	105
584	151875	RHS	NH 29	40	0.2217	0.1743	0.0903	0.0462	0.027	0.0177	0.0086	39.8	992	231.1	105
585	152000	LHS	NH 29	40	0.1933	0.1414	0.081	0.0542	0.036	0.0262	0.0094	39.8	999.7	280.5	105
586	152125	RHS	NH 29	40	0.255	0.2059	0.0905	0.0531	0.0337	0.0308	0.0117	39.8	1000.3	282.3	105
587	152250	LHS	NH 29	40	0.2389	0.2002	0.1083	0.0634	0.0431	0.029	0.0118	39.8	994.4	282.3	105
588	152375	RHS	NH 29	40	0.2552	0.1678	0.0723	0.0444	0.0278	0.0225	0.0122	39.8	999.7	277.2	105
589	152500	LHS	NH 29	40	0.1911	0.1493	0.0875	0.0577	0.0472	0.033	0.0246	41.6	919.4	285	104.9
590	152625	RHS	NH 29	40	0.2895	0.2293	0.1158	0.0622	0.0442	0.0289	0.0125	41.6	934.2	267.4	105
591	152750	LHS	NH 29	40	0.2223	0.1694	0.0959	0.0562	0.041	0.0323	0.0262	41.6	925.7	283.9	105
592	152875	RHS	NH 29	40	0.304	0.2323	0.1188	0.0688	0.0525	0.0268	0.0117	41.6	939.5	248.1	105
593	153000	LHS	NH 29	40	0.2901	0.2317	0.1205	0.0734	0.0551	0.0416	0.0324	41.6	935.2	283.1	104.9
594	153125	RHS	NH 29	40	0.2533	0.1915	0.0953	0.0623	0.0476	0.031	0.0111	41.6	937.4	282.7	105
595	153250	LHS	NH 29	40	0.3156	0.223	0.1282	0.0694	0.0432	0.0326	0.01	41.6	934.7	202.8	105
596	153375	RHS	NH 29	40	0.243	0.1686	0.074	0.042	0.0319	0.0222	0.0106	41.6	932.6	273.5	105
597	153500	LHS	NH 29	40	0.2462	0.1777	0.0736	0.0451	0.0374	0.0235	0.0093	41.6	939.5	255.4	105

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
598	153625	RHS	NH 29	40	0.2132	0.1371	0.0643	0.045	0.0363	0.0217	0.0097	41.6	940	284.8	105
599	153750	LHS	NH 29	40	0.5505	0.4154	0.1677	0.0857	0.0566	0.0437	0.0207	41.9	939.5	222.4	116
600	153875	RHS	NH 29	40	0.3845	0.2796	0.1272	0.0767	0.0537	0.0426	0.0101	42.9	934.2	273.7	116
601	154000	LHS	NH 29	40	0.3485	0.2455	0.096	0.0527	0.0411	0.0338	0.0168	41.9	936.3	274.3	116
602	154125	RHS	NH 29	40	0.487	0.3731	0.1798	0.099	0.0707	0.0554	0.0287	42.9	928.9	273.1	116
603	154250	LHS	NH 29	40	0.4732	0.3608	0.1743	0.0954	0.0686	0.0532	0.0278	41.9	903.6	277.8	116
604	154375	RHS	NH 29	40	0.3961	0.2988	0.1313	0.0782	0.0585	0.0451	0.0104	41.9	927.9	274.6	116
605	154500	LHS	NH 29	40	0.5397	0.4098	0.1863	0.0877	0.0432	0.0361	0.0203	42.9	935.8	229.8	116
606	154625	RHS	NH 29	40	0.3658	0.2626	0.1176	0.0704	0.05	0.042	0.0165	42.9	931.6	276	116
607	154750	LHS	NH 29	40	0.4466	0.3435	0.1525	0.0863	0.0656	0.0433	0.0075	42.3	934.7	201.1	116
608	154875	RHS	NH 29	40	0.3971	0.2709	0.1422	0.0936	0.0538	0.0369	0.0168	42.9	915.7	275.3	116
609	155000	LHS	NH 29	40	0.3296	0.2306	0.1033	0.0619	0.047	0.0276	0.0102	42.3	928.4	274.2	116
610	155125	RHS	NH 29	40	0.3699	0.2722	0.1287	0.0706	0.0512	0.035	0.0061	42.9	924.7	225.1	116
611	155250	LHS	NH 29	40	0.3268	0.2438	0.1217	0.0637	0.0454	0.0238	0.0095	42.3	907.3	276.1	116
612	155375	RHS	NH 29	40	0.5168	0.3704	0.1551	0.0814	0.0522	0.0405	0.0211	42.9	935.2	241.9	116
613	155500	LHS	NH 29	40	0.234	0.1843	0.07	0.041	0.025	0.0216	0.0079	42.9	927.3	274.4	116
614	155625	RHS	NH 29	40	0.391	0.2796	0.1282	0.0736	0.0513	0.0402	0.0177	42.3	932.1	267.9	116
615	155750	LHS	NH 29	40	0.5261	0.3528	0.1382	0.0729	0.0508	0.0418	0.0194	42.9	934.2	218.7	116
616	155875	RHS	NH 29	40	0.4197	0.3043	0.1199	0.0667	0.0393	0.0266	0.0115	42.3	936.3	250.7	116
617	156000	LHS	NH 29	40	0.4626	0.3261	0.1323	0.0885	0.0694	0.0504	0.0182	42.9	929.4	277	116
618	156125	RHS	NH 29	40	0.5306	0.3921	0.1538	0.0782	0.0526	0.0394	0.0227	42.3	930	239.2	116
619	156250	LHS	NH 29	40	0.5788	0.4408	0.1926	0.0939	0.0567	0.0388	0.0171	42.3	921	204.7	116
620	156375	RHS	NH 29	40	0.3503	0.2795	0.152	0.088	0.0573	0.0441	0.0181	42.3	918.4	277.7	115.9
621	156500	LHS	NH 29	40	0.5536	0.389	0.1634	0.0729	0.0508	0.0446	0.0217	42.9	891.4	212.1	116
622	156625	RHS	NH 29	40	0.4824	0.3731	0.176	0.0933	0.0664	0.0516	0.0192	42.3	923.1	274.1	116
623	156750	LHS	NH 29	40	0.4781	0.3722	0.1803	0.0952	0.0672	0.053	0.02	42.9	933.7	276.9	116
624	156875	RHS	NH 29	40	0.389	0.2532	0.0989	0.0597	0.0393	0.0221	0.0089	42.3	927.3	240.6	116
625	157000	LHS	NH 29	40	0.4772	0.3572	0.1408	0.0649	0.0347	0.0226	0.0113	42.9	933.7	210.4	113
626	157125	RHS	NH 29	40	0.3106	0.2026	0.0877	0.0519	0.0424	0.0288	0.0131	39.2	958.9	268.3	105
627	157250	LHS	NH 29	40	0.4348	0.2853	0.1126	0.0644	0.0549	0.0347	0.0101	39.2	993.8	257.2	105

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
628	157375	RHS	NH 29	40	0.394	0.2895	0.1233	0.0857	0.0566	0.0369	0.0143	39.2	1001.5	268.9	105
629	157500	LHS	NH 29	40	0.2483	0.1881	0.1008	0.062	0.0433	0.0268	0.0162	41.6	928.9	284.8	105
NH 129															
1	0	RHS	NH 129	40	0.4247	0.3291	0.1592	0.0854	0.0562	0.0374	0.0221	34.1	1324.13	274.4	112
2	250	LHS	NH 129	40	0.4234	0.3176	0.1424	0.076	0.0395	0.0304	0.0091	34.1	1313.845	252.8	112
3	500	RHS	NH 129	40	0.4024	0.3265	0.1462	0.0735	0.0474	0.0365	0.0181	37	1178.417	277.8	112
4	750	LHS	NH 129	40	0.4168	0.3309	0.1583	0.0867	0.0555	0.0375	0.0223	34.1	1276.452	277.4	112
5	1000	RHS	NH 129	40	0.4468	0.3563	0.1756	0.0974	0.0653	0.0473	0.0197	37	1241.654	277.8	112
6	1125	LHS	NH 129	40	0.3567	0.2656	0.1137	0.0645	0.0345	0.0207	0.0074	41.6	930.5	238.4	110
7	1250	RHS	NH 129	40	0.2179	0.1665	0.0761	0.0473	0.025	0.0166	0.0056	41.6	919.9	237.6	110
8	1375	LHS	NH 129	40	0.2239	0.1777	0.0872	0.0595	0.0415	0.0347	0.0198	41.6	940	238.1	109.9
9	1500	RHS	NH 129	40	0.1338	0.0846	0.055	0.0318	0.0152	0.0068	0.0033	41.6	922.6	236.9	110
10	1625	LHS	NH 129	40	0.2606	0.1778	0.0535	0.0323	0.0206	0.008	0.0031	41.6	917.3	238.8	110
11	1750	RHS	NH 129	40	0.2417	0.1883	0.1031	0.065	0.0456	0.0343	0.0042	41.6	913.1	237.6	110
12	1875	LHS	NH 129	40	0.2273	0.1702	0.0878	0.0538	0.0354	0.025	0.0096	41.6	902.5	237	110
13	2000	RHS	NH 129	40	0.2522	0.1973	0.1095	0.0695	0.052	0.0397	0.0256	41.6	938.9	239	109.9
14	2125	LHS	NH 129	40	0.2962	0.2144	0.0958	0.0535	0.0331	0.0266	0.0028	42	928.4	230.5	110
15	2250	RHS	NH 129	40	0.25	0.1732	0.0676	0.0449	0.0335	0.0161	0.0061	42	930.5	238	110
16	2375	LHS	NH 129	40	0.2652	0.2094	0.1128	0.0684	0.0428	0.0372	0.0138	42	912	238.9	109.9
17	2500	RHS	NH 129	40	0.3371	0.2282	0.0899	0.0481	0.0339	0.017	0.0083	42	905.2	237.8	110
18	2625	LHS	NH 129	40	0.1923	0.1311	0.1003	0.0738	0.0468	0.0236	0.0089	42	919.9	238.7	110
19	2750	RHS	NH 129	40	0.2501	0.1944	0.091	0.0546	0.0389	0.0283	0.0109	42	928.4	237.9	109.9
20	2875	LHS	NH 129	40	0.3038	0.2173	0.0905	0.0627	0.0517	0.0393	0.0196	42	922.1	239	110
21	3000	RHS	NH 129	40	0.2513	0.1845	0.0904	0.0557	0.0351	0.024	0.0089	42	935.8	238.9	110
22	3125	LHS	NH 129	40	0.3782	0.2773	0.1277	0.0747	0.0529	0.0348	0.019	42	907.3	238.2	110
23	3250	RHS	NH 129	40	0.2137	0.1695	0.0858	0.0487	0.0296	0.0204	0.005	42	915.2	238.9	110
24	3375	LHS	NH 129	40	0.1981	0.1547	0.082	0.0533	0.038	0.0261	0.0159	42	933.1	238.9	110
25	3500	RHS	NH 129	40	0.2293	0.1811	0.0852	0.048	0.0304	0.0184	0.0079	42	905.2	238.5	110
26	3625	LHS	NH 129	40	0.444	0.3267	0.1555	0.0957	0.0706	0.0571	0.0326	39.2	981.3	268.5	104.9
27	3750	RHS	NH 129	40	0.3983	0.3037	0.1466	0.0833	0.0596	0.049	0.01	39.2	981.3	267.5	105

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
28	3875	LHS	NH 129	40	0.2884	0.2107	0.0797	0.0402	0.0343	0.0276	0.0101	38	1048.6	223.2	96
29	4000	RHS	NH 129	40	0.4973	0.3808	0.1825	0.0983	0.0714	0.0553	0.0296	38	1036.7	221.3	96
30	4125	LHS	NH 129	40	0.403	0.3122	0.1498	0.0835	0.0588	0.0506	0.0103	38	1031.5	215.5	111
31	4250	RHS	NH 129	40	0.3878	0.2734	0.1259	0.0712	0.0584	0.0525	0.0072	38	1017.6	216.9	111
32	4375	LHS	NH 129	40	0.2076	0.1326	0.0513	0.0312	0.0181	0.0094	0.0045	38	1035.4	210.4	111
33	4500	RHS	NH 129	40	0.4759	0.3654	0.1619	0.0915	0.0704	0.0461	0.0079	38	1037.4	212.3	111
34	4625	LHS	NH 129	40	0.2691	0.197	0.0925	0.0531	0.0397	0.0315	0.0073	38	1035.4	245.1	111
35	4750	RHS	NH 129	40	0.4838	0.3798	0.1615	0.0766	0.0359	0.0282	0.0097	38	1009	210.4	111
36	4875	LHS	NH 129	40	0.5912	0.4092	0.1699	0.0776	0.054	0.0463	0.0228	37	987.4	210	111
37	5000	RHS	NH 129	40	0.2907	0.2143	0.0897	0.0502	0.0367	0.0298	0.007	38.2	1038	244.6	102
38	5125	LHS	NH 129	40	0.2613	0.1779	0.0498	0.0313	0.0225	0.0123	0.0091	38.2	1047.3	239.1	102
39	5250	RHS	NH 129	40	0.3904	0.2786	0.1146	0.0658	0.0456	0.0318	0.0163	38.2	1024.9	244.7	102
40	5375	LHS	NH 129	40	0.4216	0.3282	0.1348	0.0692	0.0436	0.029	0.0106	38.2	1040	235.9	102
41	5500	RHS	NH 129	40	0.3427	0.2413	0.1089	0.0652	0.0456	0.0394	0.0154	38.2	1022.9	244.5	102
42	5625	LHS	NH 129	40	0.3708	0.28	0.1154	0.0573	0.0416	0.0378	0.0104	38.2	1036.1	227.9	108
43	5750	RHS	NH 129	40	0.3715	0.2751	0.1351	0.079	0.0565	0.0414	0.0146	38.2	983.3	228.6	108
44	5875	LHS	NH 129	40	0.6811	0.5329	0.2233	0.103	0.069	0.0496	0.0181	39.6	970.7	226.3	108
45	6000	RHS	NH 129	40	0.4056	0.3287	0.1419	0.0758	0.0469	0.0364	0.0178	40.3	916.8	226.9	108
46	6125	LHS	NH 129	40	0.1823	0.1223	0.0675	0.041	0.0323	0.0266	0.0071	42.7	937.4	319.8	107
47	6250	RHS	NH 129	40	0.2172	0.1385	0.0628	0.0461	0.0366	0.0224	0.0096	43	921	315.3	107
48	6375	LHS	NH 129	40	0.2313	0.1613	0.0676	0.0351	0.024	0.0135	0.0066	42	907.3	237.4	110
49	6500	RHS	NH 129	40	0.2087	0.1372	0.0635	0.0338	0.0144	0.007	0.0035	33.1	1127.715	218.4	110
50	6750	LHS	NH 129	40	0.303	0.2334	0.1201	0.0694	0.0477	0.0312	0.0087	33.1	1262.109	218.4	110
51	7000	RHS	NH 129	40	0.1993	0.1571	0.0903	0.0563	0.0447	0.0363	0.023	34.6	1339.086	341.3	110
52	7125	LHS	NH 129	40	0.2413	0.1754	0.0876	0.0538	0.0366	0.0239	0.0082	42	918.4	238	110
53	7250	RHS	NH 129	40	0.1315	0.0796	0.0533	0.0313	0.0153	0.0064	0.0032	42	935.2	237.6	110
54	7375	LHS	NH 129	40	0.3486	0.252	0.1021	0.0603	0.0445	0.0389	0.0147	40.3	905.2	228.3	108
55	7500	RHS	NH 129	40	0.635	0.4579	0.196	0.1039	0.0752	0.058	0.0095	40.3	937.9	226.3	108
56	7625	LHS	NH 129	40	0.4221	0.3121	0.133	0.0724	0.0433	0.0285	0.0128	40.3	927.9	227.3	108
57	7750	RHS	NH 129	40	0.2574	0.1868	0.0927	0.0528	0.0318	0.0291	0.0103	42	936.8	236.4	110

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
58	8000	LHS	NH 129	40	0.3181	0.2586	0.1265	0.073	0.0521	0.0374	0.024	34.6	1331.422	346.4	110
59	8250	RHS	NH 129	40	0.1955	0.1556	0.0882	0.0576	0.045	0.0356	0.0242	34.6	1329.555	345.2	110
60	8500	LHS	NH 129	40	0.2105	0.1488	0.0703	0.0515	0.0418	0.0328	0.0082	34.6	1349.599	329.1	110
61	8750	RHS	NH 129	40	0.3604	0.2639	0.1143	0.0642	0.0342	0.0201	0.0074	34.6	1352.448	218	110
62	9000	LHS	NH 129	40	0.3163	0.2659	0.143	0.0882	0.0599	0.0516	0.036	34.6	1354.413	346.7	109.9
63	9125	RHS	NH 129	40	0.2786	0.2065	0.1092	0.0664	0.047	0.0336	0.0096	42	938.9	239	110
64	9250	LHS	NH 129	40	0.2546	0.1816	0.0872	0.0574	0.0331	0.03	0.0116	42	933.7	237.2	110
65	9375	RHS	NH 129	40	0.3417	0.2464	0.0957	0.0528	0.0416	0.0334	0.0171	40.3	935.8	225.5	108
66	9500	LHS	NH 129	40	0.4283	0.2912	0.1226	0.0592	0.0418	0.0232	0.0058	40.3	909.9	228.7	108
67	9625	RHS	NH 129	40	0.437	0.3291	0.1533	0.0971	0.0709	0.0563	0.0328	36.5	972.5	297.3	103
68	9750	LHS	NH 129	40	0.3801	0.2731	0.103	0.0608	0.0382	0.0293	0.0191	41.5	931.6	245.6	112
69	9875	RHS	NH 129	40	0.2607	0.2072	0.0962	0.0588	0.0421	0.0301	0.0115	42	917.8	238.2	110
70	10000	LHS	NH 129	40	0.2328	0.1767	0.0819	0.0505	0.0268	0.0178	0.006	34.6	1293.202	228.1	110
71	10250	RHS	NH 129	40	0.2529	0.2137	0.12	0.0726	0.0564	0.0348	0.0283	34.6	1339.086	345.4	110
72	10500	LHS	NH 129	40	0.2923	0.2532	0.131	0.0869	0.0539	0.0415	0.0272	34.6	1334.271	345.9	110
73	10750	RHS	NH 129	40	0.2696	0.2222	0.1183	0.0791	0.0526	0.0359	0.0328	34.6	1317.077	346.6	110
74	11000	LHS	NH 129	40	0.1986	0.1578	0.0793	0.0555	0.0391	0.0313	0.0064	34.6	1179.523	270.7	110
75	11125	RHS	NH 129	40	0.2312	0.1731	0.092	0.0614	0.0431	0.0287	0.0147	42	933.1	234.9	110
76	11250	LHS	NH 129	40	0.2397	0.1822	0.0923	0.0538	0.0331	0.0187	0.0067	42	933.7	238.6	110
77	11375	RHS	NH 129	40	0.2691	0.1926	0.0886	0.0524	0.038	0.0299	0.0103	42	934.2	239	109.9
78	11500	LHS	NH 129	40	0.2118	0.1648	0.0839	0.0521	0.0352	0.0205	0.0075	42.7	902.5	238.4	110
79	11625	RHS	NH 129	40	0.241	0.1706	0.0694	0.0435	0.0271	0.0113	0.0055	42.7	931	235.3	110
80	11750	LHS	NH 129	40	0.2552	0.1898	0.087	0.0517	0.0351	0.0239	0.0121	42.7	937.4	238	109.8
81	11875	RHS	NH 129	40	0.3207	0.213	0.0659	0.0447	0.0332	0.0232	0.0111	41.5	931	234.5	112
82	12000	LHS	NH 129	40	0.4779	0.3781	0.176	0.094	0.0676	0.0527	0.0198	41.5	939.5	221.9	112
83	12125	RHS	NH 129	40	0.4385	0.3104	0.1367	0.068	0.0513	0.0337	0.0121	38.3	1049.3	204	112
84	12250	LHS	NH 129	40	0.3117	0.2306	0.1013	0.0625	0.0478	0.038	0.0194	41.5	893	316.8	112
85	12375	RHS	NH 129	40	0.4624	0.3053	0.1302	0.0605	0.0398	0.0233	0.0112	38.3	995.8	208.5	112
86	12500	LHS	NH 129	40	0.5471	0.3993	0.1739	0.0867	0.0589	0.0483	0.0098	41.5	926.8	204.2	112
87	12625	RHS	NH 129	40	0.4914	0.3669	0.1665	0.0935	0.0688	0.0583	0.0293	38.3	1034.8	230.8	112

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
88	12750	LHS	NH 129	40	0.2321	0.1808	0.0697	0.0432	0.0251	0.0219	0.0079	38.3	1005.1	247.4	112
89	12875	RHS	NH 129	40	0.2664	0.1994	0.0824	0.0546	0.0366	0.0273	0.0115	42.7	931	238.5	110
90	13000	LHS	NH 129	40	0.3517	0.2843	0.1614	0.1023	0.0702	0.0532	0.0352	34.6	1369.642	346.4	109.9
91	13250	RHS	NH 129	40	0.2256	0.1716	0.0967	0.0577	0.0412	0.0329	0.0262	34.6	1356.28	344.9	110
92	13500	LHS	NH 129	40	0.3418	0.2672	0.118	0.0808	0.0522	0.0377	0.0291	34.6	1367.775	338.8	110
93	13625	RHS	NH 129	40	0.3665	0.2653	0.1088	0.0595	0.0447	0.0291	0.0144	42.7	930.5	238.7	110
94	13750	LHS	NH 129	40	0.2079	0.1444	0.07	0.0497	0.0405	0.033	0.0081	42.7	937.4	238.9	110
95	13875	RHS	NH 129	40	0.2508	0.2029	0.1061	0.0599	0.0393	0.0287	0.0087	42.7	936.8	237.4	110
96	14000	LHS	NH 129	40	0.2954	0.2328	0.1138	0.0692	0.0509	0.0394	0.0279	42.7	934.7	238.6	109.7
97	14125	RHS	NH 129	40	0.2698	0.2165	0.1139	0.0638	0.0416	0.031	0.0094	42.7	919.4	238.1	109.9
98	14250	LHS	NH 129	40	0.3299	0.243	0.1283	0.0714	0.0451	0.0325	0.0162	42.7	930.5	238.4	109.9
99	14375	RHS	NH 129	40	0.2114	0.1598	0.0698	0.0375	0.021	0.0107	0.0052	42.7	898.8	238.1	110
100	14500	LHS	NH 129	40	0.2749	0.2091	0.0969	0.0584	0.0381	0.0208	0.0099	42.7	928.4	238.9	110
101	14625	RHS	NH 129	40	0.1504	0.1122	0.0398	0.0285	0.0207	0.0164	0.0062	42.7	934.2	237.7	110
102	14750	LHS	NH 129	40	0.3378	0.265	0.1121	0.0538	0.0341	0.025	0.0122	42.7	910.4	234.8	110
103	14875	RHS	NH 129	40	0.2464	0.186	0.0825	0.0474	0.0297	0.0262	0.0089	42.7	902.5	317.4	107
104	15000	LHS	NH 129	40	0.296	0.2325	0.1033	0.0551	0.0365	0.0213	0.0102	42.7	910.4	279.5	107
105	15125	RHS	NH 129	40	0.3165	0.2201	0.1022	0.0473	0.0273	0.0189	0.0092	42.7	924.2	205.8	107
106	15250	LHS	NH 129	40	0.1369	0.0856	0.0567	0.0324	0.0154	0.0068	0.0033	42.7	929.4	216.4	107
107	15375	RHS	NH 129	40	0.1778	0.1301	0.0727	0.0502	0.0341	0.0236	0.0088	42.7	911.5	318	107
108	15500	LHS	NH 129	40	0.1823	0.1223	0.0675	0.041	0.0323	0.0266	0.0071	42.7	937.4	319.8	107
109	15625	RHS	NH 129	40	0.2172	0.1385	0.0628	0.0461	0.0366	0.0224	0.0096	43	921	315.3	107
110	15750	LHS	NH 129	40	0.3269	0.2486	0.0992	0.0604	0.039	0.0228	0.0081	41.5	904.6	210.3	112
111	15875	RHS	NH 129	40	0.2777	0.1896	0.0528	0.0338	0.0241	0.0129	0.0099	38.3	1049.9	203	112
112	16000	LHS	NH 129	40	0.4217	0.3175	0.1419	0.0832	0.056	0.0362	0.016	41.5	922.6	228.3	112
113	16125	RHS	NH 129	40	0.3673	0.255	0.0935	0.0594	0.0375	0.0249	0.01	38.3	1028.8	206	112
114	16250	LHS	NH 129	40	0.6152	0.4754	0.1934	0.0923	0.0584	0.0195	0.0097	41.5	931.6	204.2	112
115	16375	RHS	NH 129	40	0.3101	0.2012	0.0847	0.0516	0.0436	0.0296	0.0126	42	918.9	265.4	111
116	16500	LHS	NH 129	40	0.4372	0.2863	0.1146	0.0647	0.0544	0.034	0.0103	39.7	976.6	261.5	111
117	16625	RHS	NH 129	40	0.3641	0.2796	0.1113	0.0631	0.0367	0.0229	0.008	39.7	996.7	264.2	111

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
118	16750	LHS	NH 129	40	0.3892	0.286	0.1485	0.0863	0.0631	0.0522	0.0221	39.7	996.7	264.9	111
119	16875	RHS	NH 129	40	0.2118	0.1345	0.0509	0.0311	0.0183	0.0094	0.0045	42	906.7	264.5	111
120	17000	LHS	NH 129	40	0.4046	0.3059	0.1295	0.0731	0.0624	0.0448	0.0116	39.7	940.5	265.2	111
121	17125	RHS	NH 129	40	0.4491	0.3085	0.1323	0.086	0.0673	0.0489	0.0182	42	925.7	264.5	111
122	17250	LHS	NH 129	40	0.2458	0.1797	0.0788	0.046	0.0348	0.0251	0.0121	39.7	966.6	265.9	111
123	17375	RHS	NH 129	40	0.3389	0.2625	0.1241	0.072	0.0479	0.0284	0.014	41.7	926.8	261.3	111
124	17500	LHS	NH 129	40	0.3961	0.3083	0.1333	0.0838	0.0669	0.048	0.0228	41.5	939.5	299	108
125	17625	RHS	NH 129	40	0.3034	0.2049	0.0861	0.0524	0.0429	0.0278	0.0128	39.7	1004.4	299.9	108
126	17750	LHS	NH 129	40	0.3846	0.2829	0.1182	0.0582	0.0427	0.0383	0.0106	40.1	940	246.1	108
127	17875	RHS	NH 129	40	0.3471	0.2514	0.1026	0.0593	0.0425	0.0383	0.0145	41.5	937.4	300.3	108
128	18000	LHS	NH 129	40	0.2065	0.1652	0.082	0.049	0.0311	0.0256	0.0132	43	909.9	319.4	107
129	18500	RHS	NH 129	40	0.2717	0.2329	0.1292	0.0782	0.0597	0.0372	0.0302	43	915.7	318.1	107
130	18625	LHS	NH 129	40	0.1658	0.1156	0.058	0.0381	0.0296	0.0152	0.0075	43	937.9	318.4	107
131	18750	RHS	NH 129	40	0.4621	0.3273	0.1235	0.0593	0.0467	0.0272	0.0128	40.1	896.2	207.9	108
132	18875	LHS	NH 129	40	0.4726	0.3137	0.1362	0.0621	0.041	0.0238	0.0118	40.1	938.4	203.9	108
133	19000	RHS	NH 129	40	0.2741	0.2122	0.0982	0.0491	0.027	0.0135	0.0075	43	927.3	206.5	107
134	22000	LHS	NH 129	40	0.2876	0.2412	0.1394	0.0824	0.0557	0.0454	0.0311	43	917.3	319.9	107
135	22125	RHS	NH 129	40	0.2796	0.232	0.1104	0.0606	0.0501	0.0268	0.0091	43	938.9	273.4	107
136	22250	LHS	NH 129	40	0.301	0.2297	0.1364	0.0909	0.0671	0.0501	0.0211	43	924.2	318.8	107
137	22375	RHS	NH 129	40	0.2503	0.1764	0.0839	0.0486	0.0349	0.0282	0.0099	43	935.8	282.5	102.9
138	22500	LHS	NH 129	40	0.1685	0.1223	0.0638	0.0413	0.0293	0.012	0.0041	43	923.1	273.2	103
139	22625	RHS	NH 129	40	0.2663	0.1923	0.0815	0.0488	0.0329	0.0276	0.0134	43	898.8	283.7	103
140	22750	LHS	NH 129	40	0.2127	0.1524	0.077	0.052	0.0343	0.026	0.0076	43	932.1	281.1	103
141	22875	RHS	NH 129	40	0.2831	0.2091	0.0941	0.055	0.0356	0.025	0.0057	43	921.5	198.4	103
142	23000	LHS	NH 129	40	0.2186	0.1543	0.0697	0.0436	0.0292	0.0164	0.0083	43	939.5	283.7	103
143	23125	RHS	NH 129	40	0.2261	0.1542	0.0777	0.0516	0.032	0.0164	0.0088	43	918.4	282.8	103
144	23250	LHS	NH 129	40	0.2628	0.1912	0.0954	0.0568	0.0404	0.0291	0.0131	43	932.1	283.3	103
145	23375	RHS	NH 129	40	0.2385	0.1734	0.098	0.0647	0.0454	0.0316	0.0085	43	931	280.7	103
146	23500	LHS	NH 129	40	0.3018	0.2132	0.0963	0.0444	0.0257	0.0174	0.0088	42.9	934.2	212.2	103
147	23625	RHS	NH 129	40	0.1945	0.134	0.0662	0.0468	0.0383	0.0304	0.0074	42.9	900.9	282.6	103

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
148	23750	LHS	NH 129	40	0.3076	0.2288	0.0933	0.0552	0.0377	0.0282	0.0066	42.9	936.8	215.1	103
149	23875	RHS	NH 129	40	0.2324	0.1717	0.0874	0.0534	0.0372	0.0243	0.0067	42.9	914.1	282.5	103
150	24000	LHS	NH 129	40	0.2771	0.1954	0.0817	0.0443	0.0306	0.0158	0.0081	42.9	938.9	268	103
151	24125	RHS	NH 129	40	0.261	0.1805	0.0931	0.0592	0.0431	0.0345	0.0066	42.9	922.6	281.1	103
152	24250	LHS	NH 129	40	0.2674	0.1862	0.0783	0.0469	0.0329	0.022	0.0074	42.9	900.9	275.7	103
153	24375	RHS	NH 129	40	0.2005	0.1344	0.0681	0.0449	0.0417	0.0191	0.0168	42.9	918.4	283.7	103
154	24500	LHS	NH 129	40	0.2655	0.2063	0.1009	0.0622	0.0348	0.0214	0.01	42.9	927.9	283	109
155	24625	RHS	NH 129	40	0.3447	0.2819	0.1353	0.0576	0.0329	0.0261	0.0153	42.9	932.1	280.7	109
156	24750	LHS	NH 129	40	0.2019	0.1444	0.0767	0.0522	0.0388	0.0258	0.0084	42.9	915.2	281.8	109
157	24875	RHS	NH 129	40	0.2795	0.2016	0.0848	0.0584	0.0475	0.036	0.0182	42.1	925.2	227.7	95
158	25000	LHS	NH 129	40	0.2369	0.1493	0.0639	0.0421	0.0302	0.01	0.0053	42.1	911	225.4	95
159	25125	RHS	NH 129	40	0.1718	0.1272	0.0667	0.0478	0.0327	0.0177	0.0123	41.5	908.3	226.9	95
160	25250	LHS	NH 129	40	0.3063	0.2255	0.117	0.072	0.0507	0.04	0.0282	42.1	898.8	227.7	94.9
161	25375	RHS	NH 129	40	0.3167	0.2424	0.1249	0.0722	0.0392	0.0309	0.0099	42.1	937.9	226.5	95
162	25500	LHS	NH 129	40	0.1616	0.1172	0.0648	0.0403	0.0244	0.0191	0.0094	41.1	934.2	325.2	114
163	25625	RHS	NH 129	40	0.3002	0.2145	0.0897	0.0549	0.0414	0.0288	0.0109	41.5	924.7	300.9	108
164	25750	LHS	NH 129	40	0.3794	0.2936	0.1463	0.0835	0.0613	0.0462	0.023	41.5	933.7	300.8	108
165	25875	RHS	NH 129	40	0.2119	0.1345	0.0506	0.0312	0.0184	0.0094	0.0045	40.1	934.2	207.7	108
166	26000	LHS	NH 129	40	0.2309	0.1484	0.0711	0.0372	0.0265	0.0211	0.0081	40.1	917.3	299.9	108
167	26125	RHS	NH 129	40	0.5439	0.4084	0.1731	0.0911	0.0678	0.0465	0.0156	40.1	934.7	206.6	108
168	26250	LHS	NH 129	40	0.3101	0.2018	0.0854	0.0511	0.0424	0.0286	0.013	40.1	928.9	297.3	108
169	26375	RHS	NH 129	40	0.3202	0.2346	0.1135	0.0642	0.0415	0.032	0.0119	41.1	926.8	264.9	101
170	26500	LHS	NH 129	40	0.2729	0.1856	0.1014	0.0626	0.0363	0.0261	0.0127	41.1	917.3	295.3	101
171	26625	RHS	NH 129	40	0.3854	0.289	0.1403	0.0749	0.0494	0.0367	0.013	41.1	911.5	214.3	101
172	26750	LHS	NH 129	40	0.2717	0.2167	0.1133	0.0716	0.041	0.0316	0.0222	40.9	933.1	294.9	100.9
173	26875	RHS	NH 129	40	0.2512	0.1892	0.0882	0.051	0.035	0.0217	0.0115	40.9	920.5	292.6	101
174	27000	LHS	NH 129	40	0.2736	0.21	0.0955	0.0539	0.0343	0.0304	0.0118	40.9	927.9	293.3	101
175	27125	RHS	NH 129	40	0.3624	0.2955	0.1325	0.0707	0.0442	0.0324	0.0118	40.9	920.5	204.5	101
176	27250	LHS	NH 129	40	0.2164	0.1465	0.0622	0.0354	0.0216	0.0143	0.0078	40.9	936.3	249.1	101
177	27375	RHS	NH 129	40	0.3387	0.2749	0.1213	0.0846	0.0532	0.0396	0.0309	40.9	940	291.7	101

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
178	27500	LHS	NH 129	40	0.2816	0.2157	0.1104	0.064	0.044	0.0289	0.0081	40.9	930	221.2	101
179	27625	RHS	NH 129	40	0.2464	0.1982	0.109	0.0745	0.0566	0.0415	0.0278	40.9	934.7	295.5	101
180	27750	LHS	NH 129	40	0.244	0.1937	0.1053	0.0712	0.042	0.0275	0.0099	40.9	923.6	293.9	101
181	27875	RHS	NH 129	40	0.261	0.203	0.1096	0.0637	0.0451	0.0298	0.0189	40.9	909.9	296	101
182	28000	LHS	NH 129	40	0.2248	0.1745	0.0908	0.0531	0.0346	0.0242	0.0062	40.9	926.3	221.1	101
183	28125	RHS	NH 129	40	0.178	0.131	0.0692	0.041	0.0257	0.0176	0.0073	40.9	930.5	291.3	101
184	28250	LHS	NH 129	40	0.3162	0.2227	0.113	0.0551	0.035	0.0225	0.0143	40.9	935.2	269.5	101
185	28375	RHS	NH 129	40	0.2306	0.1823	0.0841	0.0639	0.0508	0.0347	0.0191	40.9	936.3	346.7	117
186	28500	LHS	NH 129	40	0.4463	0.3177	0.1202	0.0842	0.0608	0.0173	0.0026	40.9	914.7	219.4	117
187	28625	RHS	NH 129	40	0.2372	0.1902	0.1047	0.0656	0.0513	0.0388	0.0341	40.9	938.9	346.6	116.9
188	28750	LHS	NH 129	40	0.1647	0.1161	0.0633	0.0489	0.0263	0.017	0.0079	40.9	925.7	342.5	117
189	28875	RHS	NH 129	40	0.1753	0.1232	0.0679	0.0523	0.0279	0.0186	0.0084	40.1	928.4	345.7	117
190	29000	LHS	NH 129	40	0.3593	0.2859	0.128	0.086	0.0548	0.039	0.0304	40.1	919.9	338.7	117
191	29125	RHS	NH 129	40	0.4053	0.322	0.1213	0.059	0.0393	0.0289	0.0224	40.1	918.9	219.3	117
192	29250	LHS	NH 129	40	0.2116	0.1426	0.0712	0.0469	0.0404	0.0203	0.0177	40.1	933.1	346	117
193	29375	RHS	NH 129	40	0.2564	0.1865	0.0985	0.0646	0.0473	0.0326	0.0109	42.1	931.6	310.6	114
194	29500	LHS	NH 129	40	0.2558	0.2097	0.1114	0.0573	0.034	0.0153	0.0077	34.6	1315.21	225.8	110
195	29750	RHS	NH 129	40	0.1845	0.1207	0.0658	0.0434	0.0328	0.0259	0.0072	34.6	1314.228	338.8	110
196	30000	LHS	NH 129	40	0.2256	0.1542	0.074	0.0559	0.0418	0.0228	0.0068	34.6	1350.3	218.4	110
197	30250	RHS	NH 129	40	0.3034	0.2454	0.1337	0.0841	0.0538	0.0408	0.032	34.6	1376.5	346.2	110
198	30500	LHS	NH 129	40	0.1217	0.1078	0.0568	0.0289	0.0212	0.0163	0.0053	34.6	1384.3	345.2	110
199	30750	RHS	NH 129	40	0.2641	0.1961	0.1079	0.0698	0.0498	0.0335	0.0092	34.6	1246.2	261.6	110
200	31000	LHS	NH 129	40	0.1986	0.1579	0.0839	0.0541	0.0379	0.0265	0.0163	34.6	1363.9	346.5	110
201	31250	RHS	NH 129	40	0.282	0.2313	0.1096	0.0723	0.0468	0.0322	0.0219	34.6	1369.7	346.1	110
202	31500	LHS	NH 129	40	0.2592	0.1958	0.0994	0.0564	0.0351	0.0207	0.0069	34.6	1297.7	224.1	110
203	31625	RHS	NH 129	40	0.2934	0.191	0.1092	0.0607	0.0366	0.0263	0.007	41.1	938.4	206.6	114
204	31750	LHS	NH 129	40	0.1916	0.1302	0.1002	0.0724	0.0461	0.0237	0.009	41.1	910.4	323.8	114
205	31875	RHS	NH 129	40	0.1883	0.1434	0.0717	0.044	0.028	0.0193	0.0077	42.1	934.7	314.6	114
206	32000	LHS	NH 129	40	0.2559	0.2107	0.102	0.0634	0.0384	0.0296	0.0148	41.1	923.1	322.8	114
207	32125	RHS	NH 129	40	0.2891	0.2106	0.1001	0.0611	0.0329	0.0216	0.0087	42.1	929.4	211.7	114

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
208	32250	LHS	NH 129	40	0.2667	0.1883	0.0921	0.0641	0.0457	0.0373	0.0186	41.1	921	325.9	114
209	32375	RHS	NH 129	40	0.2845	0.2218	0.0966	0.052	0.0345	0.02	0.0096	42.1	933.1	212.8	114
210	32500	LHS	NH 129	40	0.2289	0.1826	0.0864	0.0524	0.0349	0.027	0.0175	40.1	905.2	346.2	116.9
211	32625	RHS	NH 129	40	0.281	0.2257	0.1059	0.067	0.0383	0.0227	0.0108	40.1	913.1	260.4	117
212	32750	LHS	NH 129	40	0.2517	0.1902	0.1023	0.0581	0.0372	0.0226	0.0054	40.1	931.6	219.9	117
213	32875	RHS	NH 129	40	0.2827	0.2086	0.0958	0.0535	0.0371	0.0288	0.0066	40.1	935.8	223	117
214	33000	LHS	NH 129	40	0.2581	0.1959	0.1033	0.0578	0.0374	0.023	0.0054	40.1	909.9	219.4	117
215	33125	RHS	NH 129	40	0.2463	0.1831	0.0924	0.0556	0.0392	0.0261	0.0071	40.1	936.3	235.1	117
216	33250	LHS	NH 129	40	0.2738	0.1997	0.1019	0.0604	0.0429	0.0304	0.0142	40.1	933.7	346.9	117
217	33375	RHS	NH 129	40	0.216	0.1496	0.0627	0.033	0.0225	0.0125	0.0062	39.5	973.1	219	117
218	33500	LHS	NH 129	40	0.2689	0.2186	0.1105	0.0582	0.0414	0.0277	0.0116	42.1	938.4	268.8	114
219	34000	RHS	NH 129	40	0.2973	0.2353	0.1016	0.0549	0.0354	0.0201	0.0098	41.6	933.1	285.2	115
220	34125	LHS	NH 129	40	0.2855	0.2159	0.1115	0.0646	0.0497	0.0252	0.011	41.6	916.2	282.4	115
221	34250	RHS	NH 129	40	0.2009	0.1623	0.0956	0.0679	0.0417	0.0352	0.0198	41.6	935.8	285.7	114.8
222	34375	LHS	NH 129	40	0.3511	0.2569	0.1004	0.0469	0.0313	0.0188	0.0103	41.6	930.5	278.8	115
223	34500	RHS	NH 129	40	0.2747	0.2006	0.0927	0.0558	0.0365	0.0255	0.0128	39.5	982.5	311.3	117
224	34625	LHS	NH 129	40	0.2573	0.1802	0.0837	0.0488	0.0267	0.018	0.0104	39.5	1003.2	240.8	117
225	34750	RHS	NH 129	40	0.2592	0.1739	0.071	0.0416	0.0282	0.0186	0.0072	39.5	1003.2	221.1	117
226	34875	LHS	NH 129	40	0.3009	0.2158	0.0865	0.0531	0.041	0.0324	0.0178	39.5	999.1	344.4	117
227	35000	RHS	NH 129	40	0.2512	0.1764	0.0757	0.0323	0.0173	0.0117	0.0059	41.6	932.1	272.5	115
228	36000	LHS	NH 129	40	0.234	0.1779	0.0833	0.0421	0.0262	0.0169	0.0111	41.6	925.7	279.9	115
229	36125	RHS	NH 129	40	0.3287	0.2465	0.0982	0.0604	0.0395	0.0303	0.0108	38.5	1061.8	239.2	106
230	36250	LHS	NH 129	40	0.2534	0.1904	0.0864	0.0546	0.0377	0.0256	0.0126	38.5	1053.2	237.9	106
231	36375	RHS	NH 129	40	0.2253	0.1609	0.0776	0.054	0.0342	0.0273	0.0105	41.6	937.4	237	106
232	36500	LHS	NH 129	40	0.3626	0.2798	0.1342	0.0832	0.0611	0.0486	0.0275	39.5	986.1	242.2	103
233	36625	RHS	NH 129	40	0.239	0.1661	0.0805	0.0521	0.039	0.0284	0.0079	39.5	993.2	242.7	103
234	36750	LHS	NH 129	40	0.2655	0.1989	0.0959	0.0551	0.0372	0.0232	0.0121	39.5	945.3	242.7	103
235	36875	RHS	NH 129	40	0.2596	0.1797	0.0857	0.0599	0.0438	0.0345	0.0172	39.5	967.7	242.8	103
236	37000	LHS	NH 129	40	0.2357	0.1697	0.0705	0.042	0.0349	0.0222	0.0087	38.5	1061.8	237.1	106
237	38500	RHS	NH 129	40	0.2678	0.2077	0.1048	0.0659	0.0433	0.0379	0.0132	41.6	917.3	238.1	106

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
238	38625	LHS	NH 129	40	0.2052	0.1683	0.0851	0.0435	0.0252	0.0165	0.0083	38.5	1048.6	239.7	106
239	38750	RHS	NH 129	40	0.2394	0.1773	0.0904	0.0586	0.044	0.0296	0.0103	41.6	930	238.5	106
240	38875	LHS	NH 129	40	0.2687	0.1808	0.1004	0.0577	0.035	0.0245	0.0065	38.5	1063.8	236.9	106
241	39000	RHS	NH 129	40	0.1888	0.1464	0.0747	0.0521	0.0374	0.029	0.006	41.6	919.4	238.7	106
242	39125	LHS	NH 129	40	0.1814	0.1246	0.0651	0.0323	0.0206	0.0118	0.009	38.5	1008.4	238.7	106
243	39250	RHS	NH 129	40	0.2537	0.1915	0.09	0.0453	0.0277	0.0182	0.0119	39.5	930.5	242.5	103
244	39375	LHS	NH 129	40	0.1424	0.0965	0.0432	0.0225	0.0152	0.0095	0.0062	39.5	998.5	242.3	103
245	39500	RHS	NH 129	40	0.3253	0.2309	0.1045	0.0473	0.0277	0.0183	0.0096	39.5	972.5	240.5	103
246	39625	LHS	NH 129	40	0.2527	0.195	0.0933	0.0463	0.0256	0.0126	0.007	39.5	968.3	242.2	103
247	39750	RHS	NH 129	40	0.2337	0.1603	0.072	0.0467	0.032	0.0173	0.0088	39.5	930.5	242.9	103
248	39875	LHS	NH 129	40	0.2034	0.1303	0.0597	0.0426	0.0342	0.0207	0.009	39.5	966.6	241.3	103
249	40000	RHS	NH 129	40	0.2356	0.1606	0.0751	0.0455	0.0298	0.0196	0.0096	41.6	900.4	237.9	106
250	46000	LHS	NH 129	40	0.2335	0.1629	0.0628	0.0422	0.0314	0.015	0.0057	38.5	1066.4	238.1	106
251	46125	RHS	NH 129	40	0.2541	0.176	0.0734	0.0421	0.0287	0.0192	0.0072	41.6	924.2	240	105.9
252	46250	LHS	NH 129	40	0.213	0.1525	0.0685	0.0435	0.0226	0.0123	0.0042	38.5	1072.4	239.8	106
253	46375	RHS	NH 129	40	0.2728	0.1977	0.1003	0.0582	0.034	0.0308	0.011	41.6	939.5	238	106
254	46500	LHS	NH 129	40	0.2502	0.1991	0.097	0.0589	0.0364	0.0284	0.014	41.6	909.9	239.4	106
255	46625	RHS	NH 129	40	0.2542	0.1806	0.0986	0.066	0.0468	0.031	0.0159	41.6	902.5	239.2	106
256	46750	LHS	NH 129	40	0.2367	0.1552	0.0644	0.0455	0.0339	0.0209	0.0092	41.6	934.2	239.3	106
257	46875	RHS	NH 129	40	0.2458	0.1908	0.0951	0.0583	0.0425	0.0284	0.0111	38.5	1061.8	239.5	105.9
258	47000	LHS	NH 129	40	0.2051	0.1627	0.0998	0.0694	0.0421	0.0351	0.02	39.9	995.5	239.5	106
259	47125	RHS	NH 129	40	0.2871	0.2036	0.0945	0.0536	0.035	0.029	0.0131	39.9	996.7	238.8	106
260	47250	LHS	NH 129	40	0.2087	0.1452	0.0722	0.0516	0.0397	0.0215	0.0063	38.5	1074.3	239.7	106
261	47375	RHS	NH 129	40	0.3353	0.2501	0.0999	0.0589	0.0392	0.03	0.007	39.9	984.9	236.9	106
262	47500	LHS	NH 129	40	0.2504	0.1875	0.0972	0.0603	0.043	0.0325	0.0112	39.9	935.8	240	106
263	47625	RHS	NH 129	40	0.2117	0.1632	0.0978	0.0586	0.0431	0.0291	0.0099	39.9	974.2	239.8	106
264	47750	LHS	NH 129	40	0.2354	0.1567	0.0774	0.0327	0.0162	0.0079	0.0045	39.9	993.2	238.2	106
265	47875	RHS	NH 129	40	0.2354	0.1789	0.094	0.0543	0.0345	0.0209	0.005	38.5	980.6	239.9	106
266	48000	LHS	NH 129	40	0.3357	0.2597	0.136	0.0783	0.042	0.033	0.0107	39.9	905.1	239.7	106
267	48125	RHS	NH 129	40	0.2893	0.244	0.1276	0.0766	0.0534	0.037	0.0082	39.9	982.5	238.6	106

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
268	48250	LHS	NH 129	40	0.2393	0.1852	0.0957	0.0563	0.0365	0.0258	0.0066	39.9	958.9	238.9	106
269	48375	RHS	NH 129	40	0.248	0.1655	0.0678	0.0485	0.0361	0.022	0.0099	39.9	915.1	239.5	106
270	48500	LHS	NH 129	40	0.2045	0.1488	0.0739	0.0488	0.0313	0.0175	0.0087	38.5	1056.5	240	106
271	48625	RHS	NH 129	40	0.1802	0.1225	0.0625	0.036	0.0314	0.0183	0.0103	39.9	1002	237.9	106
272	48750	LHS	NH 129	40	0.1718	0.1235	0.0529	0.0344	0.0162	0.0079	0.0039	38.5	1073.7	204.2	105
273	48875	RHS	NH 129	40	0.2136	0.1351	0.0629	0.0395	0.0307	0.0219	0.0069	39.5	990.2	240.4	103
274	49000	LHS	NH 129	40	0.2483	0.193	0.0862	0.0506	0.0314	0.0283	0.0109	39.5	1005	242.1	103
275	49125	RHS	NH 129	40	0.2337	0.1785	0.107	0.0688	0.054	0.0413	0.0336	39.5	958.3	243	103
276	49250	LHS	NH 129	40	0.3077	0.2408	0.1448	0.0937	0.063	0.0546	0.0146	36.4	1042.1	324.9	110
277	49375	RHS	NH 129	40	0.2593	0.1878	0.094	0.0574	0.0394	0.0246	0.0087	36.4	1004.9	303.1	112
278	49500	LHS	NH 129	40	0.2797	0.2073	0.1157	0.0674	0.0481	0.0335	0.0095	37.4	1027.9	232.6	97
279	49625	RHS	NH 129	40	0.1203	0.1081	0.0546	0.0299	0.0217	0.016	0.0053	37.4	1025	231.8	97
280	49750	LHS	NH 129	40	0.2042	0.1656	0.0891	0.0558	0.0426	0.0283	0.0188	39.2	990.2	232.9	96.9
281	49875	RHS	NH 129	40	0.185	0.1471	0.0838	0.0538	0.043	0.0332	0.0227	39.2	1000.9	231.9	96.9
282	50000	LHS	NH 129	40	0.1944	0.1508	0.0743	0.0456	0.0325	0.0231	0.0137	39.2	987.3	232.1	97
283	50125	RHS	NH 129	40	0.1659	0.1302	0.0786	0.0412	0.0338	0.0206	0.0114	39.2	991.4	232.5	97
284	50250	LHS	NH 129	40	0.1414	0.0978	0.0511	0.0326	0.0268	0.0166	0.008	39.2	978.4	232.4	97
285	50375	RHS	NH 129	40	0.2683	0.2011	0.0937	0.0541	0.0373	0.0231	0.0124	39.2	1005	232.6	96.9
286	50500	LHS	NH 129	40	0.1597	0.1147	0.0602	0.0424	0.0368	0.0251	0.0134	39.2	971.3	314.3	105
287	50625	RHS	NH 129	40	0.225	0.1648	0.0754	0.0462	0.0243	0.0131	0.0045	39.2	999.7	198.9	105
288	50750	LHS	NH 129	40	0.2608	0.199	0.1009	0.0641	0.0473	0.0348	0.0256	39.2	1003.8	314.5	105
289	50875	RHS	NH 129	40	0.3038	0.2418	0.1469	0.0947	0.0631	0.0539	0.0145	39.2	996.1	264.2	105
290	51000	LHS	NH 129	40	0.205	0.1687	0.0972	0.0636	0.0468	0.0338	0.0221	39.2	998.5	312.4	104.9
291	51125	RHS	NH 129	40	0.2483	0.1983	0.1083	0.0737	0.0561	0.0428	0.025	39.2	979.6	314.9	104.9
292	51250	LHS	NH 129	40	0.1502	0.1117	0.0621	0.0377	0.0231	0.0183	0.0089	39.2	1002	314.3	105
293	51375	RHS	NH 129	40	0.2604	0.1822	0.0788	0.0423	0.0284	0.0088	0.0045	39.2	981.3	198.5	105
294	51500	LHS	NH 129	40	0.2307	0.1773	0.0943	0.058	0.0408	0.0259	0.0151	39.2	1005	313.7	105
295	51625	RHS	NH 129	40	0.2204	0.1743	0.0981	0.0591	0.0458	0.0283	0.0087	39.2	1003.2	260.4	105
296	51750	LHS	NH 129	40	0.2218	0.1692	0.0994	0.0646	0.0501	0.0388	0.0314	39.2	994.4	312.7	105
297	51875	RHS	NH 129	40	0.1798	0.1257	0.0606	0.0382	0.0295	0.0217	0.0053	39.9	992.6	281.7	105

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
298	52000	LHS	NH 129	40	0.1517	0.1059	0.0558	0.035	0.0291	0.018	0.0084	34.6	1345.767	342.7	110
299	52250	RHS	NH 129	40	0.2691	0.2187	0.1139	0.058	0.0362	0.0159	0.0082	34.6	1354.413	218.3	110
300	52500	LHS	NH 129	40	0.2369	0.2005	0.1064	0.0564	0.0349	0.0261	0.0216	36.4	1258.679	346.9	110
301	52750	RHS	NH 129	40	0.2545	0.2136	0.1125	0.0614	0.0372	0.0282	0.0225	36.4	1267.089	345.9	110
302	53000	LHS	NH 129	40	0.3077	0.2408	0.1448	0.0937	0.063	0.0546	0.0146	36.4	1109.422	324.9	110
303	53250	RHS	NH 129	40	0.2375	0.179	0.0848	0.0591	0.0417	0.034	0.0206	36.4	1281.462	344.7	110
304	53500	LHS	NH 129	40	0.258	0.2073	0.1127	0.0547	0.0346	0.0155	0.0078	36.4	1246.01	219.9	110
305	53625	RHS	NH 129	40	0.274	0.223	0.1056	0.0608	0.0505	0.0298	0.0104	38.5	1062.5	291.6	105
306	53750	LHS	NH 129	40	0.1743	0.1159	0.0632	0.039	0.0309	0.0251	0.0068	39.9	1000.9	319.4	105
307	53875	RHS	NH 129	40	0.1878	0.1527	0.0715	0.0405	0.0149	0.0076	0.0037	38.5	1059.2	208.8	105
308	54000	LHS	NH 129	40	0.1033	0.0718	0.0344	0.0202	0.0136	0.0092	0.004	39.9	947	323.1	105
309	54125	RHS	NH 129	40	0.2135	0.1711	0.0847	0.0663	0.0407	0.0305	0.0125	38.5	985.3	322.6	105
310	54250	LHS	NH 129	40	0.2668	0.1972	0.0875	0.0532	0.0371	0.0269	0.0111	39.2	999.7	241.9	105
311	54375	RHS	NH 129	40	0.1992	0.1483	0.0813	0.0556	0.0395	0.0292	0.0163	39.2	971.9	314.5	105
312	54500	LHS	NH 129	40	0.2092	0.1652	0.0622	0.0454	0.0244	0.0126	0.0084	39.2	999.1	206.7	104.9
313	54625	RHS	NH 129	40	0.1578	0.1168	0.0657	0.0487	0.036	0.0247	0.0121	39.5	1003.8	313.5	105
314	54750	LHS	NH 129	40	0.2201	0.1587	0.0854	0.0428	0.0257	0.0197	0.007	39.5	1000.3	211.4	105
315	54875	RHS	NH 129	40	0.1366	0.101	0.0606	0.0451	0.0364	0.0263	0.0167	39.5	1003.2	312.9	104.9
316	55000	LHS	NH 129	40	0.1255	0.0781	0.051	0.0296	0.0143	0.0062	0.0031	39.9	993.2	210.5	105
317	60000	RHS	NH 129	40	0.1983	0.1375	0.0825	0.0353	0.0207	0.0139	0.0094	38.5	1057.2	311.4	105
318	60125	LHS	NH 129	40	0.1415	0.0857	0.0504	0.0225	0.0113	0.0057	0.0029	39.9	1002	209.1	105
319	60250	RHS	NH 129	40	0.1124	0.1004	0.0527	0.0276	0.0201	0.015	0.005	38.5	1013	319.3	105
320	60375	LHS	NH 129	40	0.1789	0.1219	0.0936	0.0681	0.0435	0.0222	0.0083	39.9	984.3	321.1	105
321	60500	RHS	NH 129	40	0.1214	0.0905	0.0443	0.0267	0.017	0.0087	0.0043	38.5	1063.1	318.4	105
322	60625	LHS	NH 129	40	0.2178	0.1557	0.0717	0.031	0.0148	0.0072	0.0042	39.9	988.4	206.7	105
323	60750	RHS	NH 129	40	0.1296	0.0841	0.0394	0.0281	0.0149	0.0043	0.0026	38.5	1013	205.9	105
324	60875	LHS	NH 129	40	0.2517	0.1657	0.0712	0.0448	0.0275	0.0226	0.0124	39.5	1002.6	298.3	105
325	61000	RHS	NH 129	40	0.2234	0.1705	0.0822	0.0545	0.0396	0.0349	0.0277	39.5	999.1	311.1	105
326	61125	LHS	NH 129	40	0.1603	0.1209	0.0628	0.0431	0.0313	0.0163	0.0116	39.5	996.1	286.8	99
327	61250	RHS	NH 129	40	0.1338	0.0928	0.0522	0.0369	0.0286	0.0166	0.0112	39.5	981.3	285.5	99

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
328	61375	LHS	NH 129	40	0.2217	0.1743	0.0903	0.0462	0.027	0.0177	0.0086	39.8	992	231.1	105
329	61500	RHS	NH 129	40	0.1933	0.1414	0.081	0.0542	0.036	0.0262	0.0094	39.8	999.7	280.5	105
330	61625	LHS	NH 129	40	0.255	0.2059	0.0905	0.0531	0.0337	0.0308	0.0117	39.8	1000.3	282.3	105
331	61750	RHS	NH 129	40	0.2389	0.2002	0.1083	0.0634	0.0431	0.029	0.0118	39.8	994.4	282.3	105
332	61875	LHS	NH 129	40	0.2214	0.1898	0.101	0.0593	0.0399	0.027	0.0111	39.9	955.9	320.6	105
333	62000	RHS	NH 129	40	0.5376	0.4185	0.1693	0.0885	0.0646	0.0447	0.0155	34.1	1333.455	244	112
334	62250	LHS	NH 129	40	0.4517	0.3469	0.1784	0.0947	0.0711	0.042	0.0204	37	1219.554	277.8	111.9
335	62500	RHS	NH 129	40	0.3433	0.2475	0.1018	0.0593	0.0435	0.0384	0.0144	34.1	1340.952	276.4	112
336	62750	LHS	NH 129	40	0.4441	0.3017	0.122	0.0575	0.0397	0.0312	0.009	37	1239.356	225.3	112
337	63000	RHS	NH 129	40	0.3343	0.2573	0.1271	0.0786	0.05	0.0308	0.016	35.5	1289.602	274.1	112
338	63250	LHS	NH 129	40	0.3835	0.2778	0.1192	0.0617	0.0522	0.0394	0.0183	37	1229.072	275.7	112
339	63500	RHS	NH 129	40	0.3875	0.2897	0.1515	0.09	0.0643	0.0528	0.0228	35.5	1267.722	277.7	111.9
340	63750	LHS	NH 129	40	0.3502	0.2704	0.1278	0.0768	0.0472	0.0297	0.0135	37	1204.456	277.3	112
341	64000	RHS	NH 129	40	0.3398	0.2288	0.0869	0.0551	0.0355	0.0233	0.0091	37	1231.37	271.4	112
342	64250	LHS	NH 129	40	0.35	0.2558	0.1112	0.0634	0.0485	0.0383	0.0097	38.2	1243.292	245	102
343	64500	RHS	NH 129	40	0.4856	0.3727	0.1582	0.0871	0.0624	0.035	0.0178	35.5	1301.871	241.9	102
344	64750	LHS	NH 129	40	0.3863	0.2984	0.119	0.0677	0.0312	0.0234	0.0107	38.2	1229.529	240.3	102
345	65000	RHS	NH 129	40	0.306	0.204	0.0844	0.0515	0.0427	0.028	0.0127	35.5	1300.951	243.9	102
346	65250	LHS	NH 129	40	0.2907	0.2143	0.0897	0.0502	0.0367	0.0298	0.007	38.2	1200.499	244.6	102
347	65500	RHS	NH 129	40	0.5915	0.4294	0.1749	0.0816	0.0507	0.0355	0.0166	35.5	1272.118	203.2	102
348	65750	LHS	NH 129	40	0.2613	0.1779	0.0498	0.0313	0.0225	0.0123	0.0091	38.2	1211.255	239.1	102
349	66000	RHS	NH 129	40	0.5174	0.3858	0.1642	0.0779	0.0522	0.0422	0.0166	35.5	1296.657	227.7	102
350	66250	LHS	NH 129	40	0.4111	0.3103	0.1507	0.0771	0.0422	0.0357	0.0057	35.5	1288.784	209.2	102
351	66500	RHS	NH 129	40	0.3905	0.277	0.1257	0.0701	0.0571	0.0514	0.0073	35.5	1259.031	240.8	102
352	66750	LHS	NH 129	40	0.4026	0.3231	0.1406	0.0732	0.0463	0.0362	0.0178	38.2	1242.482	243.5	102
353	67000	RHS	NH 129	40	0.5126	0.3725	0.1642	0.0871	0.0588	0.0472	0.0234	35.5	1292.26	244.4	102
354	67125	LHS	NH 129	40	0.2048	0.1583	0.0931	0.0552	0.0402	0.027	0.0094	38.5	1032.8	323.3	105
355	67250	RHS	NH 129	40	0.1498	0.1119	0.064	0.0409	0.0301	0.0184	0.0056	39.9	934.6	319.3	105
356	67375	LHS	NH 129	40	0.2284	0.1594	0.07	0.0397	0.0298	0.0205	0.0099	38.5	1054.5	324.2	105
357	67500	RHS	NH 129	40	0.3917	0.2433	0.1102	0.0839	0.0603	0.0434	0.0107	36	1149	223.2	114

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
358	67625	LHS	NH 129	40	0.3197	0.2451	0.1278	0.0846	0.0602	0.0468	0.0181	36	1090.4	324.2	105
359	67750	RHS	NH 129	40	0.3119	0.2215	0.1187	0.0912	0.0558	0.0435	0.0127	35.5	1097.1	323.3	105
360	67875	LHS	NH 129	40	0.2238	0.1406	0.0629	0.0383	0.0193	0.0091	0.003	36.4	966.1	212.1	106
361	68000	RHS	NH 129	40	0.2552	0.1678	0.0723	0.0444	0.0278	0.0225	0.0122	39.8	999.7	277.2	105
362	68125	LHS	NH 129	40	0.1911	0.1493	0.0875	0.0577	0.0472	0.033	0.0246	41.6	919.4	285	104.9
363	68250	RHS	NH 129	40	0.2895	0.2293	0.1158	0.0622	0.0442	0.0289	0.0125	41.6	934.2	267.4	105
364	68375	LHS	NH 129	40	0.2223	0.1694	0.0959	0.0562	0.041	0.0323	0.0262	41.6	925.7	283.9	105
365	68500	RHS	NH 129	40	0.304	0.2323	0.1188	0.0688	0.0525	0.0268	0.0117	41.6	939.5	248.1	105
366	68625	LHS	NH 129	40	0.2901	0.2317	0.1205	0.0734	0.0551	0.0416	0.0324	41.6	935.2	283.1	104.9
367	68750	RHS	NH 129	40	0.2533	0.1915	0.0953	0.0623	0.0476	0.031	0.0111	41.6	937.4	282.7	105
368	68875	LHS	NH 129	40	0.3156	0.223	0.1282	0.0694	0.0432	0.0326	0.01	41.6	934.7	202.8	105
369	69000	RHS	NH 129	40	0.3374	0.2653	0.1266	0.0931	0.0617	0.0449	0.0063	36.4	1055.6	213.1	106
370	72000	LHS	NH 129	40	0.2041	0.1407	0.0558	0.0381	0.0134	0.0068	0.0034	36.4	1072.2	205.8	111
371	72125	RHS	NH 129	40	0.3024	0.2302	0.1268	0.0849	0.0661	0.0549	0.0065	36.4	1058	212.7	111
372	72250	LHS	NH 129	40	0.3556	0.2694	0.1453	0.1011	0.0835	0.0618	0.0125	37.8	991.7	256.7	111
373	72375	RHS	NH 129	40	0.2131	0.1633	0.0849	0.0528	0.0444	0.0277	0.0052	37.8	1071.3	207.2	111
374	72500	LHS	NH 129	40	0.243	0.1686	0.074	0.042	0.0319	0.0222	0.0106	41.6	932.6	273.5	105
375	72625	RHS	NH 129	40	0.2462	0.1777	0.0736	0.0451	0.0374	0.0235	0.0093	41.6	939.5	255.4	105
376	72750	LHS	NH 129	40	0.2132	0.1371	0.0643	0.045	0.0363	0.0217	0.0097	41.6	940	284.8	105
377	72875	RHS	NH 129	40	0.2483	0.1881	0.1008	0.062	0.0433	0.0268	0.0162	41.6	928.9	284.8	105
378	73000	LHS	NH 129	40	0.2617	0.1988	0.1003	0.0628	0.045	0.0384	0.0081	37.8	1015.6	229	111
379	75000	RHS	NH 129	40	0.295	0.2389	0.1216	0.0769	0.0567	0.0378	0.024	38.5	1069.1	274.7	101
380	75125	LHS	NH 129	40	0.4008	0.301	0.1523	0.0976	0.0735	0.0526	0.0266	38.5	1051.9	256.4	101
381	75250	RHS	NH 129	40	0.3589	0.2651	0.1197	0.0707	0.0497	0.0326	0.0176	41.6	924.2	238.7	110
382	75375	LHS	NH 129	40	0.2583	0.1951	0.0867	0.0498	0.031	0.0274	0.0094	41.6	931	235.9	110
383	75500	RHS	NH 129	40	0.3441	0.2662	0.1582	0.1121	0.0809	0.0554	0.0294	38.5	1053.9	274.2	101
384	77000	LHS	NH 129	40	0.2299	0.1371	0.0778	0.0412	0.0332	0.021	0.0105	38.5	1067.1	274.4	101
385	77125	RHS	NH 129	40	0.2918	0.2327	0.117	0.0769	0.0487	0.0368	0.0153	38.5	1046.6	247.8	108
386	77250	LHS	NH 129	40	0.2043	0.1481	0.0795	0.0507	0.0425	0.0312	0.0125	38.5	1066.4	249.6	107.9
387	77375	RHS	NH 129	40	0.3801	0.2967	0.1426	0.0906	0.0676	0.0484	0.0191	38.5	1063.1	248.3	108

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
388	77500	LHS	NH 129	40	0.2615	0.188	0.0951	0.0589	0.0365	0.0248	0.0093	41.6	930.5	238.3	110
389	77625	RHS	NH 129	40	0.3567	0.2656	0.1137	0.0645	0.0345	0.0207	0.0074	41.6	930.5	238.4	110
390	77750	LHS	NH 129	40	0.2179	0.1665	0.0761	0.0473	0.025	0.0166	0.0056	41.6	919.9	237.6	110
391	77875	RHS	NH 129	40	0.2239	0.1777	0.0872	0.0595	0.0415	0.0347	0.0198	41.6	940	238.1	109.9
392	78000	LHS	NH 129	40	0.3824	0.2965	0.1448	0.0918	0.0685	0.0488	0.0191	38.5	1057.2	247.5	108
393	79000	RHS	NH 129	40	0.2659	0.1875	0.1014	0.0717	0.0509	0.0412	0.0192	38.5	1074.3	247.3	108
394	79125	LHS	NH 129	40	0.2859	0.2095	0.1008	0.0576	0.0484	0.0374	0.0134	38.5	1073	249.3	108
395	79250	RHS	NH 129	40	0.1338	0.0846	0.055	0.0318	0.0152	0.0068	0.0033	41.6	922.6	236.9	110
396	79375	LHS	NH 129	40	0.2606	0.1778	0.0535	0.0323	0.0206	0.008	0.0031	41.6	917.3	238.8	110
397	79500	RHS	NH 129	40	0.2657	0.2	0.0919	0.0654	0.0557	0.0419	0.0173	38.5	1067.1	248.1	107.9
398	80000	LHS	NH 129	40	0.2436	0.148	0.0822	0.044	0.0359	0.0218	0.0111	38.5	1067.1	249.5	108
399	80125	RHS	NH 129	40	0.3007	0.2182	0.1041	0.0658	0.0436	0.0393	0.0181	38.5	1075	248.4	108
400	80250	LHS	NH 129	40	0.3101	0.2256	0.1135	0.0731	0.0579	0.0426	0.0158	38.5	1071	249.9	108
401	80375	RHS	NH 129	40	0.3613	0.2753	0.1512	0.0984	0.0788	0.0587	0.0137	38.5	1044.6	249.9	108
402	80500	LHS	NH 129	40	0.3142	0.2428	0.1313	0.0812	0.0578	0.0471	0.0234	38.5	1044.6	249.9	108
403	80625	RHS	NH 129	40	0.2688	0.1725	0.0747	0.0519	0.0371	0.0236	0.0092	39	1000.9	281	112
404	80750	LHS	NH 129	40	0.3161	0.243	0.1256	0.0886	0.0637	0.0499	0.0253	39	1000.9	281	112
405	80875	RHS	NH 129	40	0.3207	0.2475	0.1223	0.0787	0.0659	0.0415	0.0162	39	994.9	292.7	112
406	81000	LHS	NH 129	40	0.3598	0.2918	0.1675	0.1152	0.0866	0.0565	0.0225	39	977.2	296	112
407	81125	RHS	NH 129	40	0.3289	0.2577	0.1387	0.0874	0.0631	0.0496	0.0241	39	980.8	295.4	112
408	81250	LHS	NH 129	40	0.4268	0.3384	0.1656	0.1073	0.0756	0.0542	0.0134	39	1004.4	215.8	112
409	81375	RHS	NH 129	40	0.3155	0.2256	0.1201	0.0922	0.0575	0.045	0.0132	39	989.6	293.8	112
410	81500	LHS	NH 129	40	0.3241	0.247	0.1346	0.0874	0.0646	0.0485	0.0093	39	1000.9	231.5	112
411	81625	RHS	NH 129	40	0.2348	0.1797	0.0927	0.0606	0.0411	0.0316	0.0061	39	1000.9	238.1	112
412	81750	LHS	NH 129	40	0.2043	0.1628	0.1046	0.0643	0.0544	0.0426	0.018	39	1000.9	238.1	112
413	81875	RHS	NH 129	40	0.2729	0.2095	0.1108	0.0776	0.0539	0.0471	0.0171	39	1005	292.2	112
414	82000	LHS	NH 129	40	0.2956	0.188	0.1166	0.0934	0.0481	0.0291	0.0104	39	995.5	289.3	112
415	82125	RHS	NH 129	40	0.3045	0.2288	0.143	0.0726	0.0601	0.0352	0.0194	39	973.7	294.8	112
416	82250	LHS	NH 129	40	0.2417	0.1883	0.1031	0.065	0.0456	0.0343	0.0042	41.6	913.1	237.6	110
417	82375	RHS	NH 129	40	0.2273	0.1702	0.0878	0.0538	0.0354	0.025	0.0096	41.6	902.5	237	110

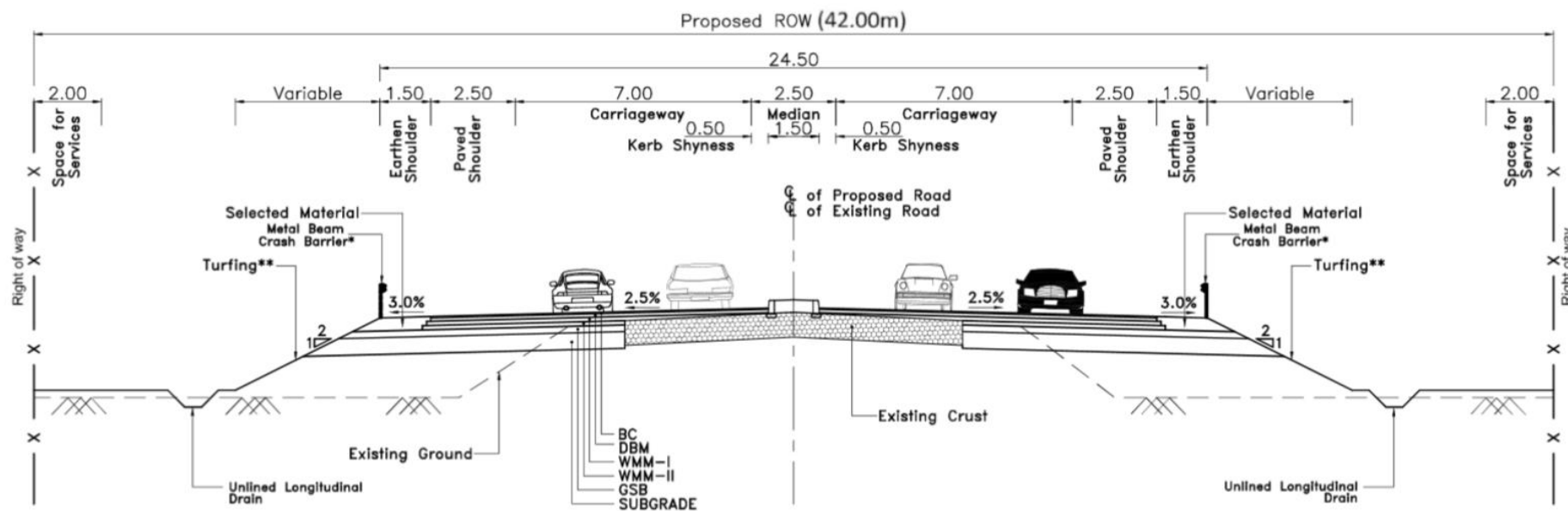
Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
418	82500	LHS	NH 129	40	0.2522	0.1973	0.1095	0.0695	0.052	0.0397	0.0256	41.6	938.9	239	109.9
419	82625	RHS	NH 129	40	0.2962	0.2144	0.0958	0.0535	0.0331	0.0266	0.0028	42	928.4	230.5	110
420	82750	LHS	NH 129	40	0.25	0.1732	0.0676	0.0449	0.0335	0.0161	0.0061	42	930.5	238	110
421	82875	RHS	NH 129	40	0.2652	0.2094	0.1128	0.0684	0.0428	0.0372	0.0138	42	912	238.9	109.9
422	83000	LHS	NH 129	40	0.3371	0.2282	0.0899	0.0481	0.0339	0.017	0.0083	42	905.2	237.8	110
423	83125	RHS	NH 129	40	0.1923	0.1311	0.1003	0.0738	0.0468	0.0236	0.0089	42	919.9	238.7	110
424	83250	LHS	NH 129	40	0.2501	0.1944	0.091	0.0546	0.0389	0.0283	0.0109	42	928.4	237.9	109.9
425	83375	RHS	NH 129	40	0.3038	0.2173	0.0905	0.0627	0.0517	0.0393	0.0196	42	922.1	239	110
426	83500	LHS	NH 129	40	0.2513	0.1845	0.0904	0.0557	0.0351	0.024	0.0089	42	935.8	238.9	110
427	83625	RHS	NH 129	40	0.3782	0.2773	0.1277	0.0747	0.0529	0.0348	0.019	42	907.3	238.2	110
428	83750	LHS	NH 129	40	0.2137	0.1695	0.0858	0.0487	0.0296	0.0204	0.005	42	915.2	238.9	110
429	83875	RHS	NH 129	40	0.1981	0.1547	0.082	0.0533	0.038	0.0261	0.0159	42	933.1	238.9	110
430	84000	LHS	NH 129	40	0.2293	0.1811	0.0852	0.048	0.0304	0.0184	0.0079	42	905.2	238.5	110
431	84125	RHS	NH 129	40	0.2313	0.1613	0.0676	0.0351	0.024	0.0135	0.0066	42	907.3	237.4	110
432	84250	LHS	NH 129	40	0.2413	0.1754	0.0876	0.0538	0.0366	0.0239	0.0082	42	918.4	238	110
433	84375	RHS	NH 129	40	0.1315	0.0796	0.0533	0.0313	0.0153	0.0064	0.0032	42	935.2	237.6	110
434	84500	LHS	NH 129	40	0.2708	0.1926	0.0762	0.0526	0.0363	0.0302	0.016	39	981.9	295.8	112
435	85000	RHS	NH 129	40	0.3656	0.263	0.1547	0.0953	0.0709	0.0569	0.0276	39	1000.3	294.8	112
436	85125	LHS	NH 129	40	0.2686	0.1868	0.0715	0.0495	0.0417	0.0311	0.0133	39	980.8	291.2	112
437	85250	RHS	NH 129	40	0.2574	0.1868	0.0927	0.0528	0.0318	0.0291	0.0103	42	936.8	236.4	110
438	85375	LHS	NH 129	40	0.2786	0.2065	0.1092	0.0664	0.047	0.0336	0.0096	42	938.9	239	110
439	85500	RHS	NH 129	40	0.4138	0.3006	0.1525	0.0915	0.0668	0.0463	0.0237	39	1002	291.5	112
440	87000	LHS	NH 129	40	0.3757	0.3012	0.1454	0.087	0.0654	0.0494	0.0179	39	1005	287	112
441	87125	RHS	NH 129	40	0.3113	0.2339	0.1243	0.0911	0.0586	0.0449	0.0127	39.5	1001.5	291.7	112
442	87250	LHS	NH 129	40	0.2301	0.1623	0.0857	0.0603	0.0457	0.0378	0.0071	39.5	996.7	279.7	112
443	87375	RHS	NH 129	40	0.319	0.2401	0.1121	0.0715	0.0461	0.0425	0.0193	39.5	991.4	295.9	112
444	87500	LHS	NH 129	40	0.2363	0.1819	0.1017	0.0679	0.0494	0.0377	0.0134	39.5	953	294.9	112
445	87625	RHS	NH 129	40	0.3636	0.2665	0.1535	0.0974	0.0709	0.0566	0.0279	39.5	1001.5	294.8	112
446	87750	LHS	NH 129	40	0.3233	0.2418	0.1294	0.0836	0.0555	0.048	0.0165	39.5	1003.8	264.3	116
447	87875	RHS	NH 129	40	0.3746	0.2809	0.1441	0.0881	0.0627	0.0442	0.0223	39.5	999.7	230.3	116

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
448	88000	LHS	NH 129	40	0.3374	0.2648	0.1451	0.0988	0.0782	0.0601	0.0226	39.5	999.7	230.3	116
449	88125	RHS	NH 129	40	0.3422	0.2616	0.1411	0.0853	0.0596	0.0507	0.0258	39.5	990.8	299.7	116
450	88250	LHS	NH 129	40	0.278	0.2157	0.109	0.0711	0.0468	0.0345	0.0147	39.5	1003.2	283.1	116
451	88375	RHS	NH 129	40	0.294	0.1852	0.1209	0.0919	0.0486	0.0302	0.0104	39.5	981.3	201.4	116
452	88500	LHS	NH 129	40	0.3531	0.2731	0.1481	0.0969	0.0779	0.0558	0.0135	39.5	986.7	200.9	116
453	88625	RHS	NH 129	40	0.3834	0.3049	0.1669	0.0953	0.0803	0.042	0.0216	39.5	999.1	198	116
454	88750	LHS	NH 129	40	0.362	0.2859	0.1469	0.0955	0.069	0.052	0.0164	39.5	992.6	198.4	116
455	88875	RHS	NH 129	40	0.3064	0.2268	0.1306	0.0912	0.065	0.058	0.029	39.5	982.5	306.6	116
456	89000	LHS	NH 129	40	0.3117	0.2256	0.1059	0.062	0.0421	0.0251	0.0071	39.5	1003.8	197.9	116
457	89125	RHS	NH 129	40	0.2883	0.2094	0.1147	0.0796	0.0609	0.0501	0.0177	39.5	994.9	306.8	116
458	89250	LHS	NH 129	40	0.305	0.2228	0.1407	0.0722	0.0609	0.0344	0.0196	39.5	1005	298.8	116
459	89375	RHS	NH 129	40	0.3392	0.2539	0.1331	0.0929	0.0666	0.0533	0.0271	39.5	988.4	307.9	116
460	89500	LHS	NH 129	40	0.3193	0.2492	0.1241	0.0879	0.0609	0.0485	0.0179	39.5	1001.5	330.6	113
461	89625	RHS	NH 129	40	0.2821	0.1902	0.1027	0.0604	0.0293	0.0217	0.0114	39.5	1001.5	228.1	113
462	89750	LHS	NH 129	40	0.379	0.2909	0.1438	0.0905	0.067	0.0488	0.0188	39.9	1002	244.9	113
463	89875	RHS	NH 129	40	0.2546	0.1816	0.0872	0.0574	0.0331	0.03	0.0116	42	933.7	237.2	110
464	90000	LHS	NH 129	40	0.2607	0.2072	0.0962	0.0588	0.0421	0.0301	0.0115	42	917.8	238.2	110
465	90125	RHS	NH 129	40	0.2312	0.1731	0.092	0.0614	0.0431	0.0287	0.0147	42	933.1	234.9	110
466	90250	LHS	NH 129	40	0.2397	0.1822	0.0923	0.0538	0.0331	0.0187	0.0067	42	933.7	238.6	110
467	90375	RHS	NH 129	40	0.2691	0.1926	0.0886	0.0524	0.038	0.0299	0.0103	42	934.2	239	109.9
468	90500	LHS	NH 129	40	0.2118	0.1648	0.0839	0.0521	0.0352	0.0205	0.0075	42.7	902.5	238.4	110
469	90625	RHS	NH 129	40	0.241	0.1706	0.0694	0.0435	0.0271	0.0113	0.0055	42.7	931	235.3	110
470	90750	LHS	NH 129	40	0.2552	0.1898	0.087	0.0517	0.0351	0.0239	0.0121	42.7	937.4	238	109.8
471	90875	RHS	NH 129	40	0.2664	0.1994	0.0824	0.0546	0.0366	0.0273	0.0115	42.7	931	238.5	110
472	91000	LHS	NH 129	40	0.3665	0.2653	0.1088	0.0595	0.0447	0.0291	0.0144	42.7	930.5	238.7	110
473	91125	RHS	NH 129	40	0.2079	0.1444	0.07	0.0497	0.0405	0.033	0.0081	42.7	937.4	238.9	110
474	91250	LHS	NH 129	40	0.2508	0.2029	0.1061	0.0599	0.0393	0.0287	0.0087	42.7	936.8	237.4	110
475	91375	RHS	NH 129	40	0.2954	0.2328	0.1138	0.0692	0.0509	0.0394	0.0279	42.7	934.7	238.6	109.7
476	91500	LHS	NH 129	40	0.2698	0.2165	0.1139	0.0638	0.0416	0.031	0.0094	42.7	919.4	238.1	109.9
477	91625	RHS	NH 129	40	0.3299	0.243	0.1283	0.0714	0.0451	0.0325	0.0162	42.7	930.5	238.4	109.9

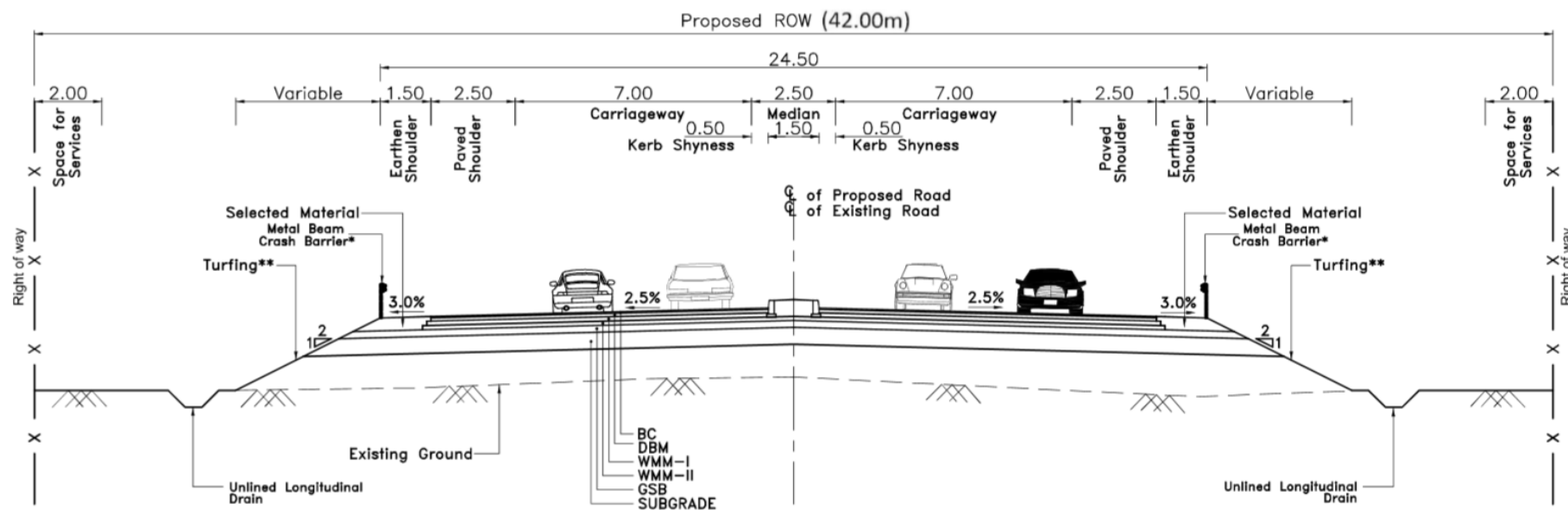
Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
478	91750	LHS	NH 129	40	0.2114	0.1598	0.0698	0.0375	0.021	0.0107	0.0052	42.7	898.8	238.1	110
479	91875	RHS	NH 129	40	0.2749	0.2091	0.0969	0.0584	0.0381	0.0208	0.0099	42.7	928.4	238.9	110
480	92000	LHS	NH 129	40	0.1504	0.1122	0.0398	0.0285	0.0207	0.0164	0.0062	42.7	934.2	237.7	110
481	92125	RHS	NH 129	40	0.3378	0.265	0.1121	0.0538	0.0341	0.025	0.0122	42.7	910.4	234.8	110
482	92250	LHS	NH 129	40	0.2464	0.186	0.0825	0.0474	0.0297	0.0262	0.0089	42.7	902.5	317.4	107
483	92375	RHS	NH 129	40	0.296	0.2325	0.1033	0.0551	0.0365	0.0213	0.0102	42.7	910.4	279.5	107
484	92500	LHS	NH 129	40	0.3165	0.2201	0.1022	0.0473	0.0273	0.0189	0.0092	42.7	924.2	205.8	107
485	92625	RHS	NH 129	40	0.1369	0.0856	0.0567	0.0324	0.0154	0.0068	0.0033	42.7	929.4	216.4	107
486	92750	LHS	NH 129	40	0.1778	0.1301	0.0727	0.0502	0.0341	0.0236	0.0088	42.7	911.5	318	107
487	92875	RHS	NH 129	40	0.3317	0.2391	0.1189	0.0835	0.0541	0.0366	0.0119	39.9	981.3	221.1	113
488	93000	LHS	NH 129	40	0.1873	0.1523	0.0939	0.0652	0.0393	0.0326	0.0188	37.4	1263.893	233	96.9
489	93250	RHS	NH 129	40	0.17	0.1291	0.079	0.0415	0.0343	0.0206	0.0116	37.4	1226.005	232.1	97
490	93500	LHS	NH 129	40	0.2103	0.1558	0.079	0.055	0.0441	0.0382	0.0286	37.4	1253.418	233	97
491	93750	RHS	NH 129	40	0.2797	0.2073	0.1157	0.0674	0.0481	0.0335	0.0095	37.4	1145.438	232.6	97
492	94000	LHS	NH 129	40	0.1521	0.1216	0.0719	0.0503	0.0375	0.0293	0.0091	37.4	1209.847	232.3	97
493	94250	RHS	NH 129	40	0.1203	0.1081	0.0546	0.0299	0.0217	0.016	0.0053	37.4	1142.206	231.8	97
494	94500	LHS	NH 129	40	0.1867	0.1453	0.0773	0.0502	0.0352	0.0249	0.0151	37.4	1253.418	232.8	96.9
495	94750	RHS	NH 129	40	0.3752	0.278	0.1243	0.0833	0.0569	0.0392	0.0308	37.4	1204.275	232.4	97
496	95000	LHS	NH 129	40	0.1663	0.1289	0.0738	0.0486	0.0366	0.0098	0.0049	37.4	1267.904	231.6	97
497	95250	RHS	NH 129	40	0.3789	0.2744	0.1044	0.0499	0.0333	0.0201	0.0111	37.4	1219.542	226.8	97
498	95500	LHS	NH 129	40	0.2116	0.1678	0.0821	0.0562	0.04	0.0328	0.019	37.4	1268.796	232.9	97
499	95750	RHS	NH 129	40	0.2229	0.178	0.0982	0.0612	0.0477	0.0367	0.032	37.4	1265.564	232.7	97
500	96000	LHS	NH 129	40	0.3758	0.2815	0.1381	0.0797	0.0552	0.0413	0.0145	34.7	1335.414	267.5	112
501	96250	RHS	NH 129	40	0.3719	0.281	0.1164	0.0642	0.0346	0.0221	0.0084	34.7	1365.118	262.2	112
502	96500	LHS	NH 129	40	0.3574	0.266	0.13	0.0749	0.0483	0.0393	0.0128	36.4	1267.941	267.6	112
503	96750	RHS	NH 129	40	0.2244	0.1735	0.0742	0.0412	0.0292	0.0215	0.0065	36.4	1281.462	266.6	112
504	97000	LHS	NH 129	40	0.3541	0.2696	0.1343	0.0751	0.047	0.0395	0.0129	34.1	1328.841	277.7	112
505	97250	RHS	NH 129	40	0.4478	0.3541	0.1443	0.0741	0.0469	0.0309	0.0113	36.4	1267.941	258.5	112
506	97500	LHS	NH 129	40	0.4462	0.3054	0.1282	0.089	0.0682	0.0485	0.0179	34.1	1256.842	273.8	112
507	97750	RHS	NH 129	40	0.3273	0.2278	0.0957	0.0619	0.0498	0.0368	0.0088	36.4	1284.762	277.2	112

Sl No.	Chainage	Side	Road Stretch	Load (kN)	Geophone 1 (mm)	Geophone 2 (mm)	Geophone 3 (mm)	Geophone 4 (mm)	Geophone 5 (mm)	Geophone 6 (mm)	Geophone 7 (mm)	Manual Temp. (°C)	Back Calculated Moduli		
													BT	Granular	Subgrade
508	98000	LHS	NH 129	40	0.2893	0.1779	0.0777	0.0457	0.0383	0.0251	0.0037	34.1	1332.493	227.1	112
509	98250	RHS	NH 129	40	0.2223	0.1722	0.0739	0.0452	0.0338	0.0198	0.0099	36.4	1200.552	276.7	112
510	98500	LHS	NH 129	40	0.4424	0.343	0.1452	0.073	0.0458	0.0312	0.0109	34.1	1327.879	263.6	112
511	98750	RHS	NH 129	40	0.5866	0.4445	0.1764	0.0831	0.0575	0.0468	0.0164	34.1	1328.841	226.4	112
512	99000	LHS	NH 129	40	0.4013	0.3209	0.1407	0.0742	0.0448	0.036	0.0176	34.1	1333.455	275	112
513	99250	RHS	NH 129	40	0.4795	0.37	0.1841	0.1019	0.0712	0.0551	0.0289	36.4	1257.827	275.8	112
514	99500	LHS	NH 129	40	0.5023	0.3681	0.1643	0.088	0.0604	0.0474	0.0239	36.4	1269.644	276.4	112
515	99750	RHS	NH 129	40	0.4227	0.3078	0.1278	0.0662	0.0379	0.0263	0.0116	37	1190.999	269.9	112
516	100000	LHS	NH 129	40	0.6458	0.4761	0.1609	0.0828	0.0708	0.0413	0.0218	34.1	1329.706	206.6	112
517	100250	RHS	NH 129	40	0.3958	0.3183	0.1514	0.0916	0.0575	0.0371	0.0185	34.1	1331.628	277.2	112
518	100500	LHS	NH 129	40	0.3042	0.1983	0.0626	0.0416	0.0313	0.0216	0.0105	37	1240.888	275	112
519	100750	RHS	NH 129	40	0.4189	0.3109	0.1365	0.0759	0.0392	0.0299	0.009	34.1	1311.057	249.3	112
520	101000	LHS	NH 129	40	0.4033	0.3134	0.1485	0.0847	0.0599	0.0503	0.0101	37	1212.442	271.8	112
521	101250	RHS	NH 129	40	0.3384	0.2679	0.1331	0.084	0.0528	0.0454	0.0227	34.1	1266.167	277.4	112
522	101500	LHS	NH 129	40	0.3447	0.2608	0.1292	0.0657	0.0476	0.0255	0.0102	37	1171.306	278	112
523	101750	RHS	NH 129	40	0.5663	0.399	0.1692	0.0728	0.0521	0.0461	0.0223	34.1	1303.56	232.3	112
524	102000	LHS	NH 129	40	0.2945	0.1894	0.0786	0.0465	0.0323	0.0267	0.0132	37	1211.567	275.8	112

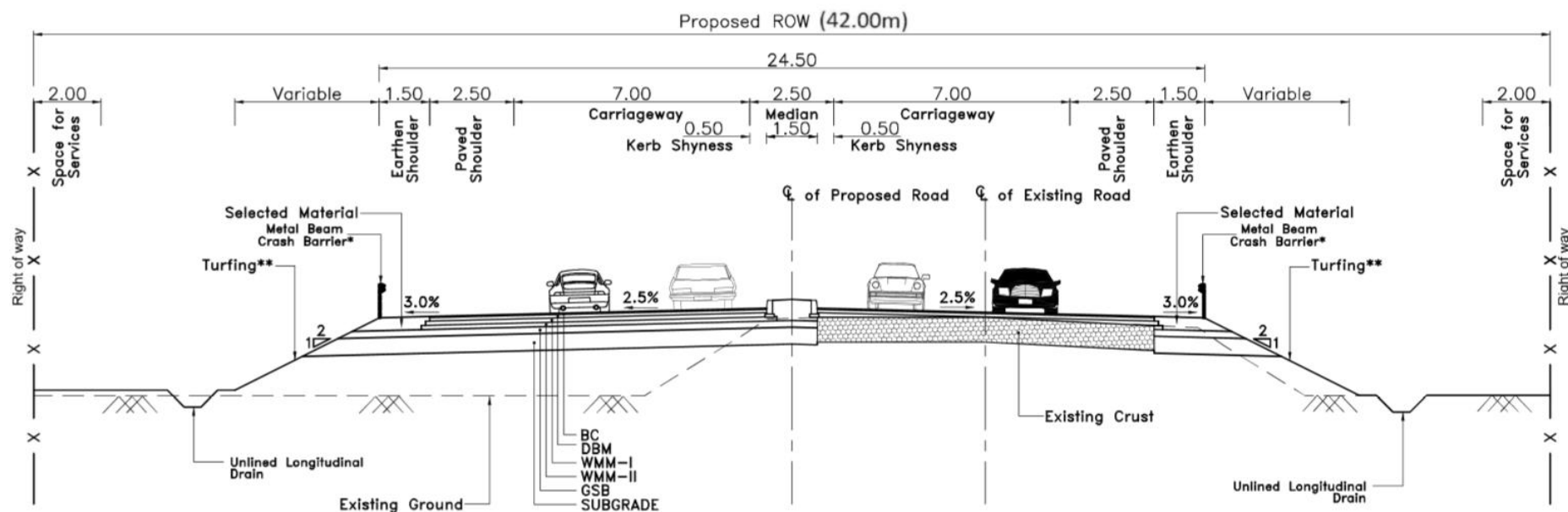
Annexure 6.1: Typical Cross Sections (Roads)



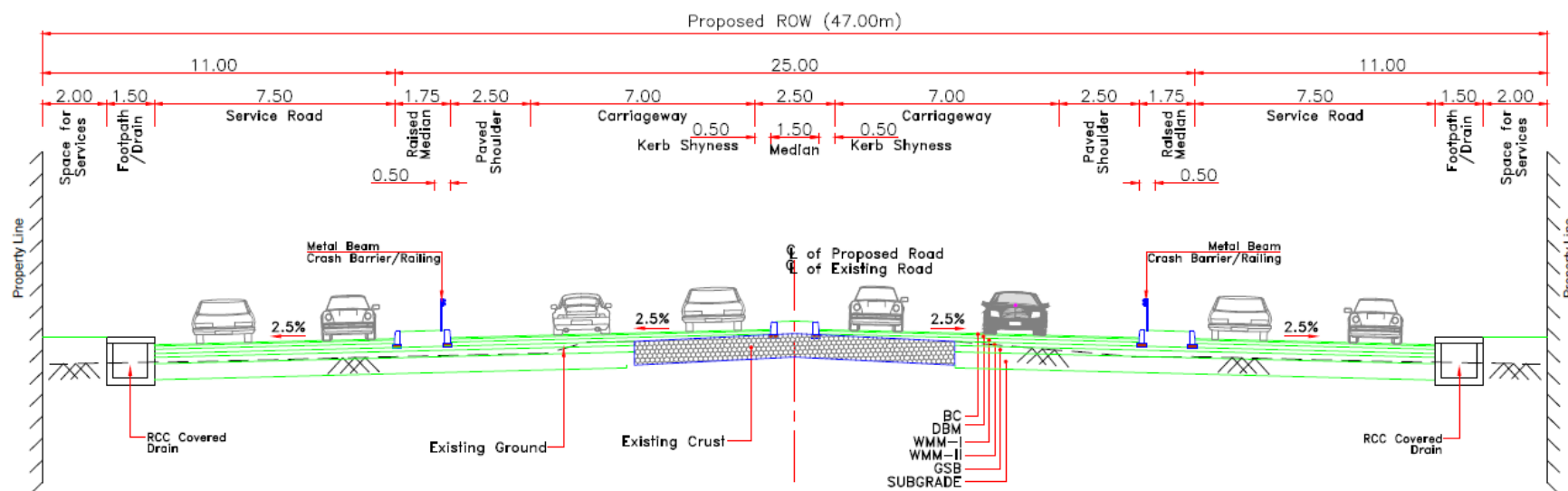
TYPE-1 : TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN IN RURAL AREA (CONCENTRIC WIDENING)



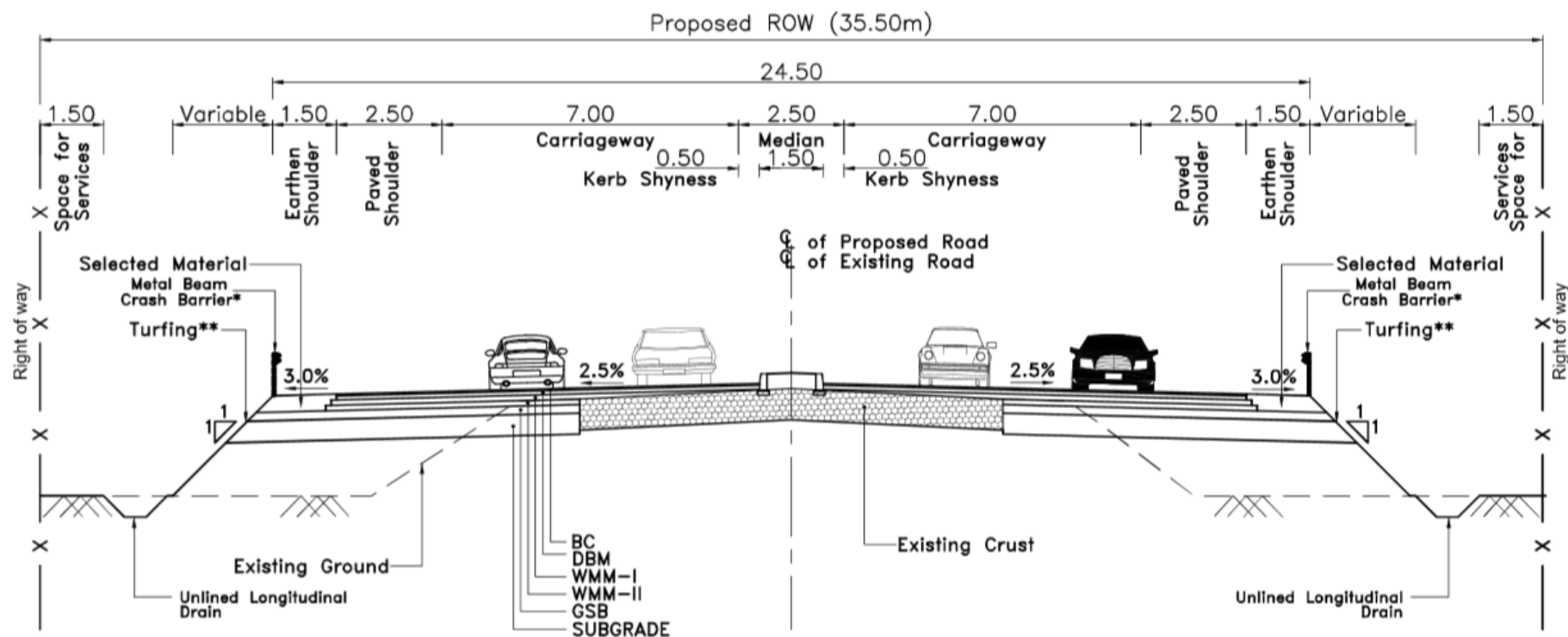
TYPE-1A : TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN IN BYPASS/REALIGNMENT STRETCHES



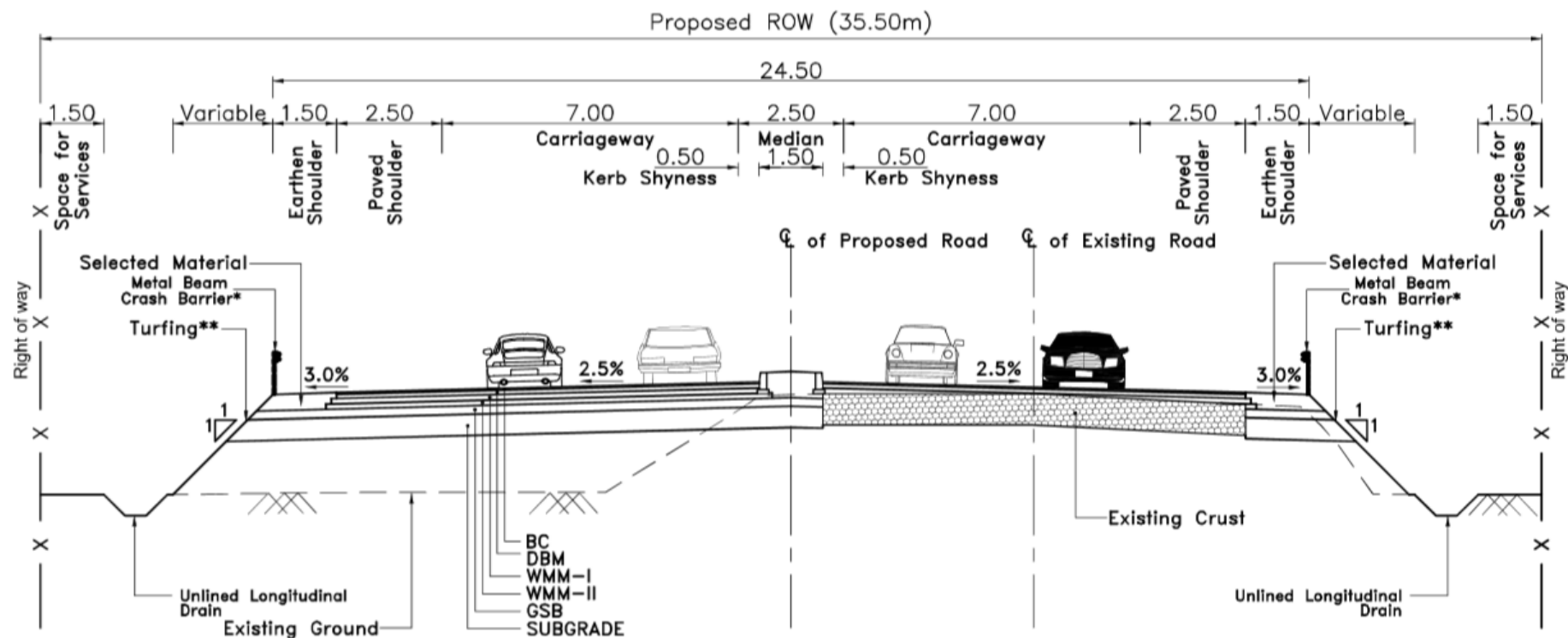
TYPE-2 : TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN IN RURAL AREA (ECCENTRIC WIDENING)



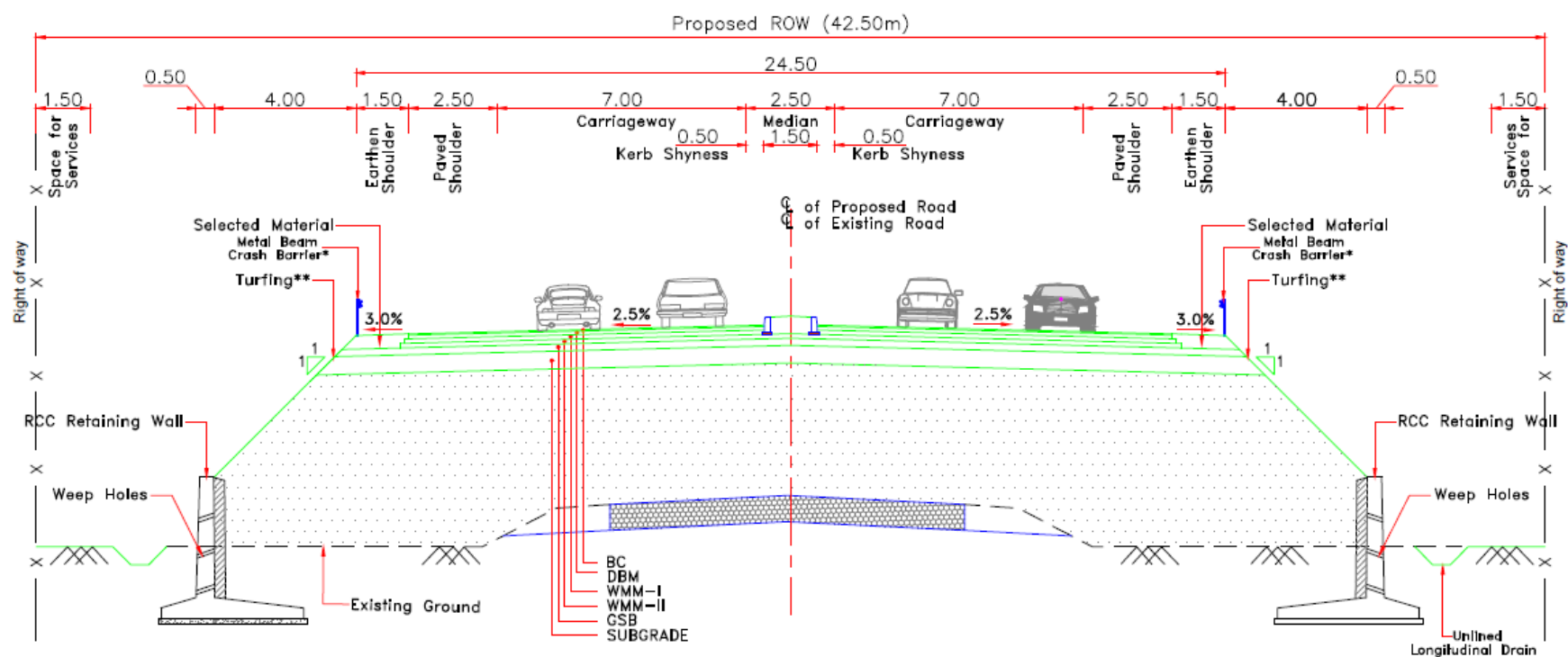
TYPE-3 : TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN AND WITH SERVICE ROAD ON BOTH SIDES IN BUILT UP AREA



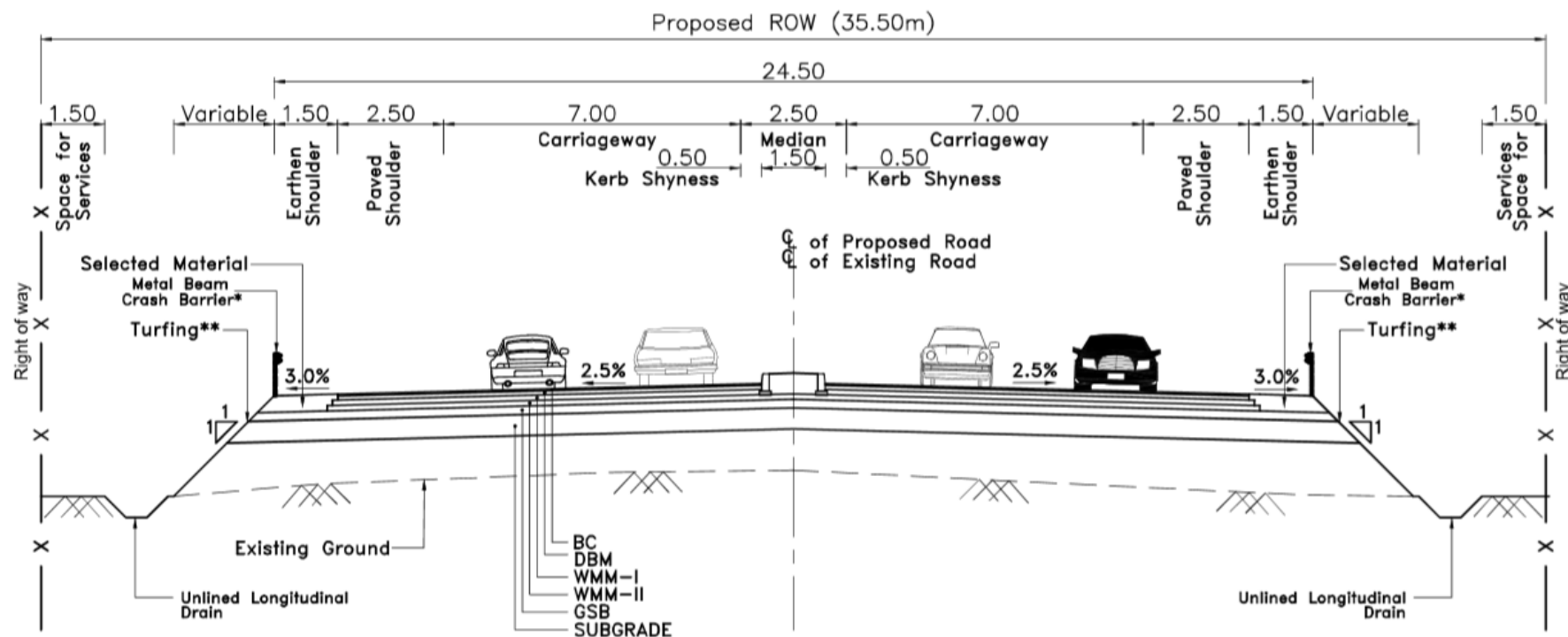
TYPE-4 : TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN WITH MINIMUM LAND ACQUISITION (CONCENTRIC WIDENING)



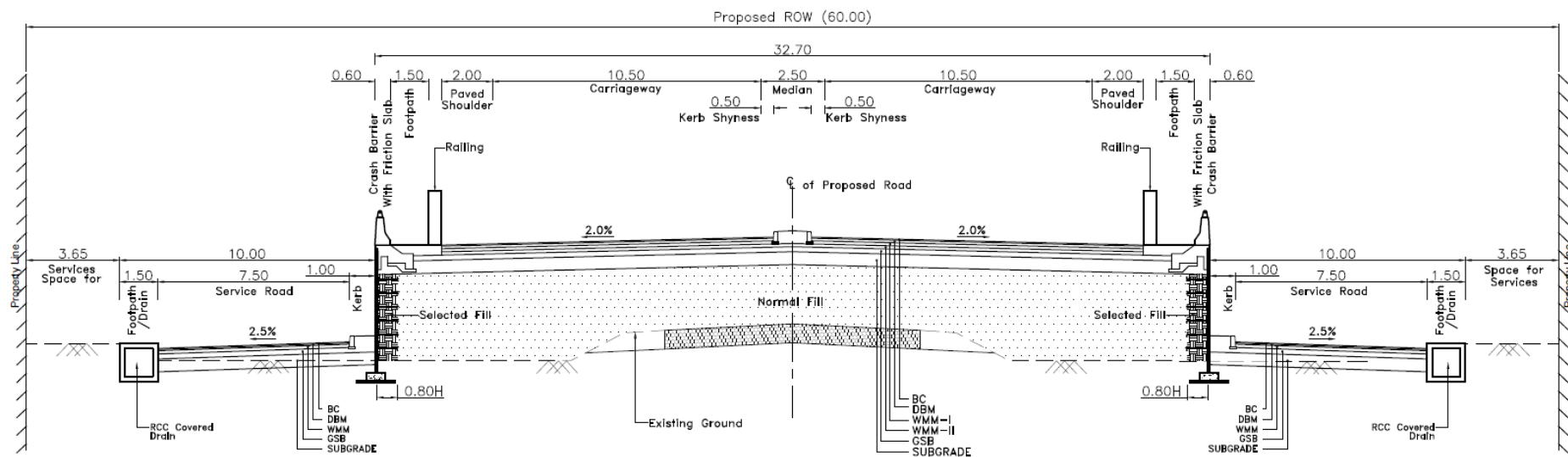
TYPE-4A : TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN WITH MINIMUM LAND ACQUISITION (ECCENTRIC WIDENING)



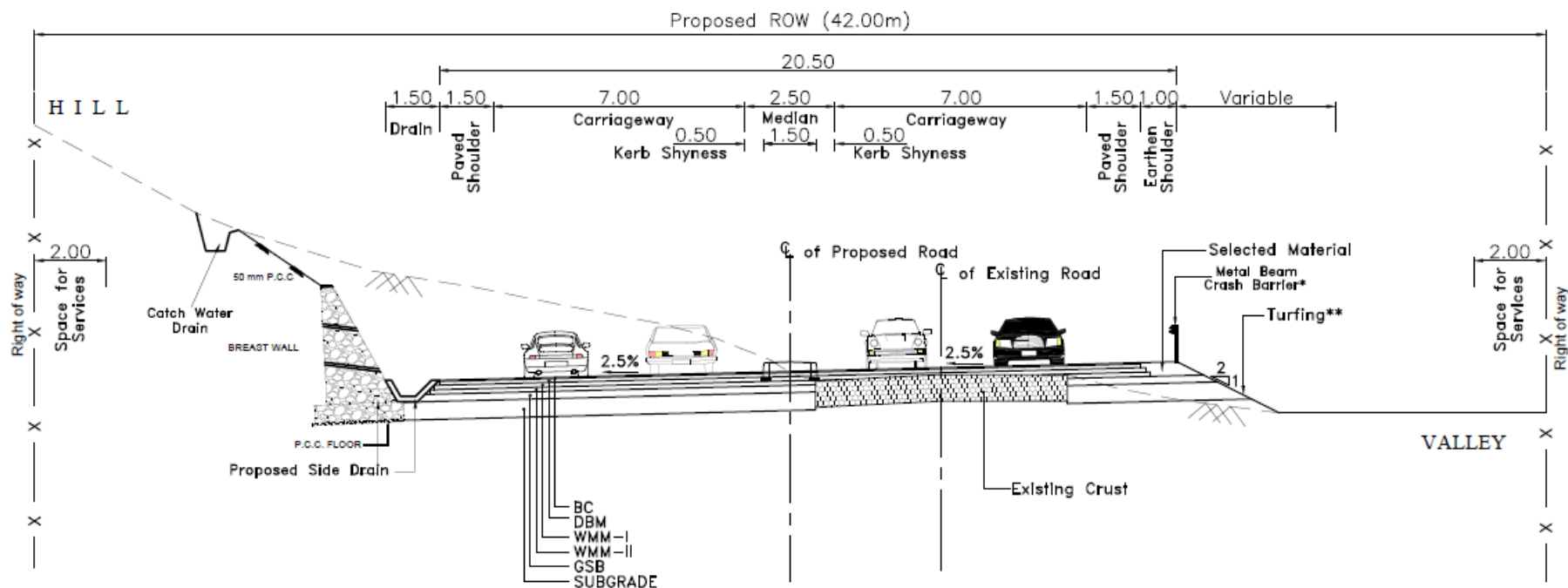
TYPE-5 : TYPICAL CROSS SECTION OF APPROACHES OF ELEPHANT UNDERPASSES (FOREST AREA)



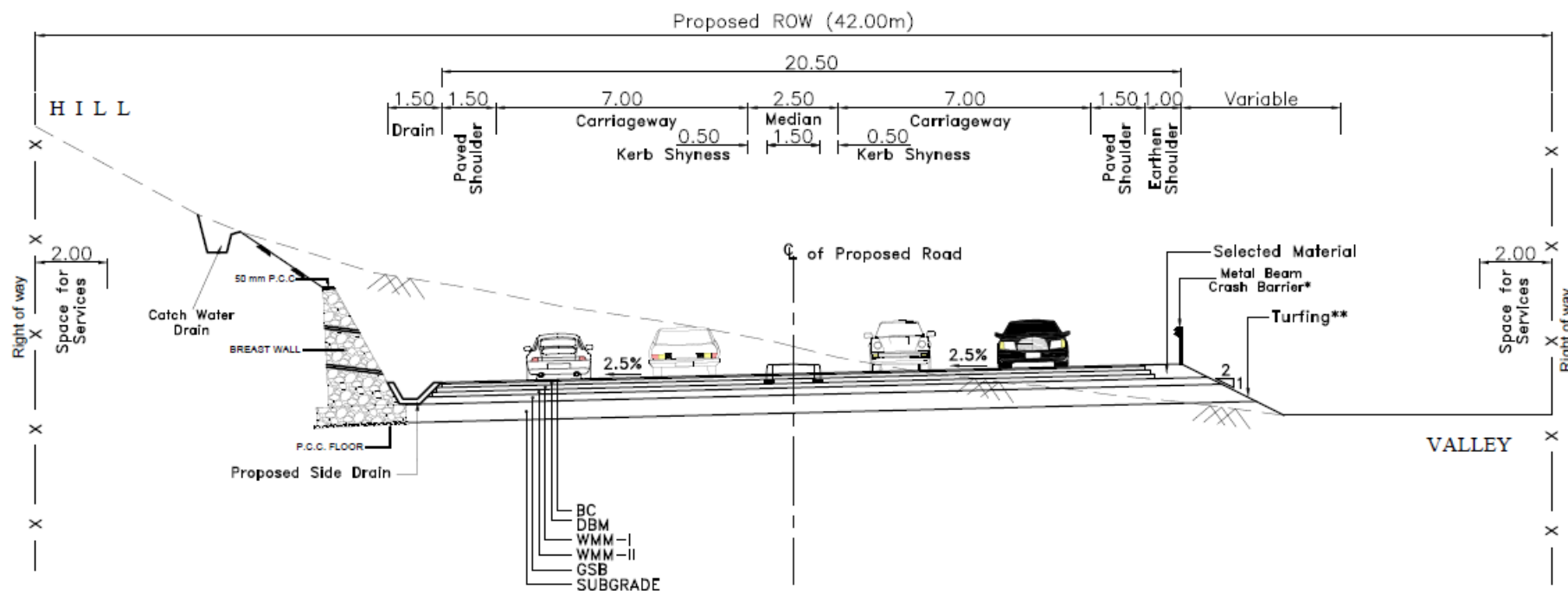
TYPE-6 : TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN WITH MINIMUM LAND ACQUISITION (NEW CONSTRUCTION)



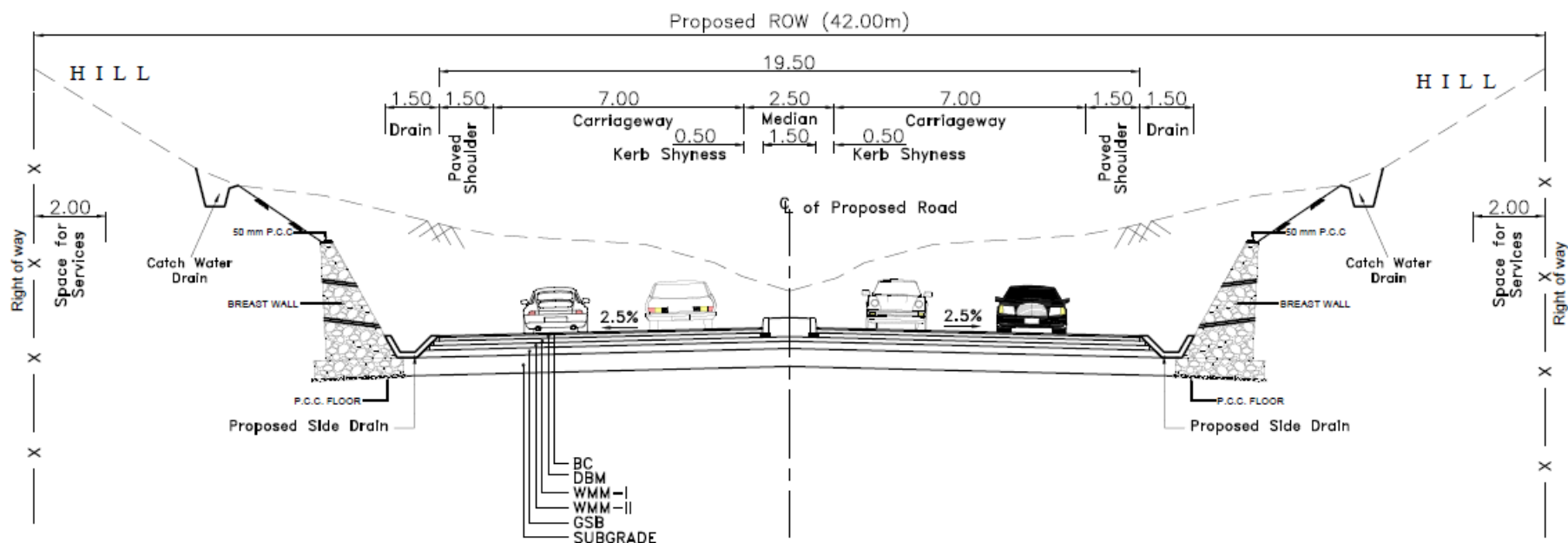
**TYPE-07 : TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY AT GRADE SEPARATOR
 APPROACHES WITH SERVICE ROAD AND RE WALL ON BOTH SIDES**



TYPE-08 : TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN (NEW CONSTRUCTION) IN CUT SECTION ONE SIDE(Mountainous Terrain One Side - Hill and One Side - Valley)



TYPE-08A : TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN (NEW CONSTRUCTION) IN CUT SECTION ONE SIDE(Mountainous Terrain One Side - Hill and One Side - Valley)



TYPE-09 : TYPICAL CROSS SECTION OF 4-LANE DIVIDED CARRIAGEWAY WITH 1.5M WIDE RAISED MEDIAN (NEW CONSTRUCTION) IN CUT SECTION BOTH SIDE

Annexure 6.2: Horizontal Alignment Report																					
Element ID	ELEMENT DETAILS								Transition Details				Horizontal Intersection Point (HIP)			Deflectin Angle			Speed (Kmph)	Superelevation	Extra Widening (m)
	Start Chainage	End Chainage	Start Easting	Start Northing	End Easting	End Northing	Radius (m)	Direction	Start Chainage	L1	L2	End Chainage	Chainage	Easting	Northing	Deg	Min	Sec			
Section-6																					
1	113+988.151	114+149.158	535179.082	2875089.674	535338.992	2875087.687	400	Left	113+873.151	55	55	114+264.158	114069.759	535258.835	2875072.368	23	3	45.082	65	4.7%	-
2	114+494.776	114+638.347	535667.243	2875195.247	535801.149	2875246.948	2000	Left					114566.592	535735.124	2875218.693	4	6	46.826	100	-	-
3	114+729.298	114+797.288	535885.886	2875279.816	535952.797	2875291.03	300	Right	114+654.298	115	115	114+872.288	114763.44	535918.704	2875289.231	12	59	6.432	80	5.0%	0.6
4	115+135.652	115+283.236	536290.494	2875273.065	536428.729	2875319.675	280	Left	115+060.652	75	75	115+358.236	115211.201	536365.9	2875277.721	30	11	59.633	65	5.0%	0.6
5	115+572.340	115+809.879	536645.844	2875510.241	536736.932	2875724.704	350	Left	115+497.340	75	75	115+884.879	115695.888	536729.24	2875601.396	38	53	7.987	80	5.0%	-
6	116+013.112	116+283.112	536733.621	2875927.79	536865.59	2876152.945	300	Right	115+938.112	75	75	116+358.112	116158.028	536745.224	2876072.242	51	33	58.592	80	5.0%	0.6
7	116+469.346	116+498.639	537029.9	2876240.414	537054.541	2876256.243	400	Left	116+414.346	75	75	116+553.639	116483.999	537042.511	2876247.877	4	11	45.535	80	5.0%	-
8	116+701.349	116+869.180	537213.393	2876382.135	537348.526	2876481.581	2000	Right					116785.314	537278.872	2876434.695	4	48	28.752	100	-	-
9	117+030.759	117+065.180	537480.727	2876574.331	537505.309	2876598.399	300	Left	116+955.759	55	55	117+140.180	117047.988	537493.709	2876585.659	6	34	25.951	65	5.0%	0.6
10	117+266.947	117+295.891	537627.719	2876758.467	537650.447	2876776.332	170	Right	117+196.947	75	75	117+365.891	117281.454	537638.321	2876768.369	9	45	18.176	65	5.0%	0.6
11	117+445.421	117+576.309	537785.515	2876839.821	537858.11	2876944.853	170	Left	117+375.421	70	70	117+646.309	117514.302	537843.091	2876877.63	44	6	49.164	65	5.0%	0.6
12	117+733.663	117+827.996	537868.08	2877101.652	537904.455	2877187.744	200	Right	117+673.663	70	70	117+887.996	117781.724	537875.923	2877149.069	27	1	27.701	65	5.0%	0.6
13	118+205.926	118+352.617	538167.241	2877459.077	538225.945	2877591.919	300	Left	118+130.926	60	60	118+427.617	118280.769	538213.164	2877518.175	28	0	57.689	65	5.0%	0.6
14	118+620.921	119+273.526	538242.819	2877859.584	538710.232	2878207.352	400	Right	118+565.921	75	75	119+328.526	119045.976	538291.749	2878281.813	93	28	43.73	80	5.0%	-
15	119+706.498	119+888.656	539130.138	2878102.122	539238.268	2877966.352	170	Right	119+666.498	55	55	119+928.656	119807.423	539224.505	2878066.334	61	23	35.901	65	5.0%	0.6
16	119+954.198	120+055.636	539241.489	2877900.921	539267.626	2877803.572	260	Left	119+929.198	40	40	120+080.636	120005.57	539244.94	2877849.664	22	21	14.063	65	5.0%	0.6
17	120+215.572	120+308.992	539343.316	2877662.736	539353.722	2877571.076	170	Right	120+175.572	25	25	120+348.992	120263.494	539361.438	2877618.373	31	29	7.726	65	5.0%	0.6
18	120+412.470	120+462.294	539328.231	2877470.852	539327.478	2877421.211	170	Left	120+372.470	40	40	120+502.294	120437.562	539324.191	2877446.087	16	47	33.041	65	5.0%	0.6
19	120+634.957	120+648.424	539365.443	2877252.886	539366.809	2877239.49	300	Right	120+559.957	40	40	120+723.424	120641.692	539366.276	2877246.203	2	34	18.857	65	5.0%	0.6
20	120+816.339	120+860.614	539365.23	2877071.723	539374.648	2877028.554	200	Left	120+756.339	75	75	120+920.614	120838.567	539367.54	2877049.615	12	41	1.622	65	5.0%	0.6
21	120+994.292	121+122.242	539430.394	2876907.203	539431.101	2876781.425	200	Right	120+934.292	60	60	121+182.242	121060.542	539451.58	2876844.431	36	39	18.373	65	5.0%	0.6
22	121+274.528	121+361.581	539368.392	2876642.817	539360.06	2876556.852	200	Left	121+214.528	60	60	121+421.581	121318.755	539354.721	2876600.756	24	56	20.19	65	5.0%	0.6
23	121+473.057	121+541.145	539386.328	2876448.601	539397.028	2876381.412	500	Right	121+428.057	60	60	121+586.145	121507.154	539393.969	2876415.372	7	48	8.421	80	5.0%	-
24	121+680.117	121+824.412	539406.916	2876242.889	539481.382	2876122.937	200	Left	121+620.117	45	45	121+884.412	121755.566	539421.524	2876168.867	41	20	15.104	65	5.0%	0.6
25	122+016.444	122+292.353	539647.462	2876026.744	539851.582	2875843.426	750	Right	121+951.444	60	60	122+357.353	122155.976	539766.574	2875954.073	21	4	40.235	100	5.0%	-
26	122+471.093	122+491.418	539956.013	2875698.397	539969.198	2875682.931	400	Left	122+416.093	65	65	122+546.418	122481.258	539962.409	2875690.497	2	54	41.019	80	5.0%	-
27	122+617.522	122+715.006	540058.623	2875594.047	540119.641	2875518.219	500	Right	122+592.522	55	55	122+740.006	122666.419	540092.84	2875559.117	11	10	15.081	80	5.0%	-
28	122+829.890	122+913.966	540184.28	2875423.473	540254.679	2875379.089	170	Left	122+759.890	25	25	122+983.966	122872.806	540213.877	2875392.395	28	20	11.792	65	5.0%	0.6
29	123+065.464	123+139.998	540404.472	2875357.993	540478.887	2875354.174	900	Left	123+035.464	70	70	123+169.998	123102.752	540441.6	2875354.542	4	44	41.961	100	4.9%	-
30	123+533.314	123+724.601	540872.098	2875353.558	541042.486	2875273.963	300	Right	123+458.314	30	30	123+799.601	123632.335	540970.428	2875341.88	36	31	59.25	65	5.0%	0.6
31	124+057.592	124+183.052	541260.865	2875022.901	541365.362	2874954.401	400	Left	123+942.592	75	75	124+298.052	124120.841	541307.698	2874980.389	17	58	15.206	80	5.0%	-
32	124+681.736	124+761.269	541842.01	2874808.653	541913.403	2874773.795	500	Right	124+586.736	95	95	124+856.269	124721.587	541879.096	2874794.069	9	6	49.494	100	5.0%	-
33	124+924.292	124+961.628	542047.67	2874681.433	542080.182	2874663.105	400	Left	124+869.292	115	115	125+016.628	124942.973	542063.498	2874671.51	5	20	52.409	100	5.0%	-
34	125+393.859	125+449.814	542478.79	2874496.122	542532.474	2874480.417	600	Left	125+313.859	80	80	125+529.814	125421.857	542505.265	2874487.017	5	20	35.738	100	5.0%	-
35	126+151.860	126+344.915	543222.734	2874353.609	543385.084	2874252.641	400	Right	126+036.860	115	115	126+459.915	126250.306	543316.334	2874323.104	27	39	10.717	100	5.0%	-
36	127+109.669	127+412.769	543843.85	2873641.267	544114.175	2873520.929	400	Left	126+994.669	115	115	127+527.769	127268.913	543955.059	2873527.289	43	24	57.253	100	5.0%	-
37	128+459.980	128+696.116	545156.417	2873618.444	545376.193	2873541.907	400	Right	128+344.980	115	115	128+811.116	128581.601	545277.941	2873613.587	33	49	26.205	100	5.0%	-
38	129+265.483	129+413.517	545783.006	2873144.236	545849.4	2873012.87	400	Right	129+150.483	115	115	129+528.517	129340.357	545828.997	2873084.767	21	12	15.691	100	5.0%	-
39	130+288.753	130+467.037	545979.309	2872147.645	546072.819	287130															

Element ID	ELEMENT DETAILS								Transition Details				Horizontal Intersection Point (HIP)			Deflectin Angle			Speed (Kmph)	Superelevation	Extra Widening (m)
	Start Chainage	End Chainage	Start Easting	Start Northing	End Easting	End Northing	Radius (m)	Direction	Start Chainage	L1	L2	End Chainage	Chainage	Easting	Northing	Deg	Min	Sec			
51	133+255.110	133+282.957	548678.591	2871530.325	548703.332	2871517.545	2000	Right					133269.034	548691.006	2871524.021	0	47	51.933	100	NA	-
52	133+434.874	133+539.807	548840.05	2871451.922	548943.219	2871456.614	170	Left	133+359.874	75	75	133+614.807	133489.072	548892.382	2871437.822	35	21	57.86	65	7.0%	0.6
53	133+790.786	133+861.632	549154.859	2871590.703	549207.107	2871638.46	500	Left	133+695.786	95	95	133+956.632	133826.269	549182.678	2871612.727	8	7	5.965	100	5.0%	-
54	134+190.247	134+206.712	549410.935	2871896.075	549419.592	2871910.079	300	Left	134+140.247	50	50	134+256.712	134198.481	549415.456	2871902.958	3	8	40.823	65	5.0%	0.6
55	134+330.494	134+409.334	549476.46	2872019.848	549544.605	2872054.266	90	Right	134+290.494	40	40	134+449.334	134372.645	549502.473	2872053.015	50	11	28.799	50	7.0%	0.9
56	134+525.443	134+543.940	549659.43	2872038.213	549677.921	2872037.926	250	Left	134+455.443	70	70	134+613.940	134534.696	549668.67	2872037.727	4	14	21.689	65	7.0%	0.6
57	134+695.322	134+917.144	549828.109	2872055.92	550032.985	2871985.001	300	Right	134+620.322	75	75	134+992.144	134811.579	549944.288	2872060.157	42	21	53.72	80	5.0%	0.6
58	135+077.271	135+198.870	550146.369	2871872.171	550258.888	2871831.232	200	Left	135+007.271	70	70	135+268.870	135140.015	550196.206	2871834.052	34	50	8.318	65	7.0%	0.6
59	135+406.745	135+623.724	550465.701	2871849.418	550654.119	2871755.581	255	Right	135+321.745	85	85	135+708.724	135522.292	550581.17	2871845.187	48	45	9.777	80	7.0%	0.6
60	136+207.866	136+386.196	550947.713	2871250.849	551075.598	2871128.686	400	Left	136+152.866	55	55	136+441.196	136298.538	550997.81	2871175.873	25	32	37.942	80	5.0%	-
61	136+639.875	136+709.979	551301.375	2871013.099	551367.036	2870988.702	500	Left	136+594.875	45	45	136+754.979	136674.985	551333.349	2870998.595	8	2	0.17	80	5.0%	-
62	136+831.212	136+883.853	551484.437	2870958.51	551533.733	2870940.154	400	Right	136+791.212	40	40	136+923.853	136857.57	551509.69	2870950.956	7	32	24.879	80	5.0%	-
63	137+243.055	137+300.594	551852.79	2870775.298	551898.973	2870741.061	400	Right	137+168.055	75	75	137+375.594	137271.874	551877.115	2870759.843	8	14	30.735	80	5.0%	-
64	137+462.399	137+698.064	552015.47	2870628.697	552238.697	2870604.51	220	Left	137+392.399	70	70	137+768.064	137592.962	552119.841	2870550.515	61	22	31.377	65	7.0%	0.6
65	137+987.164	138+057.957	552483.128	2870758.529	552549.647	2870782.269	300	Right	137+912.164	75	75	138+132.957	138022.726	552514.98	2870774.342	13	31	13.378	80	5.0%	0.6
66	138+335.327	138+364.337	552824.996	2870814.767	552853.478	2870820.264	600	Left	138+255.327	80	80	138+444.337	138349.834	552839.303	2870817.171	2	46	12.798	100	5.0%	-
67	138+706.213	138+766.789	553180.743	2870918.035	553228.14	2870955.242	170	Left	138+636.213	70	70	138+836.789	138736.826	553207.792	2870932.371	20	24	58.09	65	7.0%	0.6
68	138+923.442	138+935.079	553312.459	2871087.016	553319.773	2871096.483	300	Right	138+853.442	70	70	139+005.407	138929.425	553316.022	2871091.823	2	17	6.386	80	5.0%	0.6
69	139+219.883	139+279.448	553523.907	2871294.063	553578.598	2871316.884	170	Right	139+149.883	70	70	139+349.448	139249.974	553549.233	2871310.314	20	4	31.914	65	7.0%	0.6
70	139+435.598	139+477.929	553734.096	2871327.96	553774.523	2871340.247	200	Left	139+365.598	70	70	139+547.929	139456.843	553754.962	2871331.956	12	7	37.882	65	7.0%	0.6
71	139+655.138	139+696.829	553927.549	2871429.038	553967.869	2871439.221	170	Right	139+585.138	70	70	139+766.829	139676.089	553947.082	2871436.614	14	3	4.103	65	7.0%	0.6
72	139+832.372	139+857.069	554103.15	2871435.116	554127.694	2871437.718	200	Left	139+782.372	50	50	139+907.069	139844.736	554115.502	2871435.658	7	4	30.186	65	7.0%	0.6
73	140+102.104	140+106.811	554361.844	2871509.28	554366.132	2871511.222	300	Left	140+027.104	75	75	140+181.811	140104.457	554363.996	2871510.234	0	53	56.469	80	5.0%	0.6
74	140+275.860	140+329.674	554513.373	2871593.81	554565.959	2871604.136	170	Right	140+205.860	70	70	140+399.674	140302.994	554538.842	2871603.169	18	8	13.565	65	7.0%	0.6
75	140+497.032	140+511.371	554730.313	2871575.878	554743.411	2871570.055	170	Right	140+427.032	70	70	140+581.371	140504.205	554736.985	2871573.243	4	49	57.683	65	7.0%	0.6
76	140+723.130	140+808.186	554914.433	2871445.632	554992.522	2871412.651	300	Left	140+648.130	75	75	140+883.182	140765.943	554951.124	2871423.57	16	14	38.012	80	5.0%	0.6
77	140+984.543	141+011.356	555167.127	2871390.276	555193.76	2871393.195	200	Left	140+914.543	70	70	141+081.356	140997.97	555180.541	2871390.842	7	40	53.012	65	7.0%	0.6
78	141+169.483	141+388.484	555344.276	2871441.153	555559.212	2871426.342	350	Right	141+094.483	75	75	141+463.484	141282.702	555454.139	2871468.511	35	51	3.102	80	5.0%	-
79	141+902.039	142+047.328	556014.117	2871188.196	556152.492	2871145.616	500	Left	141+857.039	45	45	142+092.328	141975.199	556080.19	2871156.782	16	38	55.898	80	5.0%	-
80	142+306.503	142+329.966	556410.292	2871121.745	556433.411	2871125.634	170	Left	142+236.503	70	70	142+399.966	142318.253	556421.986	2871122.891	7	54	27.55	65	7.0%	0.6
81	142+496.737	142+603.650	556587.745	2871187.99	556692.579	2871179.714	170	Right	142+426.737	70	70	142+673.650	142552.028	556641.508	2871200.9	36	2	0.444	65	7.0%	0.6
82	142+734.094	142+755.049	556803.515	2871111.443	556822.089	2871101.753	300	Left	142+684.094	50	50	142+805.049	142744.576	556812.633	2871106.274	4	0	7.041	65	5.0%	0.6
83	143+027.738	143+144.369	557076.921	2871004.84	557190.368	2870978.362	700	Left	142+957.738	70	70	143+214.369	143086.189	557132.539	2870986.865	9	32	46.932	100	5.0%	-
84	143+353.324	143+365.369	557397.955	2870955.113	557409.62	2870952.121	200	Right	143+303.324	50	50	143+415.369	143359.349	557403.833	2870953.793	3	27	2.169	65	7.0%	0.6
85	143+506.630	143+562.190	557541.004	2870900.538	557596.064	2870895.251	170	Left	143+456.630	50	50	143+612.190	143534.66	557568.098	2870893.355	18	43	32.462	65	7.0%	0.6
86	143+807.504	143+819.426	557835.251	2870948.699	557846.494	2870952.665	450	Left	143+707.504	100	100	143+919.426	143813.466	557840.899	2870950.608	1	31	4.542	100	5.0%	-
87	144+222.472	144+300.376	558207.068	2871132.216	558265.56	2871183.34	300	Left	144+147.472	75	75	144+375.376	144261.644	558239.652	2871153.959	14	52	42.719	80	5.0%	0.6
88	144+643.372	144+748.771	558465.353	2871461.659	558560.904	2871500.765	150	Right	144+573.372	70	70	144+818.771	144698.352	558505.962	2871498.723	40	15	33.139	60	7.0%	0.6
89	144+887.865	144+986.275	558697.339	2871476.467	558756.939	2871403.148	100	Right	144+847.865	40	40	145+026.275	144941.467	558746.789	2871455.781	56	23	5.131	50	7.0%	0.9
90	145+067.674	145+107.525	558756.78	2871322.001	558744.42	2871284.279	130	Right	145+027.674	40	40	145+147.525	145087.757	558753.514	2871302.185	17	33	49.91	60	7.0%	0.6
91	145+242.848	145+412.747	558669.431	2871171.811	558686.983	2871011.809	150	Left	145+192.848	50	50	145+462.747	145338.218	558627.342	2871086.231	64	53	48.393	60	7.0%	0.6
92	145+515.693	145+548.732	558759.898	2870939.318	558777.565	2870911.478	150	Right	145+465.693	50	50	145+598.732	145532.279	558770.271	2870926.375	12	37	11.358	60	7.0%	0.6

Annexure 6.3A: Vertical Alignment Report (LME)												
PVI	PVI			Grade		Diff. in Grade (%)	Chainage(m)		Level(m)		Type Of Curve	K Value
	Chainage (m)	Level (m)	Curve Length	IN (%)	OUT (%)		Start of Curve	End of Curve	Start of Curve	End of Curve		
Section-6												
1	113+933.269	145.367	180	3.295	-2.184	-5.479	113+843.269	114+023.269	142.401	143.402	Hog	32.852
2	114+111.032	141.485	110	-2.184	3.257	5.441	114+056.032	114+166.032	142.686	143.276	Sag	20.218
3	114+287.846	147.244	150	3.257	-3.246	-6.503	114+212.846	114+362.846	144.801	144.81	Hog	23.067
4	114+654.944	135.329	280	-3.246	3.265	6.511	114+514.944	114+794.944	139.873	139.9	Sag	43.005
5	115+007.356	146.836	70	3.265	4.458	1.193	114+972.356	115+042.356	145.693	148.396	Sag	58.665
6	115+266.924	158.409	125	4.458	0.738	-3.720	115+204.424	115+329.424	155.622	158.87	Hog	33.601
7	115+605.446	160.908	110	0.738	-4.991	-5.729	115+550.446	115+660.446	160.502	158.163	Hog	19.201
8	115+740.000	154.193	60	-4.991	-2.745	2.246	115+710.000	115+770.000	155.69	153.369	Sag	26.723
9	115+941.470	148.662	60	-2.745	-3.057	-0.312	115+911.470	115+971.470	149.486	147.745	Hog	192.508
10	116+117.427	143.283	60	-3.057	-2.248	0.809	116+087.427	116+147.427	144.2	142.609	Sag	74.158
11	116+393.238	137.083	170	-2.248	0.544	2.792	116+308.238	116+478.238	138.994	137.545	Sag	60.888
12	116+561.780	138	60	0.544	0	-0.544	116+531.780	116+591.780	137.837	138	Hog	110.278
13	116+809.322	138	60	0	0.351	0.351	116+779.322	116+839.322	138	138.105	Sag	170.885
14	116+941.140	138.463	75	0.351	2.403	2.052	116+903.640	116+978.640	138.331	139.364	Sag	36.551
15	117+088.336	142	100	2.403	0	-2.403	117+038.336	117+138.336	140.798	142	Hog	41.614
16	117+253.808	142	100	0	-1.039	-1.039	117+203.808	117+303.808	142	141.48	Hog	96.221
17	117+443.844	140.025	170	-1.039	2.517	3.556	117+358.844	117+528.844	140.908	142.165	Sag	47.8
18	117+890.691	151.273	200	2.517	-3.255	-5.772	117+790.691	117+990.691	148.756	148.018	Hog	34.65
19	118+210.133	140.876	180	-3.255	0.409	3.664	118+120.133	118+300.133	143.805	141.244	Sag	49.133
20	118+570.000	142.347	120	0.409	-1.306	-1.715	118+510.000	118+630.000	142.102	141.563	Hog	69.97
21	118+810.000	139.212	130	-1.306	0.563	1.869	118+745.000	118+875.000	140.061	139.578	Sag	69.545
22	119+127.559	141	150	0.563	0	-0.563	119+052.559	119+202.559	140.578	141	Hog	266.408
23	119+713.353	141	150	0	-1.516	-1.516	119+638.353	119+788.353	141	139.863	Hog	98.96
24	119+930.340	137.711	130	-1.516	0.498	2.014	119+865.340	119+995.340	138.696	138.034	Sag	64.57
25	120+089.114	138.501	60	0.498	-0.758	-1.256	120+059.114	120+119.114	138.352	138.273	Hog	47.773
26	120+246.403	137.308	60	-0.758	-0.57	0.188	120+216.403	120+276.403	137.536	137.137	Sag	318.416
27	120+315.911	136.912	60	-0.57	-0.536	0.034	120+285.911	120+345.911	137.083	136.751	Sag	1752.13
28	120+415.967	136.376	60	-0.536	0.363	0.899	120+385.967	120+445.967	136.537	136.485	Sag	66.76
29	120+629.438	137.151	60	0.363	1.145	0.782	120+599.438	120+659.438	137.042	137.494	Sag	76.761
30	120+721.952	138.21	115	1.145	-0.625	-1.770	120+664.452	120+779.452	137.552	137.851	Hog	64.997
31	121+075.765	136	60	-0.625	0	0.625	121+045.765	121+105.765	136.187	136	Sag	96.058
32	121+370.000	136	60	0	-0.33	-0.330	121+340.000	121+400.000	136	135.901	Hog	181.817
33	121+489.393	135.606	85	-0.33	1.1	1.430	121+446.893	121+531.893	135.746	136.074	Sag	59.426
34	121+744.495	138.413	60	1.1	-0.029	-1.129	121+714.495	121+774.495	138.083	138.404	Hog	53.126
35	122+130.102	138.301	60	-0.029	2.306	2.335	122+100.102	122+160.102	138.31	138.993	Sag	25.693
36	122+224.022	140.467	60	2.306	0.892	-1.414	122+194.022	122+254.022	139.775	140.735	Hog	42.429
37	122+367.170	141.744	60	0.892	3.082	2.190	122+337.170	122+397.170	141.476	142.669	Sag	27.397
38	122+519.144	146.428	210	3.082	-2.717	-5.799	122+414.144	122+624.144	143.192	143.575	Hog	36.211
39	122+737.015	140.508	190	-2.717	0.22	2.937	122+642.015	122+832.015	143.089	140.717	Sag	64.678
40	123+055.022	141.209	105	0.22	1.975	1.755	123+002.522	123+107.522	141.093	142.246	Sag	59.838

Annexure 6.3A: Vertical Alignment Report (LME)

PVI	PVI			Grade		Diff. in Grade (%)	Chainage(m)		Level(m)		Type Of Curve	K Value
	Chainage (m)	Level (m)	Curve Length	IN (%)	OUT (%)		Start of Curve	End of Curve	Start of Curve	End of Curve		
41	123+244.270	144.947	90	1.975	-0.303	-2.278	123+199.270	123+289.270	144.058	144.811	Hog	39.51
42	123+516.488	144.123	80	-0.303	1.844	2.147	123+476.488	123+556.488	144.244	144.861	Sag	37.267
43	123+696.210	147.437	140	1.844	-1.119	-2.963	123+626.210	123+766.210	146.146	146.654	Hog	47.255
44	123+975.251	144.315	90	-1.119	1.028	2.147	123+930.251	124+020.251	144.819	144.778	Sag	41.921
45	124+100.000	145.598	120	1.028	-1.476	-2.504	124+040.000	124+160.000	144.981	144.712	Hog	47.919
46	124+321.204	142.333	130	-1.476	0.918	2.394	124+256.204	124+386.204	143.292	142.929	Sag	54.311
47	124+949.895	148.102	150	0.918	-1.378	-2.296	124+874.895	125+024.895	147.414	147.068	Hog	65.337
48	125+250.000	143.966	80	-1.378	-0.523	0.855	125+210.000	125+290.000	144.517	143.757	Sag	93.6
49	125+414.284	143.106	160	-0.523	3.281	3.804	125+334.284	125+494.284	143.525	145.731	Sag	42.054
50	125+962.232	161.085	500	3.281	-3.26	-6.541	125+712.232	126+212.232	152.882	152.935	Hog	76.44
51	126+616.753	139.748	250	-3.26	-0.561	2.699	126+491.753	126+741.753	143.823	139.046	Sag	92.636
52	127+305.451	135.883	100	-0.561	0.314	0.875	127+255.451	127+355.451	136.164	136.04	Sag	114.29
53	127+754.517	137.292	150	0.314	-0.695	-1.009	127+679.517	127+829.517	137.057	136.77	Hog	148.634
54	127+981.859	135.711	200	-0.695	1.803	2.498	127+881.859	128+081.859	136.406	137.514	Sag	80.066
55	128+164.326	139	150	1.803	0	-1.803	128+089.326	128+239.326	137.648	139	Hog	83.217
56	128+508.270	139	80	0	-0.549	-0.549	128+468.270	128+548.270	139	138.78	Hog	145.683
57	128+646.487	138.241	120	-0.549	2.331	2.880	128+586.487	128+706.487	138.57	139.639	Sag	41.669
58	128+807.769	142	180	2.331	0	-2.331	128+717.769	128+897.769	139.902	142	Hog	77.23
59	129+133.370	142	100	0	1.465	1.465	129+083.370	129+183.370	142	142.733	Sag	68.24
60	129+284.658	144.217	160	1.465	-0.617	-2.082	129+204.658	129+364.658	143.045	143.723	Hog	76.824
61	129+515.513	142.792	160	-0.617	0.986	1.603	129+435.513	129+595.513	143.286	143.581	Sag	99.776
62	129+941.848	146.997	185	0.986	-0.35	-1.336	129+849.348	130+034.348	146.085	146.673	Hog	138.39
63	130+293.925	145.763	200	-0.35	1.551	1.901	130+193.925	130+393.925	146.113	147.314	Sag	105.191
64	130+618.979	150.804	250	1.551	-1.615	-3.166	130+493.979	130+743.979	148.865	148.786	Hog	78.974
65	130+817.519	147.598	85	-1.615	0.355	1.970	130+775.019	130+860.019	148.284	147.749	Sag	43.149
66	130+945.086	148.051	100	0.355	-1.704	-2.059	130+895.086	130+995.086	147.873	147.199	Hog	48.571
67	131+034.948	146.52	60	-1.704	-0.251	1.453	131+004.948	131+064.948	147.031	146.445	Sag	41.293
68	131+114.330	146.321	70	-0.251	0.621	0.872	131+079.330	131+149.330	146.409	146.539	Sag	80.259
69	131+182.493	146.745	60	0.623	3.994	3.371	131+152.493	131+212.493	146.558	147.943	Sag	17.797
70	131+406.592	155.696	150	3.994	-3.972	-7.966	131+331.592	131+481.592	152.701	152.717	Hog	18.829
71	131+550.000	150	70	-3.972	0	3.972	131+515.000	131+585.000	151.39	150	Sag	17.623
72	131+673.858	150	90	0	3.272	3.272	131+628.858	131+718.858	150	151.473	Sag	27.503
73	131+879.002	156.713	100	3.272	0.4	-2.872	131+829.002	131+929.002	155.077	156.913	Hog	34.82
74	131+992.387	157.167	60	0.4	2.473	2.073	131+962.387	132+022.387	157.047	157.909	Sag	28.949
75	132+090.000	159.581	60	2.473	0.812	-1.661	132+060.000	132+120.000	158.839	159.825	Hog	36.125
76	132+165.604	160.195	60	0.812	3.2	2.388	132+135.604	132+195.604	159.951	161.155	Sag	25.126
77	132+312.224	164.887	215	3.2	-3.237	-6.437	132+204.724	132+419.724	161.447	161.407	Hog	33.4
78	132+462.361	160.027	65	-3.237	-0.711	2.526	132+429.861	132+494.861	161.079	159.796	Sag	25.732
79	132+610.608	158.973	85	-0.711	-3.297	-2.586	132+568.108	132+653.108	159.275	157.572	Hog	32.875
80	132+771.595	153.666	90	-3.297	-0.322	2.975	132+726.595	132+816.595	155.149	153.521	Sag	30.256
81	132+972.587	153.019	150	-0.322	-3.235	-2.913	132+897.587	133+047.587	153.26	150.592	Hog	51.484

Annexure 6.3A: Vertical Alignment Report (LME)

PVI	PVI			Grade		Diff. in Grade (%)	Chainage(m)		Level(m)		Type Of Curve	K Value
	Chainage (m)	Level (m)	Curve Length	IN (%)	OUT (%)		Start of Curve	End of Curve	Start of Curve	End of Curve		
82	133+143.167	147.5	85	-3.235	0	3.235	133+100.667	133+185.667	148.875	147.5	Sag	26.272
83	133+270.045	147.5	60	0	-0.436	-0.436	133+240.045	133+300.045	147.5	147.369	Hog	137.738
84	133+442.677	146.748	40	-0.436	1.544	1.980	133+422.677	133+462.677	146.835	147.057	Sag	20.203
85	133+498.365	147.608	40	1.544	0.031	-1.513	133+478.365	133+518.365	147.299	147.614	Hog	26.44
86	133+617.321	147.645	130	0.031	1.297	1.266	133+552.321	133+682.321	147.625	148.488	Sag	102.749
87	133+795.288	149.953	95	1.297	0.195	-1.102	133+747.788	133+842.788	149.337	150.046	Hog	86.213
88	133+950.339	150.255	80	0.195	1.973	1.778	133+910.339	133+990.339	150.177	151.044	Sag	44.998
89	134+083.411	152.88	120	1.973	-1.645	-3.618	134+023.411	134+143.411	151.696	151.893	Hog	33.174
90	134+197.717	151	70	-1.645	0	1.645	134+162.717	134+232.717	151.576	151	Sag	42.561
91	134+377.106	151	80	0	3.301	3.301	134+337.106	134+417.106	151	152.321	Sag	24.232
92	134+720.389	162.333	400	3.301	-3.303	-6.604	134+520.389	134+920.389	155.73	155.727	Hog	60.565
93	135+109.299	149.487	170	-3.303	0.715	4.018	135+024.299	135+194.299	152.295	150.095	Sag	42.304
94	135+291.566	150.791	110	0.715	3.304	2.589	135+236.566	135+346.566	150.398	152.608	Sag	42.487
95	135+589.699	160.643	220	3.304	-2.447	-5.751	135+479.699	135+699.699	157.008	157.951	Hog	38.254
96	135+808.182	155.297	100	-2.447	-1.063	1.384	135+758.182	135+858.182	156.52	154.766	Sag	72.254
97	135+949.456	153.796	90	-1.063	-2.268	-1.205	135+904.456	135+994.456	154.274	152.775	Hog	74.674
98	136+095.391	150.486	120	-2.268	2.913	5.181	136+035.391	136+155.391	151.847	152.234	Sag	23.161
99	136+263.952	155.397	125	2.913	-3.297	-6.210	136+201.452	136+326.452	153.576	153.336	Hog	20.127
100	136+399.030	150.943	120	-3.297	3.299	6.596	136+339.030	136+459.030	152.921	152.922	Sag	18.191
101	136+542.279	155.669	110	3.299	-1.739	-5.038	136+487.279	136+597.279	153.854	154.713	Hog	21.833
102	136+650.000	153.796	60	-1.739	0.378	2.117	136+620.000	136+680.000	154.317	153.909	Sag	28.347
103	136+829.311	154.473	100	0.378	3.3	2.922	136+779.311	136+879.311	154.284	156.123	Sag	34.218
104	137+244.312	168.168	220	3.3	-3.298	-6.598	137+134.312	137+354.312	164.538	164.54	Hog	33.344
105	137+634.390	155.304	70	-3.298	0.547	3.845	137+599.390	137+669.390	156.458	155.496	Sag	18.205
106	137+734.327	155.851	60	0.547	-0.047	-0.594	137+704.327	137+764.327	155.687	155.837	Hog	100.95
107	137+857.709	155.793	60	-0.047	1.224	1.271	137+827.709	137+887.709	155.807	156.16	Sag	47.207
108	137+953.543	156.966	110	1.224	-0.35	-1.574	137+898.543	138+008.543	156.293	156.773	Hog	69.869
109	138+060.000	156.593	60	-0.35	-0.09	0.260	138+030.000	138+090.000	156.698	156.566	Sag	230.847
110	138+132.957	156.527	60	-0.09	0.62	0.710	138+102.957	138+162.957	156.554	156.713	Sag	84.437
111	138+209.393	157.001	60	0.62	0.261	-0.359	138+179.393	138+239.393	156.815	157.079	Hog	166.993
112	138+336.878	157.334	60	0.261	0.827	0.566	138+306.878	138+366.878	157.255	157.582	Sag	105.964
113	138+417.054	157.997	60	0.827	0.352	-0.475	138+387.054	138+447.054	157.749	158.102	Hog	126.374
114	138+534.113	158.409	65	0.352	1.904	1.552	138+501.613	138+566.613	158.295	159.028	Sag	41.887
115	138+625.443	160.148	80	1.904	-1.947	-3.851	138+585.443	138+665.443	159.386	159.369	Hog	20.775
116	138+720.105	158.305	60	-1.947	-0.313	1.634	138+690.105	138+750.105	158.889	158.211	Sag	36.729
117	138+932.580	157.64	100	-0.313	-0.725	-0.412	138+882.580	138+982.580	157.797	157.277	Hog	242.63
118	139+156.907	156.013	95	-0.725	0.734	1.459	139+109.407	139+204.407	156.357	156.362	Sag	65.084
119	139+269.574	156.84	75	0.734	2.192	1.458	139+232.074	139+307.074	156.565	157.662	Sag	51.467
120	139+423.913	160.223	170	2.192	-3.104	-5.296	139+338.913	139+508.913	158.36	157.585	Hog	32.104
121	139+610.707	154.426	85	-3.104	1.364	4.468	139+568.207	139+653.207	155.745	155.005	Sag	19.027
122	139+689.560	155.501	40	1.364	3.182	1.818	139+669.560	139+709.560	155.228	156.137	Sag	22.003

Annexure 6.3A: Vertical Alignment Report (LME)

PVI	PVI			Grade		Diff. in Grade (%)	Chainage(m)		Level(m)		Type Of Curve	K Value
	Chainage (m)	Level (m)	Curve Length	IN (%)	OUT (%)		Start of Curve	End of Curve	Start of Curve	End of Curve		
123	139+750.000	157.424	60	3.182	1.157	-2.025	139+720.000	139+780.000	156.469	157.771	Hog	29.638
124	140+020.000	160.549	80	1.157	3.297	2.140	139+980.000	140+060.000	160.086	161.867	Sag	37.388
125	140+234.756	167.629	150	3.297	0.882	-2.415	140+159.756	140+309.756	165.156	168.29	Hog	62.107
126	140+396.249	169.053	80	0.882	-3.295	-4.177	140+356.249	140+436.249	168.7	167.735	Hog	19.154
127	140+498.252	165.692	80	-3.295	-0.498	2.797	140+458.252	140+538.252	167.01	165.493	Sag	28.601
128	140+942.531	163.48	150	-0.498	-3.26	-2.762	140+867.531	141+017.531	163.853	161.035	Hog	54.302
129	141+179.864	155.742	170	-3.26	3.027	6.287	141+094.864	141+264.864	158.514	158.315	Sag	27.04
130	141+495.403	165.293	210	3.027	-3.183	-6.210	141+390.403	141+600.403	162.115	161.951	Hog	33.815
131	141+726.983	157.921	165	-3.183	2.26	5.443	141+644.483	141+809.483	160.547	159.786	Sag	30.311
132	141+916.610	162.207	180	2.26	-2.433	-4.693	141+826.610	142+006.610	160.173	160.017	Hog	38.353
133	142+054.779	158.845	60	-2.433	0.806	3.239	142+024.779	142+084.779	159.575	159.087	Sag	18.525
134	142+136.077	159.5	60	0.806	0	-0.806	142+106.077	142+166.077	159.258	159.5	Hog	74.472
135	142+270.000	159.5	100	0	3.225	3.225	142+220.000	142+320.000	159.5	161.113	Sag	31.003
136	142+435.526	164.839	60	3.225	2.303	-0.922	142+405.526	142+465.526	163.871	165.53	Hog	65.046
137	142+758.967	172.288	85	2.303	-2.124	-4.427	142+716.467	142+801.467	171.309	171.385	Hog	19.201
138	142+847.014	170.418	70	-2.124	-0.542	1.582	142+812.014	142+882.014	171.161	170.228	Sag	44.252
139	142+940.000	169.914	75	-0.542	-1.53	-0.988	142+902.500	142+977.500	170.117	169.34	Hog	75.912
140	143+010.000	168.843	60	-1.53	-2.441	-0.911	142+980.000	143+040.000	169.302	168.111	Hog	65.877
141	143+103.822	166.553	65	-2.441	-3.302	-0.861	143+071.322	143+136.322	167.346	165.48	Hog	75.432
142	143+214.435	162.9	60	-3.302	0	3.302	143+184.435	143+244.435	163.891	162.9	Sag	18.168
143	143+298.672	162.9	60	0	-0.015	-0.015	143+268.672	143+328.672	162.9	162.895	Hog	3934.297
144	143+423.258	162.881	40	-0.015	1.115	1.130	143+403.258	143+443.258	162.884	163.104	Sag	35.399
145	143+490.000	163.625	40	1.115	-0.71	-1.825	143+470.000	143+510.000	163.402	163.483	Hog	21.923
146	143+578.051	163	60	-0.71	0	0.710	143+548.051	143+608.051	163.213	163	Sag	84.529
147	143+760.000	163	100	0	2.552	2.552	143+710.000	143+810.000	163	164.276	Sag	39.186
148	143+916.528	166.995	170	2.552	-3.04	-5.592	143+831.528	144+001.528	164.825	164.41	Hog	30.4
149	144+044.631	163.1	60	-3.04	0	3.040	144+014.631	144+074.631	164.012	163.1	Sag	19.736
150	144+135.231	163.1	60	0	3.277	3.277	144+105.231	144+165.231	163.1	164.083	Sag	18.307
151	144+396.113	171.65	120	3.277	-3.221	-6.498	144+336.113	144+456.113	169.684	169.718	Hog	18.467
152	144+660.865	163.123	120	-3.221	3.613	6.834	144+600.865	144+720.865	165.055	165.291	Sag	17.561
153	144+842.147	169.672	85	3.613	1.189	-2.424	144+799.647	144+884.647	168.137	170.178	Hog	35.078
154	144+959.595	171.069	40	1.189	3.13	1.941	144+939.595	144+979.595	170.831	171.695	Sag	20.616
155	145+200.000	178.593	150	3.13	0.808	-2.322	145+125.000	145+275.000	176.246	179.199	Hog	64.618
156	145+544.269	181.376	120	0.808	2.429	1.621	145+484.269	145+604.269	180.891	182.833	Sag	74.063
157	145+663.596	184.274	80	2.429	0.288	-2.141	145+623.596	145+703.596	183.303	184.389	Hog	37.38

Annexure 6.3B: Vertical Alignment Report (RME)												
PVI	PVI			Grade		Diff. in Grade (%)	Chainage(m)		Level(m)		Type Of Curve	K Value
	Chainage (m)	Level (m)	Curve Length	IN (%)	OUT (%)		Start of Curve	End of Curve	Start of Curve	End of Curve		
Section-6												
1	113+933.269	145.367	180	3.295	-2.818	-6.113	113+843.269	114+023.269	142.401	142.831	Hog	29.444
2	114+091.390	140.911	110	-2.818	3.224	6.042	114+036.390	114+146.390	142.461	142.684	Sag	18.207
3	114+287.846	147.244	150	3.224	-3.246	-6.470	114+212.846	114+362.846	144.826	144.81	Hog	23.187
4	114+654.944	135.329	280	-3.246	3.265	6.511	114+514.944	114+794.944	139.873	139.9	Sag	43.005
5	115+007.356	146.836	70	3.265	4.458	1.193	114+972.356	115+042.356	145.693	148.396	Sag	58.665
6	115+266.924	158.409	125	4.458	0.738	-3.720	115+204.424	115+329.424	155.622	158.87	Hog	33.601
7	115+605.446	160.908	110	0.738	-4.991	-5.729	115+550.446	115+660.446	160.502	158.163	Hog	19.201
8	115+740.000	154.193	60	-4.991	-2.745	2.246	115+710.000	115+770.000	155.69	153.369	Sag	26.723
9	115+941.470	148.662	60	-2.745	-3.057	-0.312	115+911.470	115+971.470	149.486	147.745	Hog	192.508
10	116+117.427	143.283	60	-3.057	-2.248	0.809	116+087.427	116+147.427	144.2	142.609	Sag	74.158
11	116+393.238	137.083	170	-2.248	0.544	2.792	116+308.238	116+478.238	138.994	137.545	Sag	60.888
12	116+561.780	138	60	0.544	0	-0.544	116+531.780	116+591.780	137.837	138	Hog	110.278
13	116+720.820	138	60	0	-0.844	-0.844	116+690.820	116+750.820	138	137.747	Hog	71.05
14	116+807.856	137.265	60	-0.844	0.399	1.243	116+777.856	116+837.856	137.518	137.385	Sag	48.241
15	116+937.326	137.782	75	0.399	2.793	2.394	116+899.826	116+974.826	137.632	138.829	Sag	31.329
16	117+088.336	142	100	2.793	0	-2.793	117+038.336	117+138.336	140.603	142	Hog	35.801
17	117+253.808	142	100	0	-1.039	-1.039	117+203.808	117+303.808	142	141.48	Hog	96.221
18	117+443.844	140.025	170	-1.039	2.517	3.556	117+358.844	117+528.844	140.908	142.165	Sag	47.8
19	117+890.691	151.273	200	2.517	-3.255	-5.772	117+790.691	117+990.691	148.756	148.018	Hog	34.65
20	118+210.133	140.876	180	-3.255	0.409	3.664	118+120.133	118+300.133	143.805	141.244	Sag	49.133
21	118+570.000	142.347	120	0.409	-1.306	-1.715	118+510.000	118+630.000	142.102	141.563	Hog	69.97
22	118+810.000	139.212	130	-1.306	0.563	1.869	118+745.000	118+875.000	140.061	139.578	Sag	69.545
23	119+127.559	141	150	0.563	0	-0.563	119+052.559	119+202.559	140.578	141	Hog	266.408
24	119+713.353	141	150	0	-1.516	-1.516	119+638.353	119+788.353	141	139.863	Hog	98.96
25	119+930.340	137.711	130	-1.516	0.498	2.014	119+865.340	119+995.340	138.696	138.034	Sag	64.57
26	120+089.114	138.501	60	0.498	-0.758	-1.256	120+059.114	120+119.114	138.352	138.273	Hog	47.773
27	120+246.403	137.308	60	-0.758	-0.57	0.188	120+216.403	120+276.403	137.536	137.137	Sag	318.416
28	120+315.911	136.912	60	-0.57	-0.536	0.034	120+285.911	120+345.911	137.083	136.751	Sag	1752.13
29	120+415.967	136.376	60	-0.536	0.363	0.899	120+385.967	120+445.967	136.537	136.485	Sag	66.76
30	120+629.438	137.151	60	0.363	1.145	0.782	120+599.438	120+659.438	137.042	137.494	Sag	76.761
31	120+721.952	138.21	115	1.145	-0.625	-1.770	120+664.452	120+779.452	137.552	137.851	Hog	64.997
32	121+075.765	136	60	-0.625	0	0.625	121+045.765	121+105.765	136.187	136	Sag	96.058
33	121+385.646	136	60	0	0.904	0.904	121+355.646	121+415.646	136	136.271	Sag	66.386
34	121+770.793	139.481	200	0.904	-0.328	-1.232	121+670.793	121+870.793	138.577	139.153	Hog	162.309
35	122+130.102	138.301	60	-0.328	2.306	2.634	122+100.102	122+160.102	138.4	138.993	Sag	22.774
36	122+224.022	140.467	60	2.306	0.892	-1.414	122+194.022	122+254.022	139.775	140.735	Hog	42.429
37	122+367.170	141.744	60	0.892	3.082	2.190	122+337.170	122+397.170	141.476	142.669	Sag	27.397
38	122+519.144	146.428	210	3.082	-2.717	-5.799	122+414.144	122+624.144	143.192	143.575	Hog	36.211
39	122+737.015	140.508	190	-2.717	0.22	2.937	122+642.015	122+832.015	143.089	140.717	Sag	64.678
40	123+055.022	141.209	105	0.22	1.975	1.755	123+002.522	123+107.522	141.093	142.246	Sag	59.838

Annexure 6.3B: Vertical Alignment Report (RME)

PVI	PVI			Grade		Diff. in Grade (%)	Chainage(m)		Level(m)		Type Of Curve	K Value
	Chainage (m)	Level (m)	Curve Length	IN (%)	OUT (%)		Start of Curve	End of Curve	Start of Curve	End of Curve		
41	123+244.270	144.947	90	1.975	-0.303	-2.278	123+199.270	123+289.270	144.058	144.811	Hog	39.51
42	123+564.392	143.978	80	-0.303	2.624	2.927	123+524.392	123+604.392	144.099	145.028	Sag	27.334
43	123+696.210	147.437	140	2.624	-1.421	-4.045	123+626.210	123+766.210	145.6	146.442	Hog	34.608
44	123+965.562	143.609	90	-1.421	1.479	2.900	123+920.562	124+010.562	144.249	144.275	Sag	31.027
45	124+100.000	145.598	120	1.479	-1.171	-2.650	124+040.000	124+160.000	144.71	144.895	Hog	45.274
46	124+353.503	142.629	130	-1.171	0.918	2.089	124+288.503	124+418.503	143.391	143.226	Sag	62.241
47	124+949.895	148.102	150	0.918	-1.378	-2.296	124+874.895	125+024.895	147.414	147.068	Hog	65.333
48	125+250.000	143.966	14	-1.378	-0.523	0.855	125+243.160	125+256.840	144.06	143.93	Sag	15.999
49	125+414.284	143.106	160	-0.523	3.281	3.804	125+334.284	125+494.284	143.525	145.731	Sag	42.056
50	125+962.232	161.085	500	3.281	-3.26	-6.541	125+712.232	126+212.232	152.882	152.935	Hog	76.44
51	126+616.753	139.748	250	-3.26	-0.561	2.699	126+491.753	126+741.753	143.823	139.046	Sag	92.636
52	127+305.451	135.883	100	-0.561	0.314	0.875	127+255.451	127+355.451	136.164	136.04	Sag	114.29
53	127+754.517	137.292	150	0.314	-0.695	-1.009	127+679.517	127+829.517	137.057	136.77	Hog	148.634
54	127+981.859	135.711	200	-0.695	1.803	2.498	127+881.859	128+081.859	136.406	137.514	Sag	80.066
55	128+164.326	139	150	1.803	0	-1.803	128+089.326	128+239.326	137.648	139	Hog	83.217
56	128+508.270	139	80	0	-0.549	-0.549	128+468.270	128+548.270	139	138.78	Hog	145.683
57	128+646.487	138.241	120	-0.549	2.331	2.880	128+586.487	128+706.487	138.57	139.639	Sag	41.669
58	128+807.769	142	180	2.331	0	-2.331	128+717.769	128+897.769	139.902	142	Hog	77.23
59	129+133.370	142	100	0	1.465	1.465	129+083.370	129+183.370	142	142.733	Sag	68.24
60	129+284.658	144.217	160	1.465	-0.617	-2.082	129+204.658	129+364.658	143.045	143.723	Hog	76.824
61	129+515.513	142.792	160	-0.617	0.986	1.603	129+435.513	129+595.513	143.286	143.581	Sag	99.776
62	129+941.848	146.997	185	0.986	-0.35	-1.336	129+849.348	130+034.348	146.085	146.673	Hog	138.39
63	130+293.925	145.763	200	-0.35	1.551	1.901	130+193.925	130+393.925	146.113	147.314	Sag	105.191
64	130+618.979	150.804	250	1.551	-1.615	-3.166	130+493.979	130+743.979	148.865	148.786	Hog	78.974
65	130+817.519	147.598	85	-1.615	0.355	1.970	130+775.019	130+860.019	148.284	147.749	Sag	43.149
66	130+945.086	148.051	100	0.355	-1.704	-2.059	130+895.086	130+995.086	147.873	147.199	Hog	48.571
67	131+034.948	146.52	60	-1.704	-0.251	1.453	131+004.948	131+064.948	147.031	146.445	Sag	41.293
68	131+114.330	146.321	70	-0.251	0.621	0.872	131+079.330	131+149.330	146.409	146.539	Sag	80.258
69	131+182.493	146.745	60	0.623	3.994	3.371	131+152.493	131+212.493	146.558	147.943	Sag	17.797
70	131+406.592	155.696	150	3.994	-3.972	-7.966	131+331.592	131+481.592	152.701	152.717	Hog	18.829
71	131+550.000	150	70	-3.972	0	3.972	131+515.000	131+585.000	151.39	150	Sag	17.623
72	131+673.858	150	90	0	3.272	3.272	131+628.858	131+718.858	150	151.473	Sag	27.503
73	131+879.002	156.713	100	3.272	0.4	-2.872	131+829.002	131+929.002	155.077	156.913	Hog	34.82
74	131+992.387	157.167	60	0.4	2.473	2.073	131+962.387	132+022.387	157.047	157.909	Sag	28.949
75	132+090.000	159.581	60	2.473	0.812	-1.661	132+060.000	132+120.000	158.839	159.825	Hog	36.125
76	132+165.604	160.195	60	0.812	3.2	2.388	132+135.604	132+195.604	159.951	161.155	Sag	25.126
77	132+312.224	164.887	215	3.2	-3.237	-6.437	132+204.724	132+419.724	161.447	161.407	Hog	33.4
78	132+462.361	160.027	65	-3.237	-0.711	2.526	132+429.861	132+494.861	161.079	159.796	Sag	25.732
79	132+610.608	158.973	85	-0.711	-3.297	-2.586	132+568.108	132+653.108	159.275	157.572	Hog	32.873
80	132+837.232	151.502	80	-3.297	1.121	4.418	132+797.232	132+877.232	152.821	151.95	Sag	18.11
81	132+972.587	153.019	150	1.121	-3.235	-4.356	132+897.587	133+047.587	152.178	150.592	Hog	34.434

Annexure 6.3B: Vertical Alignment Report (RME)

PVI	PVI			Grade		Diff. in Grade (%)	Chainage(m)		Level(m)		Type Of Curve	K Value
	Chainage (m)	Level (m)	Curve Length	IN (%)	OUT (%)		Start of Curve	End of Curve	Start of Curve	End of Curve		
82	133+143.167	147.5	85	-3.235	0	3.235	133+100.667	133+185.667	148.875	147.5	Sag	26.272
83	133+270.045	147.5	60	0	-0.978	-0.978	133+240.045	133+300.045	147.5	147.207	Hog	61.351
84	133+333.646	146.878	60	-0.978	-0.119	0.859	133+303.646	133+363.646	147.171	146.842	Sag	69.87
85	133+442.677	146.748	40	-0.119	1.544	1.663	133+422.677	133+462.677	146.772	147.057	Sag	24.045
86	133+498.365	147.608	40	1.544	0.031	-1.513	133+478.365	133+518.365	147.299	147.614	Hog	26.44
87	133+641.467	147.653	130	0.031	1.437	1.406	133+576.467	133+706.467	147.633	148.587	Sag	92.464
88	133+802.453	149.967	95	1.437	0.195	-1.242	133+754.953	133+849.953	149.284	150.06	Hog	76.45
89	133+950.339	150.255	80	0.195	1.973	1.778	133+910.339	133+990.339	150.177	151.044	Sag	44.998
90	134+083.411	152.88	120	1.973	-1.645	-3.618	134+023.411	134+143.411	151.696	151.893	Hog	33.174
91	134+197.717	151	70	-1.645	0	1.645	134+162.717	134+232.717	151.576	151	Sag	42.561
92	134+377.106	151	80	0	3.301	3.301	134+337.106	134+417.106	151	152.321	Sag	24.232
93	134+720.389	162.333	400	3.301	-3.303	-6.604	134+520.389	134+920.389	155.73	155.727	Hog	60.565
94	135+109.299	149.487	170	-3.303	0.715	4.018	135+024.299	135+194.299	152.295	150.095	Sag	42.304
95	135+291.566	150.791	110	0.715	3.304	2.589	135+236.566	135+346.566	150.398	152.608	Sag	42.487
96	135+595.641	160.839	220	3.304	-3.09	-6.394	135+485.641	135+705.641	157.204	157.44	Hog	34.405
97	135+785.704	154.966	100	-3.09	-0.714	2.376	135+735.704	135+835.704	156.511	154.609	Sag	42.096
98	135+949.456	153.796	90	-0.714	-3.282	-2.568	135+904.456	135+994.456	154.118	152.319	Hog	35.054
99	136+082.395	149.433	120	-3.282	3.285	6.567	136+022.395	136+142.395	151.402	151.404	Sag	18.274
100	136+263.952	155.397	125	3.285	-3.297	-6.582	136+201.452	136+326.452	153.344	153.336	Hog	18.99
101	136+399.030	150.943	120	-3.297	3.299	6.596	136+339.030	136+459.030	152.921	152.922	Sag	18.191
102	136+542.279	155.669	110	3.299	-2.222	-5.521	136+487.279	136+597.279	153.854	154.447	Hog	19.925
103	136+630.000	153.72	60	-2.222	0.064	2.286	136+600.000	136+660.000	154.387	153.739	Sag	26.25
104	136+810.000	153.836	100	0.064	3.3	3.236	136+760.000	136+860.000	153.804	155.486	Sag	30.903
105	137+244.312	168.168	220	3.3	-3.298	-6.598	137+134.312	137+354.312	164.538	164.54	Hog	33.344
106	137+634.390	155.304	70	-3.298	0.547	3.845	137+599.390	137+669.390	156.458	155.496	Sag	18.205
107	137+734.327	155.851	60	0.547	-0.047	-0.594	137+704.327	137+764.327	155.687	155.837	Hog	100.95
108	137+857.709	155.793	60	-0.047	1.224	1.271	137+827.709	137+887.709	155.807	156.16	Sag	47.207
109	137+953.543	156.966	110	1.224	-0.35	-1.574	137+898.543	138+008.543	156.293	156.773	Hog	69.869
110	138+075.352	156.539	60	-0.35	0.424	0.774	138+045.352	138+105.352	156.644	156.666	Sag	77.528
111	138+539.061	158.503	65	0.424	1.904	1.480	138+506.561	138+571.561	158.366	159.122	Sag	43.901
112	138+610.000	159.854	60	1.904	-0.962	-2.866	138+580.000	138+640.000	159.283	159.565	Hog	20.931
113	138+671.102	159.266	60	-0.962	-1.958	-0.996	138+641.102	138+701.102	159.555	158.679	Hog	60.293
114	138+734.070	158.033	60	-1.958	-0.411	1.547	138+704.070	138+764.070	158.621	157.91	Sag	38.8
115	138+820.000	157.68	60	-0.411	-0.039	0.372	138+808.096	138+831.904	157.729	157.675	Sag	63.991
116	138+932.969	157.636	100	-0.039	-1.017	-0.978	138+882.969	138+982.969	157.656	157.128	Hog	102.281
117	139+034.863	156.6	60	-1.017	-0.481	0.536	139+004.863	139+064.863	156.905	156.456	Sag	111.989
118	139+156.907	156.013	95	-0.481	0.527	1.008	139+109.407	139+204.407	156.241	156.263	Sag	94.271
119	139+267.395	156.595	75	0.527	2.318	1.791	139+229.895	139+304.895	156.397	157.464	Sag	41.872
120	139+423.913	160.223	170	2.318	-3.301	-5.619	139+338.913	139+508.913	158.253	157.417	Hog	30.256
121	139+602.811	154.318	85	-3.301	1.364	4.665	139+560.311	139+645.311	155.721	154.898	Sag	18.223
122	139+689.560	155.501	40	1.364	3.182	1.818	139+669.560	139+709.560	155.228	156.137	Sag	22.003

Annexure 6.3B: Vertical Alignment Report (RME)

PVI	PVI			Grade		Diff. in Grade (%)	Chainage(m)		Level(m)		Type Of Curve	K Value
	Chainage (m)	Level (m)	Curve Length	IN (%)	OUT (%)		Start of Curve	End of Curve	Start of Curve	End of Curve		
123	139+750.000	157.424	60	3.182	1.157	-2.025	139+720.000	139+780.000	156.469	157.771	Hog	29.638
124	140+020.000	160.549	80	1.157	3.297	2.140	139+980.000	140+060.000	160.086	161.867	Sag	37.388
125	140+234.756	167.629	150	3.297	0.882	-2.415	140+159.756	140+309.756	165.156	168.29	Hog	62.107
126	140+396.249	169.053	80	0.882	-3.295	-4.177	140+356.249	140+436.249	168.7	167.735	Hog	19.154
127	140+498.252	165.692	80	-3.295	-0.498	2.797	140+458.252	140+538.252	167.01	165.493	Sag	28.601
128	140+942.531	163.48	150	-0.498	-3.26	-2.762	140+867.531	141+017.531	163.853	161.035	Hog	54.302
129	141+179.864	155.742	170	-3.26	3.027	6.287	141+094.864	141+264.864	158.514	158.315	Sag	27.04
130	141+495.403	165.293	210	3.027	-3.183	-6.210	141+390.403	141+600.403	162.115	161.951	Hog	33.815
131	141+726.983	157.921	165	-3.183	2.26	5.443	141+644.483	141+809.483	160.547	159.786	Sag	30.311
132	141+916.610	162.207	180	2.26	-2.433	-4.693	141+826.610	142+006.610	160.173	160.017	Hog	38.353
133	142+054.779	158.845	60	-2.433	0.806	3.239	142+024.779	142+084.779	159.575	159.087	Sag	18.525
134	142+136.077	159.5	60	0.806	0	-0.806	142+106.077	142+166.077	159.258	159.5	Hog	74.472
135	142+270.000	159.5	100	0	3.225	3.225	142+220.000	142+320.000	159.5	161.113	Sag	31.003
136	142+435.526	164.839	60	3.225	2.303	-0.922	142+405.526	142+465.526	163.871	165.53	Hog	65.046
137	142+754.613	172.188	85	2.303	-1.272	-3.575	142+712.113	142+797.113	171.209	171.647	Hog	23.774
138	143+041.309	168.54	90	-1.272	-3.258	-1.986	142+996.309	143+086.309	169.113	167.074	Hog	45.331
139	143+214.435	162.9	60	-3.258	0	3.258	143+184.435	143+244.435	163.877	162.9	Sag	18.418
140	143+298.672	162.9	60	0	-0.015	-0.015	143+268.672	143+328.672	162.9	162.895	Hog	3934.297
141	143+423.258	162.881	40	-0.015	1.115	1.130	143+403.258	143+443.258	162.884	163.104	Sag	35.399
142	143+490.000	163.625	40	1.115	-0.71	-1.825	143+470.000	143+510.000	163.402	163.483	Hog	21.923
143	143+578.051	163	60	-0.71	0	0.710	143+548.051	143+608.051	163.213	163	Sag	84.529
144	143+760.000	163	100	0	2.552	2.552	143+710.000	143+810.000	163	164.276	Sag	39.186
145	143+916.528	166.995	170	2.552	-3.04	-5.592	143+831.528	144+001.528	164.825	164.41	Hog	30.4
146	144+044.631	163.1	60	-3.04	0	3.040	144+014.631	144+074.631	164.012	163.1	Sag	19.736
147	144+135.231	163.1	60	0	3.277	3.277	144+105.231	144+165.231	163.1	164.083	Sag	18.307
148	144+396.113	171.65	120	3.277	-3.221	-6.498	144+336.113	144+456.113	169.684	169.718	Hog	18.467
149	144+660.865	163.123	120	-3.221	3.613	6.834	144+600.865	144+720.865	165.055	165.291	Sag	17.561
150	144+842.147	169.672	85	3.613	1.189	-2.424	144+799.647	144+884.647	168.137	170.178	Hog	35.078
151	144+959.595	171.069	40	1.189	3.13	1.941	144+939.595	144+979.595	170.831	171.695	Sag	20.616
152	145+200.000	178.593	150	3.13	0.808	-2.322	145+125.000	145+275.000	176.246	179.199	Hog	64.618
153	145+544.269	181.376	120	0.808	2.429	1.621	145+484.269	145+604.269	180.891	182.833	Sag	74.063
154	145+663.596	184.274	80	2.429	0.288	-2.141	145+623.596	145+703.596	183.303	184.389	Hog	37.38

Summary of msa Calculations**Stretch - NH-29 (Daboka - Lahorijan)**

For 4-Lane Dual Carriageway		
Location	msa	Adopted msa
Km 62	17.21	18.95 Say, 20 msa
Km 127	18.95	
Km 138.45	14.34	

For 4-Lane Dual Carriageway (on LHS from Daboka to Lahorijan)		
Location	msa	Adopted msa
Km 62	17.21	18.95 Say, 20 msa
Km 127	18.95	
Km 138.45	14.34	

For 4-Lane Dual Carriageway (on RHS from Daboka to Lahorijan)		
Location	msa	Adopted msa
Km 62	7.59	8.34 Say, 20 msa
Km 127	8.34	
Km 138.45	6.32	

Equivalent Single Axle Load Calculation

Stretch - NH-29 (Daboka - Lahorijan)

Station- 62 Km

For 4-Lane Dual Carriageway

Year	Bus	LCV	2 Axle	3 Axle	MAV	Total yearly CVs (nos.)	Cummulative yearly CVs (nos.)	Yearly Design ESA	Cummulative Design ESA	MSA	Design year
VDF	1.92	2.40	6.93	9.46	13.07						
2018	263	451	164	74	65						
2019	283	483	176	79	70						
2020	305	517	189	85	75						
2021	328	554	202	91	80	457,827	457,827	720,016	720,016	0.72	1
2022	352	594	217	97	85	490,793	948,620	770,978	1,490,994	1.49	2
2023	379	636	232	103	91	526,140	1,474,761	825,556	2,316,550	2.32	3
2024	407	682	249	110	97	564,041	2,038,801	884,007	3,200,557	3.20	4
2025	437	731	267	118	104	604,680	2,643,481	946,606	4,147,163	4.15	5
2026	463	776	284	125	110	641,114	3,284,595	1,003,397	5,150,559	5.15	6
2027	490	823	301	132	116	679,748	3,964,343	1,063,602	6,214,161	6.21	7
2028	518	874	320	139	123	720,718	4,685,061	1,127,427	7,341,588	7.34	8
2029	548	928	340	148	130	764,162	5,449,223	1,195,090	8,536,678	8.54	9
2030	580	985	361	156	138	810,233	6,259,456	1,266,821	9,803,500	9.80	10
2031	610	1040	381	164	144	853,812	7,113,267	1,333,484	11,136,984	11.14	11
2032	642	1098	402	171	151	899,744	8,013,012	1,403,675	12,540,659	12.54	12
2033	675	1160	425	180	159	948,158	8,961,169	1,477,580	14,018,239	14.02	13
2034	710	1224	448	188	166	999,186	9,960,356	1,555,399	15,573,638	15.57	14
2035	747	1293	474	197	174	1,052,972	11,013,328	1,637,338	17,210,976	17.21	15
2036	786	1365	500	207	183	1,109,664	12,122,992	1,723,618	18,934,594	18.93	16
2037	827	1441	528	217	191	1,169,421	13,292,413	1,814,469	20,749,062	20.75	17
2038	870	1521	558	227	201	1,232,407	14,524,820	1,910,134	22,659,196	22.66	18
2039	915	1606	589	238	210	1,298,799	15,823,618	2,010,870	24,670,067	24.67	19
2040	963	1696	622	249	220	1,368,780	17,192,398	2,116,948	26,787,015	26.79	20
2041	1013	1790	657	261	231	1,442,546	18,634,944	2,228,651	29,015,666	29.02	21
2042	1065	1890	693	274	242	1,520,302	20,155,246	2,346,280	31,361,946	31.36	22
2043	1121	1996	732	287	253	1,602,264	21,757,510	2,470,150	33,832,096	33.83	23
2044	1179	2107	773	301	266	1,688,660	23,446,170	2,600,594	36,432,690	36.43	24
2045	1240	2225	817	315	278	1,779,731	25,225,901	2,737,963	39,170,653	39.17	25
2046	1305	2349	862	331	292	1,875,732	27,101,633	2,882,625	42,053,278	42.05	26
2047	1373	2481	911	346	306	1,976,928	29,078,561	3,034,971	45,088,249	45.09	27
2048	1444	2619	962	363	320	2,083,602	31,162,163	3,195,410	48,283,659	48.28	28
2049	1519	2766	1015	380	336	2,196,053	33,358,216	3,364,374	51,648,033	51.65	29

2050	1598	2920	1072	399	352	2,314,592	35,672,808	3,542,318	55,190,351	55.19	30
------	------	------	------	-----	-----	-----------	-------------------	-----------	------------	--------------	-----------

Equivalent Single Axle Load Calculation

Stretch - NH-29 (Daboka - Lahorijan)

Station- 127 Km

For 4-Lane Dual Carriageway

Year	Bus	LCV	2 Axle	3 Axle	MAV	Total yearly CVs (nos.)	Cummulative yearly CVs (nos.)	Yearly Design ESA	Cummulative Design ESA	MSA	Design year
VDF	1.92	2.40	6.93	9.46	13.07						
2018	284	488	182	83	72						
2019	306	523	195	89	77						
2020	329	560	209	96	83						
2021	354	601	224	102	88	499,558	499,558	792,665	792,665	0.79	1
2022	380	643	240	109	94	535,528	1,035,086	848,759	1,641,424	1.64	2
2023	409	690	257	116	101	574,096	1,609,182	908,832	2,550,256	2.55	3
2024	440	739	276	124	107	615,450	2,224,632	973,167	3,523,423	3.52	4
2025	473	792	296	133	115	659,791	2,884,422	1,042,067	4,565,490	4.57	5
2026	500	841	314	140	121	699,553	3,583,975	1,104,585	5,670,075	5.67	6
2027	529	892	334	149	128	741,717	4,325,692	1,170,861	6,840,935	6.84	7
2028	560	947	354	157	136	786,428	5,112,120	1,241,121	8,082,056	8.08	8
2029	592	1006	376	166	144	833,842	5,945,962	1,315,606	9,397,662	9.40	9
2030	626	1068	400	176	152	884,121	6,830,082	1,394,569	10,792,232	10.79	10
2031	659	1128	422	184	159	931,670	7,761,752	1,467,927	12,260,158	12.26	11
2032	693	1190	446	193	167	981,786	8,743,539	1,545,164	13,805,323	13.81	12
2033	729	1257	471	202	175	1,034,609	9,778,148	1,626,489	15,431,811	15.43	13
2034	767	1327	497	212	184	1,090,285	10,868,433	1,712,116	17,143,927	17.14	14
2035	807	1401	525	222	192	1,148,969	12,017,402	1,802,277	18,946,204	18.95	15
2036	849	1479	554	233	202	1,210,824	13,228,226	1,897,211	20,843,416	20.84	16
2037	893	1562	585	244	211	1,276,020	14,504,246	1,997,173	22,840,589	22.84	17
2038	940	1649	618	256	221	1,344,741	15,848,987	2,102,430	24,943,019	24.94	18
2039	989	1741	653	268	232	1,417,176	17,266,163	2,213,265	27,156,284	27.16	19
2040	1040	1838	689	281	243	1,493,527	18,759,690	2,329,974	29,486,258	29.49	20
2041	1094	1941	728	295	255	1,574,007	20,333,697	2,452,869	31,939,127	31.94	21
2042	1151	2049	769	309	267	1,658,838	21,992,535	2,582,281	34,521,408	34.52	22
2043	1211	2164	812	324	280	1,748,258	23,740,794	2,718,557	37,239,965	37.24	23
2044	1274	2285	857	339	293	1,842,516	25,583,309	2,862,062	40,102,027	40.10	24
2045	1340	2412	905	355	307	1,941,872	27,525,182	3,013,183	43,115,210	43.12	25
2046	1410	2547	956	372	322	2,046,605	29,571,787	3,172,324	46,287,534	46.29	26
2047	1483	2689	1009	390	338	2,157,006	31,728,793	3,339,914	49,627,447	49.63	27
2048	1560	2840	1066	409	354	2,273,383	34,002,177	3,516,403	53,143,850	53.14	28
2049	1641	2998	1126	429	371	2,396,060	36,398,236	3,702,266	56,846,116	56.85	29

2050	1727	3166	1189	449	389	2,525,378	38,923,615	3,898,003	60,744,119	60.74	30
------	------	------	------	-----	-----	-----------	-------------------	-----------	------------	--------------	-----------

Equivalent Single Axle Load Calculation

Stretch - NH-29 (Daboka - Lahorijan)

Station- 138.45 Km

For 4-Lane Dual Carriageway

Year	Bus	LCV	2 Axle	3 Axle	MAV	Total yearly CVs (nos.)	Cummulative yearly CVs (nos.)	Yearly Design ESA	Cummulative Design ESA	MSA	Design year
VDF	1.92	2.40	6.93	9.46	13.07						
2018	217	376	137	62	54						
2019	234	403	147	67	58						
2020	252	432	157	71	62						
2021	271	463	168	76	66	381,275	381,275	599,741	599,741	0.60	1
2022	291	496	181	81	70	408,740	790,015	642,201	1,241,942	1.24	2
2023	313	532	194	87	75	438,190	1,228,205	687,674	1,929,616	1.93	3
2024	336	570	208	93	80	469,766	1,697,971	736,374	2,665,991	2.67	4
2025	362	611	223	99	86	503,625	2,201,596	788,531	3,454,521	3.45	5
2026	383	648	236	105	91	533,985	2,735,582	835,853	4,290,374	4.29	6
2027	405	688	251	111	96	566,181	3,301,763	886,020	5,176,394	5.18	7
2028	428	731	267	117	102	600,322	3,902,084	939,204	6,115,598	6.12	8
2029	453	776	283	124	107	636,526	4,538,611	995,586	7,111,183	7.11	9
2030	480	824	301	131	114	674,919	5,213,530	1,055,359	8,166,542	8.17	10
2031	504	870	317	138	119	711,236	5,924,766	1,110,910	9,277,452	9.28	11
2032	531	918	335	144	125	749,515	6,674,281	1,169,401	10,446,853	10.45	12
2033	558	970	354	151	131	789,862	7,464,143	1,230,988	11,677,841	11.68	13
2034	587	1024	374	159	137	832,389	8,296,532	1,295,837	12,973,678	12.97	14
2035	618	1081	395	166	144	877,214	9,173,746	1,364,120	14,337,798	14.34	15
2036	650	1141	417	174	151	924,462	10,098,207	1,436,021	15,773,818	15.77	16
2037	684	1205	440	182	158	974,264	11,072,471	1,511,732	17,285,550	17.29	17
2038	719	1272	465	191	165	1,026,759	12,099,230	1,591,455	18,877,006	18.88	18
2039	757	1343	491	200	173	1,082,092	13,181,321	1,675,406	20,552,412	20.55	19
2040	796	1418	518	210	182	1,140,418	14,321,739	1,763,808	22,316,220	22.32	20
2041	837	1498	547	220	190	1,201,899	15,523,638	1,856,900	24,173,120	24.17	21
2042	881	1581	578	231	200	1,266,706	16,790,344	1,954,930	26,128,050	26.13	22
2043	927	1669	610	242	209	1,335,019	18,125,363	2,058,163	28,186,212	28.19	23
2044	975	1763	645	253	219	1,407,029	19,532,392	2,166,875	30,353,087	30.35	24
2045	1026	1861	681	265	230	1,482,937	21,015,329	2,281,359	32,634,446	32.63	25
2046	1079	1965	719	278	241	1,562,954	22,578,283	2,401,923	35,036,369	35.04	26
2047	1135	2075	759	292	252	1,647,302	24,225,585	2,528,891	37,565,259	37.57	27
2048	1194	2191	802	306	264	1,736,218	25,961,803	2,662,605	40,227,864	40.23	28
2049	1256	2313	846	320	277	1,829,948	27,791,751	2,803,425	43,031,289	43.03	29

2050	1322	2443	894	336	290	1,928,756	29,720,507	2,951,730	45,983,019	45.98	30
------	------	------	-----	-----	-----	-----------	-------------------	-----------	------------	--------------	-----------

Equivalent Single Axle Load Calculation

Stretch - NH-29 (Daboka - Lahorijan)

Station- 62 Km

For 4-Lane Dual Carriageway (on RHS Carriageway)

Year	Bus	LCV	2 Axle	3 Axle	MAV	Total yearly CVs (nos.)	Cummulative yearly CVs (nos.)	Yearly Design ESA	Cummulative Design ESA	MSA	Design year
VDF	1.07	1.17	2.59	3.52	5.97						
2018	263	451	164	74	65						
2019	283	483	176	79	70						
2020	305	517	189	85	75						
2021	328	554	202	91	80	457,827	457,827	317,285	317,285	0.32	1
2022	352	594	217	97	85	490,793	948,620	339,791	657,076	0.66	2
2023	379	636	232	103	91	526,140	1,474,761	363,897	1,020,973	1.02	3
2024	407	682	249	110	97	564,041	2,038,801	389,718	1,410,691	1.41	4
2025	437	731	267	118	104	604,680	2,643,481	417,376	1,828,067	1.83	5
2026	463	776	284	125	110	641,114	3,284,595	442,389	2,270,455	2.27	6
2027	490	823	301	132	116	679,748	3,964,343	468,904	2,739,359	2.74	7
2028	518	874	320	139	123	720,718	4,685,061	497,012	3,236,371	3.24	8
2029	548	928	340	148	130	764,162	5,449,223	526,808	3,763,179	3.76	9
2030	580	985	361	156	138	810,233	6,259,456	558,394	4,321,573	4.32	10
2031	610	1040	381	164	144	853,812	7,113,267	587,783	4,909,356	4.91	11
2032	642	1098	402	171	151	899,744	8,013,012	618,727	5,528,082	5.53	12
2033	675	1160	425	180	159	948,158	8,961,169	651,309	6,179,391	6.18	13
2034	710	1224	448	188	166	999,186	9,960,356	685,615	6,865,006	6.87	14
2035	747	1293	474	197	174	1,052,972	11,013,328	721,739	7,586,745	7.59	15
2036	786	1365	500	207	183	1,109,664	12,122,992	759,776	8,346,521	8.35	16
2037	827	1441	528	217	191	1,169,421	13,292,413	799,828	9,146,350	9.15	17
2038	870	1521	558	227	201	1,232,407	14,524,820	842,003	9,988,353	9.99	18
2039	915	1606	589	238	210	1,298,799	15,823,618	886,414	10,874,766	10.87	19
2040	963	1696	622	249	220	1,368,780	17,192,398	933,179	11,807,945	11.81	20
2041	1013	1790	657	261	231	1,442,546	18,634,944	982,424	12,790,369	12.79	21
2042	1065	1890	693	274	242	1,520,302	20,155,246	1,034,281	13,824,650	13.82	22
2043	1121	1996	732	287	253	1,602,264	21,757,510	1,088,890	14,913,540	14.91	23
2044	1179	2107	773	301	266	1,688,660	23,446,170	1,146,397	16,059,937	16.06	24
2045	1240	2225	817	315	278	1,779,731	25,225,901	1,206,956	17,266,893	17.27	25
2046	1305	2349	862	331	292	1,875,732	27,101,633	1,270,731	18,537,623	18.54	26
2047	1373	2481	911	346	306	1,976,928	29,078,561	1,337,892	19,875,515	19.88	27
2048	1444	2619	962	363	320	2,083,602	31,162,163	1,408,621	21,284,136	21.28	28
2049	1519	2766	1015	380	336	2,196,053	33,358,216	1,483,108	22,767,244	22.77	29

Annexure 6.5 : Improvement Proposal of Bridges and Underpass (NH-29)

<i>Existing Details</i>							<i>Proposal Details</i>							
Sl No.	Existing Chainage (km)	Existing Type of Bridge	No's of Span	Existing Span Arrang. (No. of Span x Span length in m)	Existing Total Length (m)	Existing Total Width (m)	Remarks	Improvement Proposal	Design Chainage (km)	Proposed Span Arrang (No. of Span x Span length in m)	Proposed Category	Proposed Total Length (m)	Width of proposed structure (m)	Proposed Type of Superstructure
1	116+400	Solid Slab	1	1x10.6	10.6	8.1	Widening	New 2 lane	116+640	1x10.6	MNB	10.6	Widening + 13.5	RCC Box
2	118+700	RCC T Girder	1	1x15.1	15.1	10.8	Realignment	New 4 lane	118+673	1x15.1	MNB	15.1	2x13.5	RCC T-Girder
5	-	-	-	-	-	-	New Construction (Realignment)	New 4 lane	119+535	3x30	MJB	90.0	2x13.5	PSC I-Girder
6	121+500	Solid Slab	2	2x8.9	17.8	8.3	Widening	New 2 lane	121+200	2x8.9	MNB	17.8	Widening + 13.5	RCC Box
9	-	-	-	-	-	-	New Construction (Manja Bypass)	New 4 lane	126+889	1x7.5	MNB	7.5	2x13.5	RCC Box
10	-	-	-	-	-	-	New Construction (Manja Bypass)	New 4 lane	128+320	2x7.5	MNB	15.0	2x13.5	RCC Box
11	-	-	-	-	-	-	New Construction (Manja Bypass)	New 4 lane	128+727	2x6.0	MNB	12.0	2x13.5	RCC Box
12	-	-	-	-	-	-	New Construction (Manja Bypass)	New 4 lane	128+977	3x30	MJB	90.0	2x13.5	PSC I-Girder
13	131+900	Solid Slab	2	2x7.6	15.2	8.1	Widening	New 2 lane	131+600	2x7.6	MNB	15.2	Widening + 13.5	RCC Box
14	133+600	Solid Slab	1	1x7.6	7.2	8.5	Reconstruction	New 4 lane	133+205	1x8.0	MNB	8.0	2x13.5	RCC Box
15	134+700	RCC T Girder	1	1x23.6	23.6	8.5	Retain & Repair	New 2 lane	134+280	1x23.6	MNB	23.6	Retain + 13.5	RCC T-Girder
16	140+400	RCC T Girder	1	1x22.5	22.5	8.2	Realignment	New 4 lane	139+915	1x22.5	MNB	22.5	2x13.5	RCC T-Girder
17	142+700	Solid Slab	2	1x6.1+1x6.2	12.3	8.5	Widening	New 2 lane	142+195	2x6.1	MNB	12.2	Widening + 13.5	RCC Box
18	143+700	Solid Slab	2	2x6.1	12.2	8.0	Widening	New 2 lane	143+255	2x6.1	MNB	12.2	Widening + 13.5	RCC Box
19	144+100	Solid Slab	2	2x7.0	14.0	8.5	Realignment	New 4 lane	143+620	1x8.0	MNB	8.0	2x13.5	RCC Box
20	144+600	Solid Slab	2	2x7.0	14.0	8.1	Widening	New 2 lane	144+100	2x7.0	MNB	14.0	Widening + 13.5	RCC Box

Annexure 6.6 : Widening Scheme (Section 6+7 Combined)

Design Chainage		Length (m)	TCS Type	Description
From	To			
113830	114020	190	2	Eccentric Widening - Right side
114020	114200	180	2	Eccentric Widening - Left side
114200	114420	220	9	New Construction - Both side Cutting
114420	114470	50	2	Eccentric Widening - Left side
114470	114590	120	1A	New Construction - Realignment
114590	114640	50	2	Eccentric Widening - Right side
114640	114700	60	2	Eccentric Widening - Left side
114700	114890	190	1A	New Construction - Realignment
114890	114940	50	2	Eccentric Widening - Left side
114940	115170	230	1A	New Construction - Realignment
115170	115300	130	1	Concentric Widening
115300	115360	60	2	Eccentric Widening - Left side
115360	115520	160	2	Eccentric Widening - Right side
115520	115590	70	1	Concentric Widening
115590	115750	160	2	Eccentric Widening - Right side
115750	115850	100	2	Eccentric Widening - Left side
115850	115980	130	1A	New Construction - Realignment
115980	116110	130	2	Eccentric Widening - Right side
116110	116180	70	1	Concentric Widening
116180	116500	320	1A	New Construction - Realignment
116500	116634.7	135	2	Eccentric Widening - Left side
116634.7	116645.3	11	STR	MNB
116645.3	117050	405	2	Eccentric Widening - Left side
117050	117120	70	2	Eccentric Widening - Right side
117120	117163	43	1A	New Construction - Realignment
117163	117178	15	1A	New Construction - Realignment
117178	117260	82	1A	New Construction - Realignment
117260	117410	150	2	Eccentric Widening - Right side
117410	117470	60	2	Eccentric Widening - Left side
117470	117540	70	1	Concentric Widening
117540	117570	30	2	Eccentric Widening - Left side
117570	117710	140	1A	New Construction - Realignment
117710	117810	100	2	Eccentric Widening - Right side
117810	118000	190	9	New Construction - Realignment (Both Side Cutting)
118000	118150	150	8A	New Construction - Realignment (Left Side Hill)
118150	118250	100	1	Concentric Widening
118250	118420	170	1A	New Construction - Realignment
118420	118460	40	2	Eccentric Widening - Left side
118460	118550	90	2	Eccentric Widening - Right side
118550	118610	60	1	Concentric Widening
118610	118665.5	55	2	Eccentric Widening - Right side
118665.5	118680.6	15	STR	MNB
118680.6	118710	29	2	Eccentric Widening - Right side
118710	118830	120	2	Eccentric Widening - Left side
118830	119490	660	1A	New Construction - Realignment
119490	119580	90	STR	MJB
119580	119840	260	1A	New Construction - Realignment

Annexure 6.6 : Widening Scheme (Section 6+7 Combined)

Design Chainage		Length (m)	TCS Type	Description
From	To			
119840	120200	360	1	Concentric Widening
120200	120310	110	2	Eccentric Widening - Right side
120310	120420	110	1	Concentric Widening
120420	120590	170	2	Eccentric Widening - Left side
120590	120750	160	2	Eccentric Widening - Right side
120750	121100	350	1A	New Construction - Realignment
121100	121191.1	91	2	Eccentric Widening - Right side
121191.1	121208.9	18	STR	MNB
121208.9	121330	121	2	Eccentric Widening - Right side
121330	121470	140	1A	New Construction - Realignment
121470	121690	220	2	Eccentric Widening - Right side
121690	121730	40	1	Concentric Widening
121730	121830	100	2	Eccentric Widening - Left side
121830	122030	200	2	Eccentric Widening - Right side
122030	122210	180	2	Eccentric Widening - Left side
122210	122350	140	2	Eccentric Widening - Right side
122350	122390	40	1	Concentric Widening
122390	122490	100	2	Eccentric Widening - Left side
122490	122830	340	1	Concentric Widening
122830	122900	70	2	Eccentric Widening - Left side
122900	123150	250	1	Concentric Widening
123150	123650	500	1A	New Construction - Realignment
123650	124210	560	2	Eccentric Widening - Left side
124210	124480	270	2	Eccentric Widening - Right side
124480	124625	145	2	Eccentric Widening - Left side
124625	124780	155	2	Eccentric Widening - Right side
124780	124970	190	2	Eccentric Widening - Left side
124970	125340	370	2	Eccentric Widening - Right side
125340	125560	220	1A	New Construction - Bypass
125560	125880	320	9	New Construction - Bypass (Both Side Cutting)
125880	126000	120	1A	New Construction - Bypass
126000	126300	300	9	New Construction - Bypass (Both Side Cutting)
126300	126866.3	566	1A	New Construction - Bypass
126866.3	126873.8	8	STR	MNB
126873.8	128292.5	1419	1A	New Construction - Bypass
128292.5	128307.5	15	STR	MNB
128307.5	128704	397	1A	New Construction - Bypass
128704	128716	12	STR	MNB
128716	128800	84	1A	New Construction - Bypass
128800	128932	132	1A	New Construction - Bypass
128932	129022	90	STR	MJB
129022	129100	78	1A	New Construction - Bypass
129100	129130	30	1A	New Construction - Bypass
129130	129370	240	9	New Construction - Bypass (Both Side Cutting)
129370	129480	110	1A	New Construction - Bypass
129480	129740	260	9	New Construction - Bypass (Both Side Cutting)
129740	129870	130	1A	New Construction - Bypass

Annexure 6.6 : Widening Scheme (Section 6+7 Combined)

Design Chainage		Length (m)	TCS Type	Description
From	To			
129870	130000	130	8A	New Construction - Bypass (Left Side Hill)
130000	130300	300	9	New Construction - Bypass (Both Side Cutting)
130300	130400	100	1A	New Construction - Bypass
130400	130600	200	9	New Construction - Bypass (Both Side Cutting)
130600	130630	30	1A	New Construction - Bypass
130630	130840	210	2	Eccentric Widening - Left side
130840	130990	150	1A	New Construction - Realignment
130990	131152	162	2	Eccentric Widening - Left side
131+152	131+350	198	2	Eccentric Widening - Left side
131+350	131+470	120	8	Eccentric Widening - Left Hill
131+470	131+592	122	8	Eccentric Widening - Right Hill
131+592	131+607	15		MNB
131+607	131+720	113	2	Eccentric Widening - Right side
131+720	131+800	80	8	Eccentric Widening - Left Hill
131+800	131+920	120	8	Eccentric Widening - Right Hill
131+920	132+030	110	2	Eccentric Widening - Left side
132+030	132+110	80	8	Eccentric Widening - Right Hill
132+110	132+250	140	2	Eccentric Widening - Left side
132+250	132+420	170	8	Eccentric Widening - Right Hill
132+420	132+500	80	2	Eccentric Widening - Left side
132+500	132+600	100	8	Eccentric Widening - Left Hill
132+600	132+900	300	2	Eccentric Widening - Left side
132+900	133+200	300	1A	New Construction - Realignment
133+200	133+208	8		MNB
133+208	133+720	512	2	Eccentric Widening - Left side
133+720	134+200	480	8	Eccentric Widening - Right Hill
134+200	134+268	68	2	Eccentric Widening - Right side
134+268	134+292	24		MNB
134+292	134+430	138	1A	New Construction - Realignment
134+430	134+550	120	8A	New Construction - Realignment (Left Side Hill)
134+550	134+700	150	8	Eccentric Widening - Left Hill
134+700	134+900	200	8A	New Construction - Realignment (Left Side Hill)
134+900	134+950	50	8	Eccentric Widening - Right Hill
134+950	135+200	250	2	Eccentric Widening - Right side
135+200	135+300	100	8	Eccentric Widening - Right Hill
135+300	135+400	100	2	Eccentric Widening - Right side
135+400	135+500	100	8	Eccentric Widening - Right Hill
135+500	135+600	100	2	Eccentric Widening - Left side
135+600	135+800	200	8	Eccentric Widening - Right Hill
135+800	136+000	200	1A	New Construction - Realignment
136+000	136+100	100	2	Eccentric Widening - Left side
136+100	136+200	100	1A	New Construction - Realignment
136+200	136+300	100	8	Eccentric Widening - Left Hill
136+300	136+400	100	8	Eccentric Widening - Left Hill
136+400	136+600	200	8	Eccentric Widening - Right Hill
136+600	136+900	300	2	Eccentric Widening - Left side
136+900	136+950	50	1A	New Construction - Realignment

Annexure 6.6 : Widening Scheme (Section 6+7 Combined)

Design Chainage		Length (m)	TCS Type	Description
From	To			
136+950	137+220	270	9	New Construction - Both side Cutting
137+220	137+500	280	1A	New Construction - Realignment
137+500	137+900	400	2	Eccentric Widening - Left side
137+900	138+500	600	2	Eccentric Widening - Right side
138+500	138+600	100	2	Eccentric Widening - Left side
138+600	138+800	200	8	Eccentric Widening - Left Hill
138+800	139+000	200	2	Eccentric Widening - Left side
139+000	139+150	150	1A	New Construction - Realignment
139+150	139+200	50	8A	New Construction - Realignment (Right Side Hill)
139+200	139+430	230	2	Eccentric Widening - Left side
139+430	139+550	120	1A	New Construction - Realignment
139+550	139+800	250	2	Eccentric Widening - Left side
139+800	139+904	104	1A	New Construction - Realignment
139+904	139+927	23		MNB
139+927	140+100	173	1A	New Construction - Realignment
140+100	140+500	400	2	Eccentric Widening - Left side
140+500	140+600	100	1A	New Construction - Realignment
140+600	140+750	150	8A	New Construction - Realignment (Right Side Hill)
140+750	140+950	200	8	Eccentric Widening - Right Hill
140+950	141+030	80	8	Eccentric Widening - Left Hill
141+030	141+200	170	1A	New Construction - Realignment
141+200	141+700	500	2	Eccentric Widening - Left side
141+700	141+800	100	2	Eccentric Widening - Right side
141+800	141+950	150	8	Eccentric Widening - Left Hill
141+950	142+289	339	2	Eccentric Widening - Left side
142+289	142+301	12		MNB
142+301	142+600	299	2	Eccentric Widening - Right side
142+600	142+750	150	2	Eccentric Widening - Left side
142+750	143+249	499	2	Eccentric Widening - Right side
143+249	143+261	12		MNB
143+261	143+500	239	2	Eccentric Widening - Right side
143+500	143+616	116	1A	New Construction - Realignment
143+616	143+624	8		MNB
143+624	143+800	176	1A	New Construction - Realignment
143+800	144+093	293	2	Eccentric Widening - Right side
144+093	144+107	14		MNB
144+107	144+150	43	2	Eccentric Widening - Right side
144+150	144+330	180	8	Eccentric Widening - Left Hill
144+330	144+400	70	8	Eccentric Widening - Right Hill
144+400	144+530	130	8A	New Construction - Realignment (Right Side Hill)
144+530	144+700	170	1A	New Construction - Realignment
144+700	145+150	450	2	Eccentric Widening - Left side
145+150	145+200	50	9	New Construction - Both side Cutting
145+200	145+350	150	9	New Construction - Both side Cutting
145+350	145+550	200	1A	New Construction - Realignment
145+550	145+712	162	2	Eccentric Widening - Left side

Annexure 11.1 - Toll Rate											
Location:								Total Tollable Length (Km):		17.322	
Year			Inflation (5%)	Car/Jeep/ Van	Minibus	LCV	Bus	2- Axle	3 - Axle	4-6 Axle	>= 7 Axle
			1.00	0.39	0.63	0.63	1.32	2.07	2.07	2.07	2.52
01/Apr/2011	31/Mar/2012	2012	1.05	0.41	0.66	0.66	1.39	2.17	2.17	2.17	2.65
01/Apr/2012	31/Mar/2013	2013	1.10	0.43	0.69	0.69	1.46	2.28	2.28	2.28	2.78
01/Apr/2013	31/Mar/2014	2014	1.16	0.45	0.73	0.73	1.53	2.40	2.40	2.40	2.92
01/Apr/2014	31/Mar/2015	2015	1.22	0.47	0.77	0.77	1.60	2.52	2.52	2.52	3.06
01/Apr/2015	31/Mar/2016	2016	1.28	0.50	0.80	0.80	1.68	2.64	2.64	2.64	3.22
01/Apr/2016	31/Mar/2017	2017	1.34	0.52	0.84	0.84	1.77	2.77	2.77	2.77	3.38
01/Apr/2017	31/Mar/2018	2018	1.41	0.55	0.89	0.89	1.86	2.91	2.91	2.91	3.55
01/Apr/2018	31/Mar/2019	2019	1.48	0.58	0.93	0.93	1.95	3.06	3.06	3.06	3.72
01/Apr/2019	31/Mar/2020	2020	1.55	0.61	0.98	0.98	2.05	3.21	3.21	3.21	3.91
01/Apr/2020	31/Mar/2021	2021	1.63	0.64	1.03	1.03	2.15	3.37	3.37	3.37	4.10
01/Apr/2021	31/Mar/2022	2022	1.71	0.67	1.08	1.08	2.26	3.54	3.54	3.54	4.31
01/Apr/2022	31/Mar/2023	2023	1.80	0.70	1.13	1.13	2.37	3.72	3.72	3.72	4.53
01/Apr/2023	31/Mar/2024	2024	1.89	0.74	1.19	1.19	2.49	3.90	3.90	3.90	4.75
01/Apr/2024	31/Mar/2025	2025	1.98	0.77	1.25	1.25	2.61	4.10	4.10	4.10	4.99
01/Apr/2025	31/Mar/2026	2026	2.08	0.81	1.31	1.31	2.74	4.30	4.30	4.30	5.24
01/Apr/2026	31/Mar/2027	2027	2.18	0.85	1.38	1.38	2.88	4.52	4.52	4.52	5.50
01/Apr/2027	31/Mar/2028	2028	2.29	0.89	1.44	1.44	3.03	4.74	4.74	4.74	5.78
01/Apr/2028	31/Mar/2029	2029	2.41	0.94	1.52	1.52	3.18	4.98	4.98	4.98	6.06
01/Apr/2029	31/Mar/2030	2030	2.53	0.99	1.59	1.59	3.34	5.23	5.23	5.23	6.37
01/Apr/2030	31/Mar/2031	2031	2.65	1.03	1.67	1.67	3.50	5.49	5.49	5.49	6.69
01/Apr/2031	31/Mar/2032	2032	2.79	1.09	1.76	1.76	3.68	5.77	5.77	5.77	7.02
01/Apr/2032	31/Mar/2033	2033	2.93	1.14	1.84	1.84	3.86	6.06	6.06	6.06	7.37
01/Apr/2033	31/Mar/2034	2034	3.07	1.20	1.94	1.94	4.05	6.36	6.36	6.36	7.74
01/Apr/2034	31/Mar/2035	2035	3.23	1.26	2.03	2.03	4.26	6.68	6.68	6.68	8.13
01/Apr/2035	31/Mar/2036	2036	3.39	1.32	2.13	2.13	4.47	7.01	7.01	7.01	8.53
01/Apr/2036	31/Mar/2037	2037	3.56	1.39	2.24	2.24	4.69	7.36	7.36	7.36	8.96
01/Apr/2037	31/Mar/2038	2038	3.73	1.46	2.35	2.35	4.93	7.73	7.73	7.73	9.41
01/Apr/2038	31/Mar/2039	2039	3.92	1.53	2.47	2.47	5.17	8.11	8.11	8.11	9.88
01/Apr/2039	31/Mar/2040	2040	4.12	1.61	2.59	2.59	5.43	8.52	8.52	8.52	10.37
01/Apr/2040	31/Mar/2041	2041	4.32	1.69	2.72	2.72	5.70	8.95	8.95	8.95	10.89
01/Apr/2041	31/Mar/2042	2042	4.54	1.77	2.86	2.86	5.99	9.39	9.39	9.39	11.44
01/Apr/2042	31/Mar/2043	2043	4.76	1.86	3.00	3.00	6.29	9.86	9.86	9.86	12.01
01/Apr/2043	31/Mar/2044	2044	5.00	1.95	3.15	3.15	6.60	10.36	10.36	10.36	12.61
01/Apr/2044	31/Mar/2045	2045	5.25	2.05	3.31	3.31	6.93	10.87	10.87	10.87	13.24
01/Apr/2045	31/Mar/2046	2046	5.52	2.15	3.48	3.48	7.28	11.42	11.42	11.42	13.90
01/Apr/2046	31/Mar/2047	2047	5.79	2.26	3.65	3.65	7.65	11.99	11.99	11.99	14.60
01/Apr/2047	31/Mar/2048	2048	6.08	2.37	3.83	3.83	8.03	12.59	12.59	12.59	15.33
01/Apr/2048	31/Mar/2049	2049	6.39	2.49	4.02	4.02	8.43	13.22	13.22	13.22	16.09
01/Apr/2049	31/Mar/2050	2050	6.70	2.61	4.22	4.22	8.85	13.88	13.88	13.88	16.90

Annexure 11.2 - Base Traffic

Year	Traffic Increase	Car/ Jeep/Van/ LMV	Taxi/ Tata Magic / LMV	Minibus	Std. Bus	LCV	2-Axle	3-Axle	4-Axle and 6 Axle	7 Axle Above	Total Tollable	Total Traffic
2018		1,657	34	49	259	483	182	83	72	-	2,819	-
2019		1,784	36	53	279	518	195	89	77	-	3,032	-
2020		1,922	39	57	301	555	209	96	83	-	3,261	-
2021		2,068	42	61	323	595	224	102	88	-	3,504	-
2022		2,225	45	66	348	638	240	109	94	-	3,765	-
2023		2,394	49	70	374	684	257	116	101	-	4,045	-
2024		2,576	53	76	402	733	276	124	107	-	4,347	-
2025		2,772	57	81	432	786	296	133	115	-	4,671	-
2026		2,946	60	86	457	834	314	140	121	-	4,960	-
2027		3,132	64	91	483	886	334	149	128	-	5,267	-
2028		3,329	68	96	511	941	354	157	136	-	5,594	-
2029		3,539	72	102	541	999	376	166	144	-	5,940	-
2030		3,762	77	108	573	1,061	400	176	152	-	6,308	-
2031		3,969	81	113	602	1,121	422	184	159	-	6,652	-
2032		4,187	85	119	634	1,183	446	193	167	-	7,015	-
2033		4,418	90	126	667	1,250	471	202	175	-	7,398	-
2034		4,661	95	132	701	1,320	497	212	184	-	7,802	-
2035		4,917	100	139	738	1,394	525	222	192	-	8,227	-
2036		5,187	106	146	776	1,472	554	233	202	-	8,676	-
2037		5,473	112	154	816	1,554	585	244	211	-	9,150	-
2038		5,774	118	162	859	1,641	618	256	221	-	9,649	-
2039		6,091	124	170	904	1,733	653	268	232	-	10,175	-
2040		6,426	131	179	951	1,830	689	281	243	-	10,731	-
2041		6,780	138	188	1,000	1,932	728	295	255	-	11,316	-
2042		7,153	146	198	1,052	2,041	769	309	267	-	11,934	-
2043		7,546	154	208	1,107	2,155	812	324	280	-	12,585	-
2044		7,961	163	219	1,164	2,276	857	339	293	-	13,272	-
2045		8,399	171	231	1,225	2,403	905	355	307	-	13,997	-
2046		8,861	181	243	1,288	2,538	956	372	322	-	14,761	-
2047		9,348	191	255	1,355	2,680	1,009	390	338	-	15,567	-
2048		9,862	201	269	1,426	2,830	1,066	409	354	-	16,417	-
2049		10,405	212	283	1,500	2,988	1,126	429	371	-	17,313	-
2050		10,977	224	297	1,578	3,156	1,189	449	389	-	18,259	-
2051		11,581	236	313	1,660	3,332	1,255	471	407	-	19,256	-

Annexure 11.3 - Toll Revenue

		01/Apr/2022	01/Apr/2023	01/Apr/2024	01/Apr/2025	01/Apr/2026	01/Apr/2027	01/Apr/2028	01/Apr/2029	01/Apr/2030	01/Apr/2031	01/Apr/2032	01/Apr/2033	01/Apr/2034	01/Apr/2035
Units		31/Mar/2023	31/Mar/2024	31/Mar/2025	31/Mar/2026	31/Mar/2027	31/Mar/2028	31/Mar/2029	31/Mar/2030	31/Mar/2031	31/Mar/2032	31/Mar/2033	31/Mar/2034	31/Mar/2035	31/Mar/2036
		365	365	365	365	365	365	365	365	365	365	365	365	365	365
		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Toll Revenue															
Car/Jeep/Van/ LMV	INR Crore	0.72	1.18	1.27	1.35	1.44	1.53	1.63	1.74	2.35	2.49	2.63	2.78	2.94	3.91
Taxi/ TataMagic / LMV	INR Crore	0.01	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.05	0.05	0.05	0.06	0.06	0.08
Minibus	INR Crore	0.05	0.05	0.05	0.07	0.08	0.08	0.08	0.11	0.11	0.12	0.12	0.15	0.16	0.17
Std. Bus	INR Crore	0.42	0.51	0.55	0.64	0.68	0.72	0.85	0.97	1.02	1.17	1.23	1.39	1.57	1.65
LCV	INR Crore	0.47	0.51	0.54	0.72	0.77	0.82	0.87	1.10	1.16	1.23	1.29	1.60	1.69	1.78
2-Axle	INR Crore	0.56	0.64	0.69	0.79	0.89	0.94	1.07	1.20	1.34	1.48	1.65	1.82	2.01	2.21
3-Axle	INR Crore	0.26	0.30	0.32	0.37	0.41	0.44	0.49	0.55	0.61	0.67	0.74	0.81	0.89	0.97
4-Axle and6 Axle	INR Crore	0.22	0.26	0.27	0.31	0.35	0.37	0.42	0.47	0.52	0.57	0.63	0.69	0.75	0.82
7 AxleAbove	INR Crore	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Toll Revenue	INR Crore	2.72	3.47	3.73	4.28	4.64	4.93	5.44	6.16	7.15	7.77	8.34	9.29	10.07	11.60
Adjusted Toll Revenue	INR Crore	2.72	3.47	3.73	4.28	4.64	4.93	5.44	6.16	7.15	7.77	8.34	9.29	10.07	11.60

		01/Apr/2036	01/Apr/2037	01/Apr/2038	01/Apr/2039	01/Apr/2040	01/Apr/2041	01/Apr/2042	01/Apr/2043	01/Apr/2044	01/Apr/2045	01/Apr/2046	01/Apr/2047	01/Apr/2048
Units		31/Mar/2037	31/Mar/2038	31/Mar/2039	31/Mar/2040	31/Mar/2041	31/Mar/2042	31/Mar/2043	31/Mar/2044	31/Mar/2045	31/Mar/2046	31/Mar/2047	31/Mar/2048	31/Mar/2049
		365	365	365	365	365	365	365	365	365	365	365	365	365
		2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
Toll Revenue														
Car/Jeep/Van/ LMV	INR Crore	4.14	4.38	4.63	5.72	6.05	6.40	6.77	8.38	8.87	9.38	11.12	11.76	14.05
Taxi/ TataMagic / LMV	INR Crore	0.09	0.09	0.09	0.12	0.12	0.13	0.14	0.17	0.18	0.19	0.23	0.24	0.29
Minibus	INR Crore	0.20	0.21	0.25	0.27	0.28	0.33	0.34	0.40	0.42	0.48	0.55	0.58	0.65
Std. Bus	INR Crore	1.84	2.07	2.30	2.56	2.82	3.13	3.44	3.79	4.15	4.56	4.97	5.63	6.15
LCV	INR Crore	2.15	2.27	2.70	2.85	3.01	3.52	3.72	4.33	4.57	5.26	6.02	6.36	7.22
2-Axle	INR Crore	2.44	2.78	3.04	3.44	3.75	4.22	4.59	5.13	5.72	6.35	7.05	7.79	8.60
3-Axle	INR Crore	1.06	1.20	1.30	1.46	1.59	1.77	1.91	2.12	2.34	2.58	2.84	3.12	3.42
4-Axle and6 Axle	INR Crore	0.90	1.02	1.11	1.24	1.35	1.50	1.62	1.80	1.99	2.19	2.41	2.65	2.90
7 AxleAbove	INR Crore	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Toll Revenue	INR Crore	12.81	14.01	15.42	17.65	18.97	20.99	22.51	26.12	28.24	30.99	35.20	38.14	43.29
Adjusted Toll Revenue	INR Crore	12.81	14.01	15.42	17.65	18.97	20.99	22.51	26.12	28.24	30.99	35.20	38.14	43.29

Annexure 11.4 - Profit & Loss Statement

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
INR Crore	01/Apr/2022 31/Mar/2023	01/Apr/2023 31/Mar/2024	01/Apr/2024 31/Mar/2025	01/Apr/2025 31/Mar/2026	01/Apr/2026 31/Mar/2027	01/Apr/2027 31/Mar/2028	01/Apr/2028 31/Mar/2029	01/Apr/2029 31/Mar/2030	01/Apr/2030 31/Mar/2031	01/Apr/2031 31/Mar/2032	01/Apr/2032 31/Mar/2033	01/Apr/2033 31/Mar/2034	01/Apr/2034 31/Mar/2035	01/Apr/2035 31/Mar/2036
	365 2023	365 2024	365 2025	365 2026	365 2027	365 2028	365 2029	365 2030	365 2031	365 2032	365 2033	365 2034	365 2035	365 2036

Revenue	2.72	3.47	3.73	4.28	4.64	4.93	5.44	6.16	7.15	7.77	8.34	9.29	10.07	11.60
Maintenance Cost	0.64	0.67	0.71	0.74	0.78	15.07	0.86	0.90	0.95	0.99	1.04	20.20	1.15	1.21
EBITDA	2.08	2.80	3.02	3.54	3.87	-10.14	4.58	5.26	6.21	6.78	7.30	-10.91	8.92	10.40
EBITDA Margin	76.5%	80.6%	81.1%	82.7%	83.2%	-205.7%	84.2%	85.4%	86.8%	87.2%	87.5%	-117.4%	88.6%	89.6%
Depreciation	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54
Interest	11.04	10.57	9.54	8.53	7.53	6.54	5.52	4.52	3.51	2.52	1.51	0.50	-	-
PBT	-14.50	-13.31	-12.05	-10.53	-9.20	-22.22	-6.48	-4.79	-2.84	-1.28	0.25	-16.95	3.39	4.86
Tax	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PAT	-14.50	-13.31	-12.05	-10.53	-9.20	-22.22	-6.48	-4.79	-2.84	-1.28	0.25	-16.95	3.39	4.86
PAT Margin	-533%	-384%	-323%	-246%	-198%	-451%	-119%	-78%	-40%	-16%	3%	-182%	34%	42%

	15	16	17	18	19	20	21	22	23	24	25	26	27
INR Crore	01/Apr/2036 31/Mar/2037	01/Apr/2037 31/Mar/2038	01/Apr/2038 31/Mar/2039	01/Apr/2039 31/Mar/2040	01/Apr/2040 31/Mar/2041	01/Apr/2041 31/Mar/2042	01/Apr/2042 31/Mar/2043	01/Apr/2043 31/Mar/2044	01/Apr/2044 31/Mar/2045	01/Apr/2045 31/Mar/2046	01/Apr/2046 31/Mar/2047	01/Apr/2047 31/Mar/2048	01/Apr/2048 31/Mar/2049
	365 2037	365 2038	365 2039	365 2040	365 2041	365 2042	365 2043	365 2044	365 2045	365 2046	365 2047	365 2048	365 2049

Revenue	12.81	14.01	15.42	17.65	18.97	20.99	22.51	26.12	28.24	30.99	35.20	38.14	43.29
Maintenance Cost	1.27	1.33	1.40	27.07	1.54	1.62	1.70	1.78	1.87	36.27	2.06	2.17	2.28
EBITDA	11.54	12.68	14.02	-9.42	17.43	19.38	20.82	24.33	26.36	-5.28	33.13	35.97	41.01
EBITDA Margin	90.1%	90.5%	90.9%	-53.4%	91.9%	92.3%	92.5%	93.2%	93.4%	-17.0%	94.1%	94.3%	94.7%
Depreciation	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54
Interest	-	-	-	-	-	-	-	-	-	-	-	-	-
PBT	6.01	7.15	8.48	-14.95	11.89	13.84	15.28	18.80	20.83	-10.81	27.60	30.44	35.48
Tax	-	-	-	-	-	-	-	-	-	-	-	6.36	10.07
PAT	6.01	7.15	8.48	-14.95	11.89	13.84	15.28	18.80	20.83	-10.81	27.60	24.08	25.41
PAT Margin	47%	51%	55%	-85%	63%	66%	68%	72%	74%	-35%	78%	63%	59%

Annexure 11.5 - Balance Sheet

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	01/Oct/2020	01/Apr/2021	01/Apr/2022	01/Apr/2023	01/Apr/2024	01/Apr/2025	01/Apr/2026	01/Apr/2027	01/Apr/2028	01/Apr/2029	01/Apr/2030	01/Apr/2031	01/Apr/2032	01/Apr/2033	01/Apr/2034
INR Crore	31/Mar/2021	31/Mar/2022	31/Mar/2023	31/Mar/2024	31/Mar/2025	31/Mar/2026	31/Mar/2027	31/Mar/2028	31/Mar/2029	31/Mar/2030	31/Mar/2031	31/Mar/2032	31/Mar/2033	31/Mar/2034	31/Mar/2035
	182	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035

Share Capital	13.33	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32
Reserves	-	-	-14.50	-27.80	-39.86	-50.39	-59.59	-81.81	-88.28	-93.07	-95.92	-97.19	-96.94	-113.89	-110.50
Shareholder's Fund	13.33	47.32	32.83	19.52	7.47	-3.06	-12.26	-34.48	-40.96	-45.75	-48.59	-49.87	-49.62	-66.56	-63.17
Loan Fund	31.11	110.42	110.42	100.39	90.35	80.31	70.27	60.23	50.19	40.15	30.12	20.08	10.04	0.00	0.00
Source of Fund	44.44	157.75	143.25	119.91	97.81	77.25	58.01	25.75	9.23	-5.60	-18.48	-29.79	-39.58	-66.56	-63.17

Gross Block	44.44	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75
Accumulated Depreciation	-	-	5.54	11.07	16.61	22.14	27.68	33.21	38.75	44.28	49.82	55.35	60.89	66.42	71.96
Net Block	44.44	157.75	152.21	146.68	141.14	135.61	130.07	124.54	119.00	113.47	107.93	102.40	96.86	91.33	85.79
Cash & Bank	-	-	-8.96	-26.77	-43.33	-58.36	-72.07	-98.79	-109.77	-119.06	-126.41	-132.19	-136.44	-157.89	-148.97
Application of Fund	44.44	157.75	143.25	119.91	97.81	77.25	58.01	25.75	9.23	-5.60	-18.48	-29.79	-39.58	-66.56	-63.17

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	01/Apr/2035	01/Apr/2036	01/Apr/2037	01/Apr/2038	01/Apr/2039	01/Apr/2040	01/Apr/2041	01/Apr/2042	01/Apr/2043	01/Apr/2044	01/Apr/2045	01/Apr/2046	01/Apr/2047	01/Apr/2048	01/Apr/2049
INR Crore	31/Mar/2036	31/Mar/2037	31/Mar/2038	31/Mar/2039	31/Mar/2040	31/Mar/2041	31/Mar/2042	31/Mar/2043	31/Mar/2044	31/Mar/2045	31/Mar/2046	31/Mar/2047	31/Mar/2048	31/Mar/2049	31/Mar/2050
	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050

Share Capital	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32
Reserves	-105.64	-99.63	-92.49	-84.00	-98.95	-87.06	-73.22	-57.94	-39.14	-18.31	-29.12	-1.52	22.55	47.97	76.34
Shareholder's Fund	-58.31	-52.31	-45.16	-36.68	-51.63	-39.73	-25.89	-10.61	8.19	29.02	18.20	45.80	69.88	95.29	123.66
Loan Fund	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Source of Fund	-58.31	-52.31	-45.16	-36.68	-51.63	-39.73	-25.89	-10.61	8.19	29.02	18.20	45.80	69.88	95.29	123.66

Gross Block	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75
Accumulated Depreciation	77.49	83.03	88.56	94.10	99.63	105.17	110.70	116.24	121.77	127.31	132.84	138.38	143.91	149.45	154.98
Net Block	80.26	74.72	69.19	63.65	58.12	52.58	47.05	41.51	35.98	30.44	24.91	19.37	13.84	8.30	2.77
Cash & Bank	-138.57	-127.03	-114.35	-100.33	-109.75	-92.32	-72.94	-52.13	-27.79	-1.43	-6.71	26.43	56.04	86.99	120.90
Application of Fund	-58.31	-52.31	-45.16	-36.68	-51.63	-39.73	-25.89	-10.61	8.19	29.02	18.20	45.80	69.88	95.29	123.66

Annexure 11.6 - Cash Flow Statement

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	01/Oct/2020	01/Apr/2021	01/Apr/2022	01/Apr/2023	01/Apr/2024	01/Apr/2025	01/Apr/2026	01/Apr/2027	01/Apr/2028	01/Apr/2029	01/Apr/2030	01/Apr/2031	01/Apr/2032	01/Apr/2033	01/Apr/2034
INR Crore	31/Mar/2021	31/Mar/2022	31/Mar/2023	31/Mar/2024	31/Mar/2025	31/Mar/2026	31/Mar/2027	31/Mar/2028	31/Mar/2029	31/Mar/2030	31/Mar/2031	31/Mar/2032	31/Mar/2033	31/Mar/2034	31/Mar/2035
	182	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
PAT	-	-	-14.50	-13.31	-12.05	-10.53	-9.20	-22.22	-6.48	-4.79	-2.84	-1.28	0.25	-16.95	3.39
Depreciation	-	-	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54
Interest	-	-	11.04	10.57	9.54	8.53	7.53	6.54	5.52	4.52	3.51	2.52	1.51	0.50	-
Change in Working Capital															
Cash Flow from Operating Activities	-	-	2.08	2.80	3.02	3.54	3.87	-10.14	4.58	5.26	6.21	6.78	7.30	-10.91	8.92
Capex	-73.46	-184.13	-	-	-	-	-	-	-	-	-	-	-	-	-
Cash Flow from Investing Activities	-73.46	-184.13	-	-	-	-	-	-	-	-	-	-	-	-	-
Equity	13.33	33.99	-	-	-	-	-	-	-	-	-	-	-	-	-
Term Loan Raised	31.11	79.32	-	-	-	-	-	-	-	-	-	-	-	-	-
Term Loan Repayed	-	-	-	-10.04	-10.04	-10.04	-10.04	-10.04	-10.04	-10.04	-10.04	-10.04	-10.04	-10.04	-
Grant	29.03	70.82	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Paid	-	-	-11.04	-10.57	-9.54	-8.53	-7.53	-6.54	-5.52	-4.52	-3.51	-2.52	-1.51	-0.50	-
Cash Flow from Financing Activities	73.46	184.13	-11.04	-20.61	-19.58	-18.57	-17.57	-16.58	-15.56	-14.56	-13.55	-12.56	-11.55	-10.54	-
Net Cash Flow	-	-	-8.96	-17.81	-16.56	-15.03	-13.70	-26.72	-10.98	-9.29	-7.35	-5.78	-4.25	-21.45	8.92
Opening Cash Balance		-	-	-8.96	-26.77	-43.33	-58.36	-72.07	-98.79	-109.77	-119.06	-126.41	-132.19	-136.44	-157.89
Closing Cash Balance	-	-	-8.96	-26.77	-43.33	-58.36	-72.07	-98.79	-109.77	-119.06	-126.41	-132.19	-136.44	-157.89	-148.97

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	01/Apr/2035	01/Apr/2036	01/Apr/2037	01/Apr/2038	01/Apr/2039	01/Apr/2040	01/Apr/2041	01/Apr/2042	01/Apr/2043	01/Apr/2044	01/Apr/2045	01/Apr/2046	01/Apr/2047	01/Apr/2048	01/Apr/2049
INR Crore	31/Mar/2036	31/Mar/2037	31/Mar/2038	31/Mar/2039	31/Mar/2040	31/Mar/2041	31/Mar/2042	31/Mar/2043	31/Mar/2044	31/Mar/2045	31/Mar/2046	31/Mar/2047	31/Mar/2048	31/Mar/2049	31/Mar/2050
	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
PAT	4.86	6.01	7.15	8.48	-14.95	11.89	13.84	15.28	18.80	20.83	-10.81	27.60	24.08	25.41	28.37
Depreciation	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54
Interest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Working Capital															
Cash Flow from Operating Activities	10.40	11.54	12.68	14.02	-9.42	17.43	19.38	20.82	24.33	26.36	-5.28	33.13	29.61	30.95	33.91
Capex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cash Flow from Investing Activities	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Equity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Term Loan Raised	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Term Loan Repayed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Paid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cash Flow from Financing Activities	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Cash Flow	10.40	11.54	12.68	14.02	-9.42	17.43	19.38	20.82	24.33	26.36	-5.28	33.13	29.61	30.95	33.91
Opening Cash Balance	-148.97	-138.57	-127.03	-114.35	-100.33	-109.75	-92.32	-72.94	-52.13	-27.79	-1.43	-6.71	26.43	56.04	86.99
Closing Cash Balance	-138.57	-127.03	-114.35	-100.33	-109.75	-92.32	-72.94	-52.13	-27.79	-1.43	-6.71	26.43	56.04	86.99	120.90

Annexure 11.7 - Financial Analysis

INR Crore	01/Oct/2020	01/Apr/2021	01/Apr/2022	01/Apr/2023	01/Apr/2024	01/Apr/2025	01/Apr/2026	01/Apr/2027	01/Apr/2028	01/Apr/2029	01/Apr/2030	01/Apr/2031	01/Apr/2032	01/Apr/2033	01/Apr/2034
	31/Mar/2021	31/Mar/2022	31/Mar/2023	31/Mar/2024	31/Mar/2025	31/Mar/2026	31/Mar/2027	31/Mar/2028	31/Mar/2029	31/Mar/2030	31/Mar/2031	31/Mar/2032	31/Mar/2033	31/Mar/2034	31/Mar/2035
	182	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035

Project Cash Flow	-44.44	-113.31	2.08	2.80	3.02	3.54	3.87	-10.14	4.58	5.26	6.21	6.78	7.30	-10.91	8.92
Equity Cash Flow	-13.33	-33.99	-8.96	-17.81	-16.56	-15.03	-13.70	-26.72	-10.98	-9.29	-7.35	-5.78	-4.25	-21.45	8.92
DSCR	-	-	0.19	0.14	0.15	0.19	0.22	-0.61	0.29	0.36	0.46	0.54	0.63	-1.03	-

INR Crore	01/Apr/2035	01/Apr/2036	01/Apr/2037	01/Apr/2038	01/Apr/2039	01/Apr/2040	01/Apr/2041	01/Apr/2042	01/Apr/2043	01/Apr/2044	01/Apr/2045	01/Apr/2046	01/Apr/2047	01/Apr/2048	01/Apr/2049
	31/Mar/2036	31/Mar/2037	31/Mar/2038	31/Mar/2039	31/Mar/2040	31/Mar/2041	31/Mar/2042	31/Mar/2043	31/Mar/2044	31/Mar/2045	31/Mar/2046	31/Mar/2047	31/Mar/2048	31/Mar/2049	31/Mar/2050
	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050

Project Cash Flow	10.40	11.54	12.68	14.02	-9.42	17.43	19.38	20.82	24.33	26.36	-5.28	33.13	29.61	30.95	33.91
Equity Cash Flow	10.40	11.54	12.68	14.02	-9.42	17.43	19.38	20.82	24.33	26.36	-5.28	33.13	29.61	30.95	33.91
DSCR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Project IRR	3.4%
Equity IRR	2.1%
Avg DSCR	0.13
Min DSCR	-1.03

Annexure 11.8 - Profit & Loss Statement

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
INR Crore	01/Apr/2022 31/Mar/2023	01/Apr/2023 31/Mar/2024	01/Apr/2024 31/Mar/2025	01/Apr/2025 31/Mar/2026	01/Apr/2026 31/Mar/2027	01/Apr/2027 31/Mar/2028	01/Apr/2028 31/Mar/2029	01/Apr/2029 31/Mar/2030	01/Apr/2030 31/Mar/2031	01/Apr/2031 31/Mar/2032	01/Apr/2032 31/Mar/2033	01/Apr/2033 31/Mar/2034	01/Apr/2034 31/Mar/2035	01/Apr/2035 31/Mar/2036
	365 2023	365 2024	365 2025	365 2026	365 2027	365 2028	365 2029	365 2030	365 2031	365 2032	365 2033	365 2034	365 2035	365 2036

Revenue	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50
Maintenance Cost	0.64	0.67	0.71	0.74	0.78	15.07	0.86	0.90	0.95	0.99	1.04	20.20	1.15	1.21
EBITDA	24.86	24.83	24.79	24.76	24.72	10.43	24.64	24.60	24.55	24.51	24.46	5.30	24.35	24.29
EBITDA Margin	97.5%	97.4%	97.2%	97.1%	96.9%	40.9%	96.6%	96.5%	96.3%	96.1%	95.9%	20.8%	95.5%	95.3%
Depreciation	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54
Interest	11.04	10.57	9.54	8.53	7.53	6.54	5.52	4.52	3.51	2.52	1.51	0.50	-	-
PBT	8.28	8.72	9.72	10.69	11.66	-1.65	13.58	14.55	15.50	16.46	17.42	-0.74	18.82	18.76
Tax	-	-	0.15	1.19	1.72	-	2.70	3.16	3.59	4.00	4.39	-	5.01	5.10
PAT	8.28	8.72	9.57	9.50	9.93	-1.65	10.88	11.39	11.92	12.46	13.02	-0.74	13.81	13.65
PAT Margin	32%	34%	38%	37%	39%	-6%	43%	45%	47%	49%	51%	-3%	54%	54%

	15	16	17	18	19	20	21	22	23	24	25	26	27
INR Crore	01/Apr/2036 31/Mar/2037	01/Apr/2037 31/Mar/2038	01/Apr/2038 31/Mar/2039	01/Apr/2039 31/Mar/2040	01/Apr/2040 31/Mar/2041	01/Apr/2041 31/Mar/2042	01/Apr/2042 31/Mar/2043	01/Apr/2043 31/Mar/2044	01/Apr/2044 31/Mar/2045	01/Apr/2045 31/Mar/2046	01/Apr/2046 31/Mar/2047	01/Apr/2047 31/Mar/2048	01/Apr/2048 31/Mar/2049
	365 2037	365 2038	365 2039	365 2040	365 2041	365 2042	365 2043	365 2044	365 2045	365 2046	365 2047	365 2048	365 2049

Revenue	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50
Maintenance Cost	1.27	1.33	1.40	27.07	1.54	1.62	1.70	1.78	1.87	36.27	2.06	2.17	2.28
EBITDA	24.23	24.17	24.10	-1.57	23.96	23.88	23.80	23.72	23.63	-10.77	23.44	23.33	23.22
EBITDA Margin	95.0%	94.8%	94.5%	-6.1%	94.0%	93.7%	93.3%	93.0%	92.7%	-42.2%	91.9%	91.5%	91.1%
Depreciation	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54
Interest	-	-	-	-	-	-	-	-	-	-	-	-	-
PBT	18.70	18.63	18.57	-7.10	18.42	18.35	18.27	18.18	18.09	-16.31	17.90	17.80	17.69
Tax	5.19	5.27	5.33	-	5.43	5.47	5.51	5.53	5.56	-	5.58	5.59	5.59
PAT	13.51	13.37	13.24	-7.10	12.99	12.87	12.76	12.65	12.54	-16.31	12.32	12.21	12.10
PAT Margin	53%	52%	52%	-28%	51%	50%	50%	50%	49%	-64%	48%	48%	47%

Annexure 11.9 - Balance Sheet

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	01/Oct/2020	01/Apr/2021	01/Apr/2022	01/Apr/2023	01/Apr/2024	01/Apr/2025	01/Apr/2026	01/Apr/2027	01/Apr/2028	01/Apr/2029	01/Apr/2030	01/Apr/2031	01/Apr/2032	01/Apr/2033	01/Apr/2034
INR Crore	31/Mar/2021	31/Mar/2022	31/Mar/2023	31/Mar/2024	31/Mar/2025	31/Mar/2026	31/Mar/2027	31/Mar/2028	31/Mar/2029	31/Mar/2030	31/Mar/2031	31/Mar/2032	31/Mar/2033	31/Mar/2034	31/Mar/2035
	182	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035

Share Capital	13.33	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32
Reserves	-	-	8.28	17.01	26.58	36.08	46.02	44.37	55.25	66.64	78.56	91.02	104.04	103.31	117.11	
Shareholder's Fund	13.33	47.32	55.61	64.33	73.91	83.41	93.34	91.69	102.57	113.96	125.88	138.34	151.37	150.63	164.44	
Loan Fund	31.11	110.42	110.42	100.39	90.35	80.31	70.27	60.23	50.19	40.15	30.12	20.08	10.04	0.00	0.00	
Source of Fund	44.44	157.75	166.03	164.72	164.25	163.71	163.61	151.92	152.77	154.12	156.00	158.42	161.40	150.63	164.44	

Gross Block	44.44	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75
Accumulated Depreciation	-	-	5.54	11.07	16.61	22.14	27.68	33.21	38.75	44.28	49.82	55.35	60.89	66.42	71.96	
Net Block	44.44	157.75	152.21	146.68	141.14	135.61	130.07	124.54	119.00	113.47	107.93	102.40	96.86	91.33	85.79	
Cash & Bank	-	-	13.82	18.04	23.11	28.11	33.54	27.38	33.76	40.65	48.07	56.02	64.54	59.30	78.65	
Application of Fund	44.44	157.75	166.03	164.72	164.25	163.71	163.61	151.92	152.77	154.12	156.00	158.42	161.40	150.63	164.44	

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	01/Apr/2035	01/Apr/2036	01/Apr/2037	01/Apr/2038	01/Apr/2039	01/Apr/2040	01/Apr/2041	01/Apr/2042	01/Apr/2043	01/Apr/2044	01/Apr/2045	01/Apr/2046	01/Apr/2047	01/Apr/2048	01/Apr/2049
INR Crore	31/Mar/2036	31/Mar/2037	31/Mar/2038	31/Mar/2039	31/Mar/2040	31/Mar/2041	31/Mar/2042	31/Mar/2043	31/Mar/2044	31/Mar/2045	31/Mar/2046	31/Mar/2047	31/Mar/2048	31/Mar/2049	31/Mar/2050
	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050

Share Capital	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32	47.32
Reserves	130.77	144.27	157.64	170.88	163.78	176.77	189.64	202.40	215.05	227.59	211.28	223.60	235.81	247.91	259.90	
Shareholder's Fund	178.09	191.60	204.97	218.21	211.10	224.09	236.97	249.73	262.37	274.91	258.60	270.92	283.13	295.24	307.23	
Loan Fund	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Source of Fund	178.09	191.60	204.97	218.21	211.10	224.09	236.97	249.73	262.37	274.91	258.60	270.92	283.13	295.24	307.23	

Gross Block	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75	157.75
Accumulated Depreciation	77.49	83.03	88.56	94.10	99.63	105.17	110.70	116.24	121.77	127.31	132.84	138.38	143.91	149.45	154.98	
Net Block	80.26	74.72	69.19	63.65	58.12	52.58	47.05	41.51	35.98	30.44	24.91	19.37	13.84	8.30	2.77	
Cash & Bank	97.83	116.88	135.78	154.55	152.99	171.51	189.92	208.21	226.40	244.47	233.70	251.55	269.30	286.93	304.46	
Application of Fund	178.09	191.60	204.97	218.21	211.10	224.09	236.97	249.73	262.37	274.91	258.60	270.92	283.13	295.24	307.23	

Annexure 11.10 - Cash Flow Statement

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	01/Oct/2020	01/Apr/2021	01/Apr/2022	01/Apr/2023	01/Apr/2024	01/Apr/2025	01/Apr/2026	01/Apr/2027	01/Apr/2028	01/Apr/2029	01/Apr/2030	01/Apr/2031	01/Apr/2032	01/Apr/2033	01/Apr/2034	01/Apr/2035
INR Crore	31/Mar/2021	31/Mar/2022	31/Mar/2023	31/Mar/2024	31/Mar/2025	31/Mar/2026	31/Mar/2027	31/Mar/2028	31/Mar/2029	31/Mar/2030	31/Mar/2031	31/Mar/2032	31/Mar/2033	31/Mar/2034	31/Mar/2035	
	182	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	
PAT	-	-	8.28	8.72	9.57	9.50	9.93	-1.65	10.88	11.39	11.92	12.46	13.02	-0.74	13.81	
Depreciation	-	-	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	
Interest	-	-	11.04	10.57	9.54	8.53	7.53	6.54	5.52	4.52	3.51	2.52	1.51	0.50	-	
Change in Working Capital																
Cash Flow from Operating Activities	-	-	24.86	24.83	24.65	23.57	23.00	10.43	21.94	21.44	20.97	20.51	20.07	5.30	19.34	
Capex	-73.46	-184.13	-	-	-	-	-	-	-	-	-	-	-	-	-	
Cash Flow from Investing Activities	-73.46	-184.13	-	-	-	-	-	-	-	-	-	-	-	-	-	
Equity	13.33	33.99	-	-	-	-	-	-	-	-	-	-	-	-	-	
Term Loan Raised	31.11	79.32	-	-	-	-	-	-	-	-	-	-	-	-	-	
Term Loan Repayed	-	-	-	-10.04	-10.04	-10.04	-10.04	-10.04	-10.04	-10.04	-10.04	-10.04	-10.04	-10.04	-	
Grant	29.03	70.82	-	-	-	-	-	-	-	-	-	-	-	-	-	
Interest Paid	-	-	-11.04	-10.57	-9.54	-8.53	-7.53	-6.54	-5.52	-4.52	-3.51	-2.52	-1.51	-0.50	-	
Cash Flow from Financing Activities	73.46	184.13	-11.04	-20.61	-19.58	-18.57	-17.57	-16.58	-15.56	-14.56	-13.55	-12.56	-11.55	-10.54	-	
Net Cash Flow	-	-	13.82	4.22	5.07	5.00	5.43	-6.15	6.38	6.89	7.41	7.96	8.52	-5.24	19.34	
Opening Cash Balance		-	-	13.82	18.04	23.11	28.11	33.54	27.38	33.76	40.65	48.07	56.02	64.54	59.30	
Closing Cash Balance	-	-	13.82	18.04	23.11	28.11	33.54	27.38	33.76	40.65	48.07	56.02	64.54	59.30	78.65	

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	01/Apr/2035	01/Apr/2036	01/Apr/2037	01/Apr/2038	01/Apr/2039	01/Apr/2040	01/Apr/2041	01/Apr/2042	01/Apr/2043	01/Apr/2044	01/Apr/2045	01/Apr/2046	01/Apr/2047	01/Apr/2048	01/Apr/2049
INR Crore	31/Mar/2036	31/Mar/2037	31/Mar/2038	31/Mar/2039	31/Mar/2040	31/Mar/2041	31/Mar/2042	31/Mar/2043	31/Mar/2044	31/Mar/2045	31/Mar/2046	31/Mar/2047	31/Mar/2048	31/Mar/2049	31/Mar/2050
	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
PAT	13.65	13.51	13.37	13.24	-7.10	12.99	12.87	12.76	12.65	12.54	-16.31	12.32	12.21	12.10	11.99
Depreciation	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54
Interest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Working Capital															
Cash Flow from Operating Activities	19.19	19.04	18.90	18.77	-1.57	18.53	18.41	18.29	18.18	18.07	-10.77	17.85	17.75	17.64	17.53
Capex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cash Flow from Investing Activities	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Equity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Term Loan Raised	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Term Loan Repayed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Paid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cash Flow from Financing Activities	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Cash Flow	19.19	19.04	18.90	18.77	-1.57	18.53	18.41	18.29	18.18	18.07	-10.77	17.85	17.75	17.64	17.53
Opening Cash Balance	78.65	97.83	116.88	135.78	154.55	152.99	171.51	189.92	208.21	226.40	244.47	233.70	251.55	269.30	286.93
Closing Cash Balance	97.83	116.88	135.78	154.55	152.99	171.51	189.92	208.21	226.40	244.47	233.70	251.55	269.30	286.93	304.46

Annexure 11.11 - Financial Analysis

INR Crore	01/Oct/2020	01/Apr/2021	01/Apr/2022	01/Apr/2023	01/Apr/2024	01/Apr/2025	01/Apr/2026	01/Apr/2027	01/Apr/2028	01/Apr/2029	01/Apr/2030	01/Apr/2031	01/Apr/2032	01/Apr/2033	01/Apr/2034
	31/Mar/2021	31/Mar/2022	31/Mar/2023	31/Mar/2024	31/Mar/2025	31/Mar/2026	31/Mar/2027	31/Mar/2028	31/Mar/2029	31/Mar/2030	31/Mar/2031	31/Mar/2032	31/Mar/2033	31/Mar/2034	31/Mar/2035
	182	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035

Project Cash Flow	-44.44	-113.31	24.86	24.83	24.65	23.57	23.00	10.43	21.94	21.44	20.97	20.51	20.07	5.30	19.34
Equity Cash Flow	-13.33	-33.99	13.82	4.22	5.07	5.00	5.43	-6.15	6.38	6.89	7.41	7.96	8.52	-5.24	19.34
DSCR	-	-	2.25	1.20	1.26	1.27	1.31	0.63	1.41	1.47	1.55	1.63	1.74	0.50	-

INR Crore	01/Apr/2035	01/Apr/2036	01/Apr/2037	01/Apr/2038	01/Apr/2039	01/Apr/2040	01/Apr/2041	01/Apr/2042	01/Apr/2043	01/Apr/2044	01/Apr/2045	01/Apr/2046	01/Apr/2047	01/Apr/2048	01/Apr/2049
	31/Mar/2036	31/Mar/2037	31/Mar/2038	31/Mar/2039	31/Mar/2040	31/Mar/2041	31/Mar/2042	31/Mar/2043	31/Mar/2044	31/Mar/2045	31/Mar/2046	31/Mar/2047	31/Mar/2048	31/Mar/2049	31/Mar/2050
	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050

Project Cash Flow	19.19	19.04	18.90	18.77	-1.57	18.53	18.41	18.29	18.18	18.07	-10.77	17.85	17.75	17.64	17.53
Equity Cash Flow	19.19	19.04	18.90	18.77	-1.57	18.53	18.41	18.29	18.18	18.07	-10.77	17.85	17.75	17.64	17.53
DSCR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Project IRR	11.9%
Equity IRR	15.0%
Avg DSCR	1.35
Min DSCR	0.50

Annexure 11.12 - Profit & Loss Statement

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
INR Crore	01/Apr/2022 31/Mar/2023 365 2023	01/Apr/2023 31/Mar/2024 365 2024	01/Apr/2024 31/Mar/2025 365 2025	01/Apr/2025 31/Mar/2026 365 2026	01/Apr/2026 31/Mar/2027 365 2027	01/Apr/2027 31/Mar/2028 365 2028	01/Apr/2028 31/Mar/2029 365 2029	01/Apr/2029 31/Mar/2030 365 2030	01/Apr/2030 31/Mar/2031 365 2031	01/Apr/2031 31/Mar/2032 365 2032	01/Apr/2032 31/Mar/2033 365 2033	01/Apr/2033 31/Mar/2034 365 2034	01/Apr/2034 31/Mar/2035 365 2035	01/Apr/2035 31/Mar/2036 365 2036

Revenue	40.40	40.40	40.40	40.40	40.40	40.40	40.40	40.40	40.40	40.40	40.40	40.40	40.40	40.40
Maintenance Cost	0.64	0.67	0.71	0.74	0.78	15.07	0.86	0.90	0.95	0.99	1.04	20.20	1.15	1.21
EBITDA	39.76	39.73	39.69	39.66	39.62	25.33	39.54	39.50	39.45	39.41	39.36	20.20	39.25	39.19
EBITDA Margin	98.4%	98.3%	98.3%	98.2%	98.1%	62.7%	97.9%	97.8%	97.7%	97.5%	97.4%	50.0%	97.2%	97.0%
Depreciation	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23
Interest	18.40	17.62	15.90	14.22	12.55	10.91	9.20	7.53	5.86	4.19	2.51	0.84	-	-
PBT	12.13	12.89	14.57	16.21	17.85	5.20	21.11	22.74	24.37	25.99	27.62	10.14	30.03	29.97
Tax	-	-	-	0.58	2.47	-	4.12	4.88	5.61	6.30	6.97	2.80	8.01	8.18
PAT	12.13	12.89	14.57	15.64	15.37	5.20	16.99	17.86	18.76	19.69	20.65	7.34	22.02	21.79
PAT Margin	30%	32%	36%	39%	38%	13%	42%	44%	46%	49%	51%	18%	54%	54%

	15	16	17	18	19	20	21	22	23	24	25	26	27
INR Crore	01/Apr/2036 31/Mar/2037 365 2037	01/Apr/2037 31/Mar/2038 365 2038	01/Apr/2038 31/Mar/2039 365 2039	01/Apr/2039 31/Mar/2040 365 2040	01/Apr/2040 31/Mar/2041 365 2041	01/Apr/2041 31/Mar/2042 365 2042	01/Apr/2042 31/Mar/2043 365 2043	01/Apr/2043 31/Mar/2044 365 2044	01/Apr/2044 31/Mar/2045 365 2045	01/Apr/2045 31/Mar/2046 365 2046	01/Apr/2046 31/Mar/2047 365 2047	01/Apr/2047 31/Mar/2048 365 2048	01/Apr/2048 31/Mar/2049 365 2049

Revenue	40.40	40.40	40.40	40.40	40.40	40.40	40.40	40.40	40.40	40.40	40.40	40.40	40.40
Maintenance Cost	1.27	1.33	1.40	27.07	1.54	1.62	1.70	1.78	1.87	36.27	2.06	2.17	2.28
EBITDA	39.13	39.07	39.00	13.33	38.86	38.78	38.70	38.62	38.53	4.13	38.34	38.23	38.12
EBITDA Margin	96.9%	96.7%	96.5%	33.0%	96.2%	96.0%	95.8%	95.6%	95.4%	10.2%	94.9%	94.6%	94.4%
Depreciation	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23
Interest	-	-	-	-	-	-	-	-	-	-	-	-	-
PBT	29.91	29.84	29.78	4.11	29.63	29.56	29.48	29.39	29.30	-5.10	29.11	29.01	28.90
Tax	8.34	8.47	8.59	2.25	8.79	8.87	8.94	9.00	9.05	0.45	9.12	9.15	9.17
PAT	21.57	21.37	21.19	1.86	20.85	20.69	20.54	20.40	20.26	-5.55	19.99	19.86	19.73
PAT Margin	53%	53%	52%	5%	52%	51%	51%	50%	50%	-14%	49%	49%	49%

Annexure 11.13 - Balance Sheet

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	01/Oct/2020	01/Apr/2021	01/Apr/2022	01/Apr/2023	01/Apr/2024	01/Apr/2025	01/Apr/2026	01/Apr/2027	01/Apr/2028	01/Apr/2029	01/Apr/2030	01/Apr/2031	01/Apr/2032	01/Apr/2033	01/Apr/2034
INR Crore	31/Mar/2021	31/Mar/2022	31/Mar/2023	31/Mar/2024	31/Mar/2025	31/Mar/2026	31/Mar/2027	31/Mar/2028	31/Mar/2029	31/Mar/2030	31/Mar/2031	31/Mar/2032	31/Mar/2033	31/Mar/2034	31/Mar/2035
	182	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035

Share Capital	22.22	78.87	78.87	78.87	78.87	78.87	78.87	78.87	78.87	78.87	78.87	78.87	78.87	78.87	78.87
Reserves	-	-	12.13	25.02	39.59	55.23	70.60	75.80	92.79	110.66	129.42	149.11	169.76	177.11	199.12
Shareholder's Fund	22.22	78.87	91.01	103.89	118.47	134.10	149.48	154.67	171.67	189.53	208.29	227.98	248.64	255.98	278.00
Loan Fund	51.84	184.04	184.04	167.31	150.58	133.85	117.12	100.39	83.65	66.92	50.19	33.46	16.73	0.00	0.00
Source of Fund	74.06	262.91	275.05	271.20	269.04	267.95	266.59	255.06	255.32	256.45	258.49	261.45	265.37	255.98	278.00

Gross Block	74.06	262.91	262.91	262.91	262.91	262.91	262.91	262.91	262.91	262.91	262.91	262.91	262.91	262.91	262.91
Accumulated Depreciation	-	-	9.23	18.45	27.68	36.90	46.13	55.35	64.58	73.80	83.03	92.25	101.48	110.70	119.93
Net Block	74.06	262.91	253.69	244.46	235.24	226.01	216.79	207.56	198.34	189.11	179.89	170.66	161.44	152.21	142.99
Cash & Bank	-	-	21.36	26.74	33.80	41.93	49.80	47.49	56.98	67.34	78.60	90.78	103.93	103.77	135.01
Application of Fund	74.06	262.91	275.05	271.20	269.04	267.95	266.59	255.06	255.32	256.45	258.49	261.45	265.37	255.98	278.00

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	01/Apr/2035	01/Apr/2036	01/Apr/2037	01/Apr/2038	01/Apr/2039	01/Apr/2040	01/Apr/2041	01/Apr/2042	01/Apr/2043	01/Apr/2044	01/Apr/2045	01/Apr/2046	01/Apr/2047	01/Apr/2048	01/Apr/2049
INR Crore	31/Mar/2036	31/Mar/2037	31/Mar/2038	31/Mar/2039	31/Mar/2040	31/Mar/2041	31/Mar/2042	31/Mar/2043	31/Mar/2044	31/Mar/2045	31/Mar/2046	31/Mar/2047	31/Mar/2048	31/Mar/2049	31/Mar/2050
	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050

Share Capital	78.87	78.87	78.87	78.87	78.87	78.87	78.87	78.87	78.87	78.87	78.87	78.87	78.87	78.87	78.87
Reserves	220.91	242.48	263.85	285.04	286.90	307.75	328.44	348.98	369.37	389.63	384.08	404.07	423.93	443.66	463.27
Shareholder's Fund	299.78	321.35	342.73	363.92	365.77	386.62	407.31	427.85	448.25	468.51	462.96	482.95	502.81	522.54	542.14
Loan Fund	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Source of Fund	299.78	321.35	342.73	363.92	365.77	386.62	407.31	427.85	448.25	468.51	462.96	482.95	502.81	522.54	542.14

Gross Block	262.91	262.91	262.91	262.91	262.91	262.91	262.91	262.91	262.91	262.91	262.91	262.91	262.91	262.91	262.91
Accumulated Depreciation	129.15	138.38	147.60	156.83	166.05	175.28	184.50	193.73	202.95	212.18	221.40	230.63	239.85	249.08	258.30
Net Block	133.76	124.54	115.31	106.09	96.86	87.64	78.41	69.19	59.96	50.74	41.51	32.29	23.06	13.84	4.61
Cash & Bank	166.02	196.82	227.41	257.83	268.91	298.98	328.90	358.66	388.29	417.77	421.44	450.66	479.74	508.70	537.53
Application of Fund	299.78	321.35	342.73	363.92	365.77	386.62	407.31	427.85	448.25	468.51	462.96	482.95	502.81	522.54	542.14

Annexure 11.14 - Cash Flow Statement

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	01/Oct/2020	01/Apr/2021	01/Apr/2022	01/Apr/2023	01/Apr/2024	01/Apr/2025	01/Apr/2026	01/Apr/2027	01/Apr/2028	01/Apr/2029	01/Apr/2030	01/Apr/2031	01/Apr/2032	01/Apr/2033	01/Apr/2034
INR Crore	31/Mar/2021	31/Mar/2022	31/Mar/2023	31/Mar/2024	31/Mar/2025	31/Mar/2026	31/Mar/2027	31/Mar/2028	31/Mar/2029	31/Mar/2030	31/Mar/2031	31/Mar/2032	31/Mar/2033	31/Mar/2034	31/Mar/2035
	182	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
PAT	-	-	12.13	12.89	14.57	15.64	15.37	5.20	16.99	17.86	18.76	19.69	20.65	7.34	22.02
Depreciation	-	-	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23
Interest	-	-	18.40	17.62	15.90	14.22	12.55	10.91	9.20	7.53	5.86	4.19	2.51	0.84	-
Change in Working Capital															
Cash Flow from Operating Activities	-	-	39.76	39.73	39.69	39.08	37.15	25.33	35.42	34.62	33.85	33.11	32.39	17.41	31.24
Capex	-74.06	-188.85	-	-	-	-	-	-	-	-	-	-	-	-	-
Cash Flow from Investing Activities	-74.06	-188.85	-	-	-	-	-	-	-	-	-	-	-	-	-
Equity	22.22	56.66	-	-	-	-	-	-	-	-	-	-	-	-	-
Term Loan Raised	51.84	132.20	-	-	-	-	-	-	-	-	-	-	-	-	-
Term Loan Repayed	-	-	-	-16.73	-16.73	-16.73	-16.73	-16.73	-16.73	-16.73	-16.73	-16.73	-16.73	-16.73	-
Grant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Paid	-	-	-18.40	-17.62	-15.90	-14.22	-12.55	-10.91	-9.20	-7.53	-5.86	-4.19	-2.51	-0.84	-
Cash Flow from Financing Activities	74.06	188.85	-18.40	-34.35	-32.63	-30.95	-29.28	-27.64	-25.94	-24.26	-22.59	-20.93	-19.24	-17.57	-
Net Cash Flow	-	-	21.36	5.38	7.07	8.13	7.87	-2.31	9.49	10.36	11.26	12.18	13.15	-0.16	31.24
Opening Cash Balance		-	-	21.36	26.74	33.80	41.93	49.80	47.49	56.98	67.34	78.60	90.78	103.93	103.77
Closing Cash Balance	-	-	21.36	26.74	33.80	41.93	49.80	47.49	56.98	67.34	78.60	90.78	103.93	103.77	135.01

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	01/Apr/2035	01/Apr/2036	01/Apr/2037	01/Apr/2038	01/Apr/2039	01/Apr/2040	01/Apr/2041	01/Apr/2042	01/Apr/2043	01/Apr/2044	01/Apr/2045	01/Apr/2046	01/Apr/2047	01/Apr/2048	01/Apr/2049
INR Crore	31/Mar/2036	31/Mar/2037	31/Mar/2038	31/Mar/2039	31/Mar/2040	31/Mar/2041	31/Mar/2042	31/Mar/2043	31/Mar/2044	31/Mar/2045	31/Mar/2046	31/Mar/2047	31/Mar/2048	31/Mar/2049	31/Mar/2050
	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
PAT	21.79	21.57	21.37	21.19	1.86	20.85	20.69	20.54	20.40	20.26	-5.55	19.99	19.86	19.73	19.60
Depreciation	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23
Interest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Working Capital															
Cash Flow from Operating Activities	31.01	30.80	30.60	30.41	11.08	30.07	29.92	29.77	29.62	29.48	3.68	29.22	29.09	28.96	28.83
Capex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cash Flow from Investing Activities	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Equity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Term Loan Raised	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Term Loan Repayed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Paid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cash Flow from Financing Activities	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Cash Flow	31.01	30.80	30.60	30.41	11.08	30.07	29.92	29.77	29.62	29.48	3.68	29.22	29.09	28.96	28.83
Opening Cash Balance	135.01	166.02	196.82	227.41	257.83	268.91	298.98	328.90	358.66	388.29	417.77	421.44	450.66	479.74	508.70
Closing Cash Balance	166.02	196.82	227.41	257.83	268.91	298.98	328.90	358.66	388.29	417.77	421.44	450.66	479.74	508.70	537.53

Annexure 11.15 - Financial Analysis

INR Crore	01/Oct/2020	01/Apr/2021	01/Apr/2022	01/Apr/2023	01/Apr/2024	01/Apr/2025	01/Apr/2026	01/Apr/2027	01/Apr/2028	01/Apr/2029	01/Apr/2030	01/Apr/2031	01/Apr/2032	01/Apr/2033	01/Apr/2034
	31/Mar/2021	31/Mar/2022	31/Mar/2023	31/Mar/2024	31/Mar/2025	31/Mar/2026	31/Mar/2027	31/Mar/2028	31/Mar/2029	31/Mar/2030	31/Mar/2031	31/Mar/2032	31/Mar/2033	31/Mar/2034	31/Mar/2035
	182	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035

Project Cash Flow	-74.06	-188.85	39.76	39.73	39.69	39.08	37.15	25.33	35.42	34.62	33.85	33.11	32.39	17.41	31.24
Equity Cash Flow	-22.22	-56.66	21.36	5.38	7.07	8.13	7.87	-2.31	9.49	10.36	11.26	12.18	13.15	-0.16	31.24
DSCR	-	-	2.16	1.16	1.22	1.26	1.27	0.92	1.37	1.43	1.50	1.58	1.68	0.99	-

INR Crore	01/Apr/2035	01/Apr/2036	01/Apr/2037	01/Apr/2038	01/Apr/2039	01/Apr/2040	01/Apr/2041	01/Apr/2042	01/Apr/2043	01/Apr/2044	01/Apr/2045	01/Apr/2046	01/Apr/2047	01/Apr/2048	01/Apr/2049
	31/Mar/2036	31/Mar/2037	31/Mar/2038	31/Mar/2039	31/Mar/2040	31/Mar/2041	31/Mar/2042	31/Mar/2043	31/Mar/2044	31/Mar/2045	31/Mar/2046	31/Mar/2047	31/Mar/2048	31/Mar/2049	31/Mar/2050
	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050

Project Cash Flow	31.01	30.80	30.60	30.41	11.08	30.07	29.92	29.77	29.62	29.48	3.68	29.22	29.09	28.96	28.83
Equity Cash Flow	31.01	30.80	30.60	30.41	11.08	30.07	29.92	29.77	29.62	29.48	3.68	29.22	29.09	28.96	28.83
DSCR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Project IRR	12.0%
Equity IRR	15.0%
Avg DSCR	1.38
Min DSCR	0.92

Annexure 11.16 - Profit & Loss Statement

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	01/Apr/2022	01/Apr/2023	01/Apr/2024	01/Apr/2025	01/Apr/2026	01/Apr/2027	01/Apr/2028	01/Apr/2029	01/Apr/2030	01/Apr/2031	01/Apr/2032	01/Apr/2033	01/Apr/2034	01/Apr/2035
INR Crore	31/Mar/2023	31/Mar/2024	31/Mar/2025	31/Mar/2026	31/Mar/2027	31/Mar/2028	31/Mar/2029	31/Mar/2030	31/Mar/2031	31/Mar/2032	31/Mar/2033	31/Mar/2034	31/Mar/2035	31/Mar/2036
	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036

Annuity	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60
Interest	10.09	9.40	8.70	8.00	7.31	6.61	5.92	5.22	4.52	3.83	3.13	2.44	1.74	1.04
O&M	1.16	1.22	1.28	1.34	1.41	1.48	1.55	1.63	1.71	1.80	1.89	1.98	2.08	2.18
Total Revenue	20.85	20.21	19.58	18.94	18.32	17.69	17.07	16.45	15.83	15.22	14.62	14.02	13.42	12.83
O&M Cost	0.64	0.67	0.71	0.74	0.78	15.07	0.86	0.90	0.95	0.99	1.04	20.20	1.15	1.21
EBITDA	20.21	19.54	18.87	18.20	17.54	2.62	16.21	15.55	14.89	14.23	13.58	(6.18)	12.27	11.62
EBITDA Margin	96.9%	96.7%	96.4%	96.1%	95.8%	14.8%	95.0%	94.5%	94.0%	93.5%	92.9%	-44.1%	91.4%	90.6%
Interest	11.35	10.86	9.80	8.77	7.74	6.72	5.68	4.64	3.61	2.59	1.55	0.52	-	-
PBT	8.86	8.68	9.07	9.43	9.80	(4.11)	10.54	10.91	11.28	11.65	12.03	(6.70)	12.27	11.62
Tax	2.23	2.18	0.84	1.33	1.79	-	2.61	2.97	3.30	3.61	3.90	-	4.30	4.28
PAT	6.63	6.49	8.23	8.10	8.01	(4.11)	7.93	7.94	7.98	8.03	8.12	(6.70)	7.97	7.34
PAT Margin	31.8%	32.1%	42.1%	42.8%	43.7%	-23.2%	46.5%	48.3%	50.4%	52.8%	55.6%	-47.8%	59.4%	57.3%

[illegible][illegible]

Annexure 11.17 - Balance Sheet

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	01/Oct/2020	01/Apr/2021	01/Apr/2022	01/Apr/2023	01/Apr/2024	01/Apr/2025	01/Apr/2026	01/Apr/2027	01/Apr/2028	01/Apr/2029	01/Apr/2030	01/Apr/2031	01/Apr/2032	01/Apr/2033	01/Apr/2034
INR Crore	31/Mar/2021	31/Mar/2022	31/Mar/2023	31/Mar/2024	31/Mar/2025	31/Mar/2026	31/Mar/2027	31/Mar/2028	31/Mar/2029	31/Mar/2030	31/Mar/2031	31/Mar/2032	31/Mar/2033	31/Mar/2034	31/Mar/2035
	182	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035

Share Capital	13.69	48.63	48.63	48.63	48.63	48.63	48.63	48.63	48.63	48.63	48.63	48.63	48.63	48.63	48.63
Reserves	-	-	6.63	13.13	21.36	29.46	37.47	33.36	41.29	49.23	57.20	65.24	73.36	66.66	74.63
Shareholder's Fund	13.69	48.63	55.26	61.76	69.99	78.09	86.10	81.99	89.92	97.86	105.83	113.87	121.99	115.29	123.27
Term Loan Fund	31.95	113.48	113.48	103.16	92.84	82.53	72.21	61.90	51.58	41.26	30.95	20.63	10.32	-	-
Source of Fund	45.65	162.11	168.74	164.92	162.84	160.62	158.31	143.89	141.50	139.12	136.78	134.50	132.31	115.29	123.27

Gross Block	42.73	162.11	162.11	162.11	162.11	162.11	162.11	162.11	162.11	162.11	162.11	162.11	162.11	162.11	162.11
Accumulated Depreciation	-	-	10.46	20.92	31.38	41.83	52.29	62.75	73.21	83.67	94.13	104.59	115.04	125.50	135.96
Net Block	42.73	162.11	151.65	141.19	130.73	120.27	109.81	99.36	88.90	78.44	67.98	57.52	47.06	36.60	26.15
Cash & Bank	2.92	-0.00	17.09	23.73	32.11	40.35	48.50	44.53	52.60	60.68	68.80	76.98	85.25	78.69	97.12
Application of Fund	45.65	162.11	168.74	164.92	162.84	160.62	158.31	143.89	141.50	139.12	136.78	134.50	132.31	115.29	123.27

[illegible][illegible][illegible]

Annexure 11.18 - Cash Flow Statement

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	01/Oct/2020	01/Apr/2021	01/Apr/2022	01/Apr/2023	01/Apr/2024	01/Apr/2025	01/Apr/2026	01/Apr/2027	01/Apr/2028	01/Apr/2029	01/Apr/2030	01/Apr/2031	01/Apr/2032	01/Apr/2033	01/Apr/2034
INR Crore	31/Mar/2021	31/Mar/2022	31/Mar/2023	31/Mar/2024	31/Mar/2025	31/Mar/2026	31/Mar/2027	31/Mar/2028	31/Mar/2029	31/Mar/2030	31/Mar/2031	31/Mar/2032	31/Mar/2033	31/Mar/2034	31/Mar/2035
	182	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
PAT	-	-	6.63	6.49	8.23	8.10	8.01	(4.11)	7.93	7.94	7.98	8.03	8.12	(6.70)	7.97
Depreciation	-	-	10.46	10.46	10.46	10.46	10.46	10.46	10.46	10.46	10.46	10.46	10.46	10.46	10.46
Interest	-	-	11.35	10.86	9.80	8.77	7.74	6.72	5.68	4.64	3.61	2.59	1.55	0.52	-
Cash Flow from Operating Activities	-	-	28.44	27.81	28.49	27.33	26.20	13.08	24.06	23.04	22.05	21.08	20.13	4.28	18.43
Capital Expenditure	(42.73)	(119.38)	-	-	-	-	-	-	-	-	-	-	-	-	-
Cash Flow from Investing Activities	(42.73)	(119.38)	-	-	-	-	-	-	-	-	-	-	-	-	-
Equity	13.69	34.94	-	-	-	-	-	-	-	-	-	-	-	-	-
Loan Raised	31.95	81.52	-	-	-	-	-	-	-	-	-	-	-	-	-
Loan Repayed	-	-	-	(10.32)	(10.32)	(10.32)	(10.32)	(10.32)	(10.32)	(10.32)	(10.32)	(10.32)	(10.32)	(10.32)	-
Interest Paid	-	-	(11.35)	(10.86)	(9.80)	(8.77)	(7.74)	(6.72)	(5.68)	(4.64)	(3.61)	(2.59)	(1.55)	(0.52)	-
Cash Flow from Financing Activities	45.65	116.46	(11.35)	(21.18)	(20.12)	(19.09)	(18.05)	(17.04)	(15.99)	(14.96)	(13.93)	(12.90)	(11.86)	(10.83)	-
Net Cash Flow	2.92	(2.92)	17.09	6.64	8.38	8.24	8.15	(3.96)	8.07	8.08	8.12	8.18	8.27	(6.56)	18.43
Opening Cash Balance	-	2.92	(0.00)	17.09	23.73	32.11	40.35	48.50	44.53	52.60	60.68	68.80	76.98	85.25	78.69
Closing Cash Balance	2.92	(0.00)	17.09	23.73	32.11	40.35	48.50	44.53	52.60	60.68	68.80	76.98	85.25	78.69	97.12

[illegible]

Annexure 11.19 - Financial Analysis

INR Crore	01/Oct/2020	01/Apr/2021	01/Apr/2022	01/Apr/2023	01/Apr/2024	01/Apr/2025	01/Apr/2026	01/Apr/2027	01/Apr/2028	01/Apr/2029	01/Apr/2030	01/Apr/2031	01/Apr/2032	01/Apr/2033	01/Apr/2034
	31/Mar/2021	31/Mar/2022	31/Mar/2023	31/Mar/2024	31/Mar/2025	31/Mar/2026	31/Mar/2027	31/Mar/2028	31/Mar/2029	31/Mar/2030	31/Mar/2031	31/Mar/2032	31/Mar/2033	31/Mar/2034	31/Mar/2035
	182	365	365	365	365	365	365	365	365	365	365	365	365	365	365
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035

Project Cash Flow	-45.65	-116.46	28.44	27.81	28.49	27.33	26.20	13.08	24.06	23.04	22.05	21.08	20.13	4.28	18.43
Equity Cash Flow	-13.69	-34.94	17.09	6.64	8.38	8.24	8.15	-3.96	8.07	8.08	8.12	8.18	8.27	-6.56	18.43
DSCR	-	-	2.51	1.31	1.42	1.43	1.45	0.77	1.50	1.54	1.58	1.63	1.70	0.39	-

INR Crore	01/Apr/2035	01/Apr/2036	01/Apr/2037	01/Oct/2037	01/Oct/2037	01/Oct/2037	01/Oct/2037	01/Oct/2037	01/Oct/2037	01/Oct/2037	01/Oct/2037	01/Oct/2037	01/Oct/2037	01/Oct/2037	01/Oct/2037
	31/Mar/2036	31/Mar/2037	30/Sep/2037	30/Sep/2037	30/Sep/2037	30/Sep/2037	30/Sep/2037	30/Sep/2037	30/Sep/2037	30/Sep/2037	30/Sep/2037	30/Sep/2037	30/Sep/2037	30/Sep/2037	30/Sep/2037
	365	365	183	0	0	0	0	0	0	0	0	0	0	0	0
	2036	2037	2038	2038	2038	2038	2038	2038	2038	2038	2038	2038	2038	2038	2038

Project Cash Flow	17.80	17.19	-	-	-	-	-	-	-	-	-	-	-	-	-
Equity Cash Flow	17.80	17.19	-	-	-	-	-	-	-	-	-	-	-	-	-
DSCR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Project IRR	11.0%
Equity IRR	15.0%
Avg DSCR	1.48
Min DSCR	0.77