

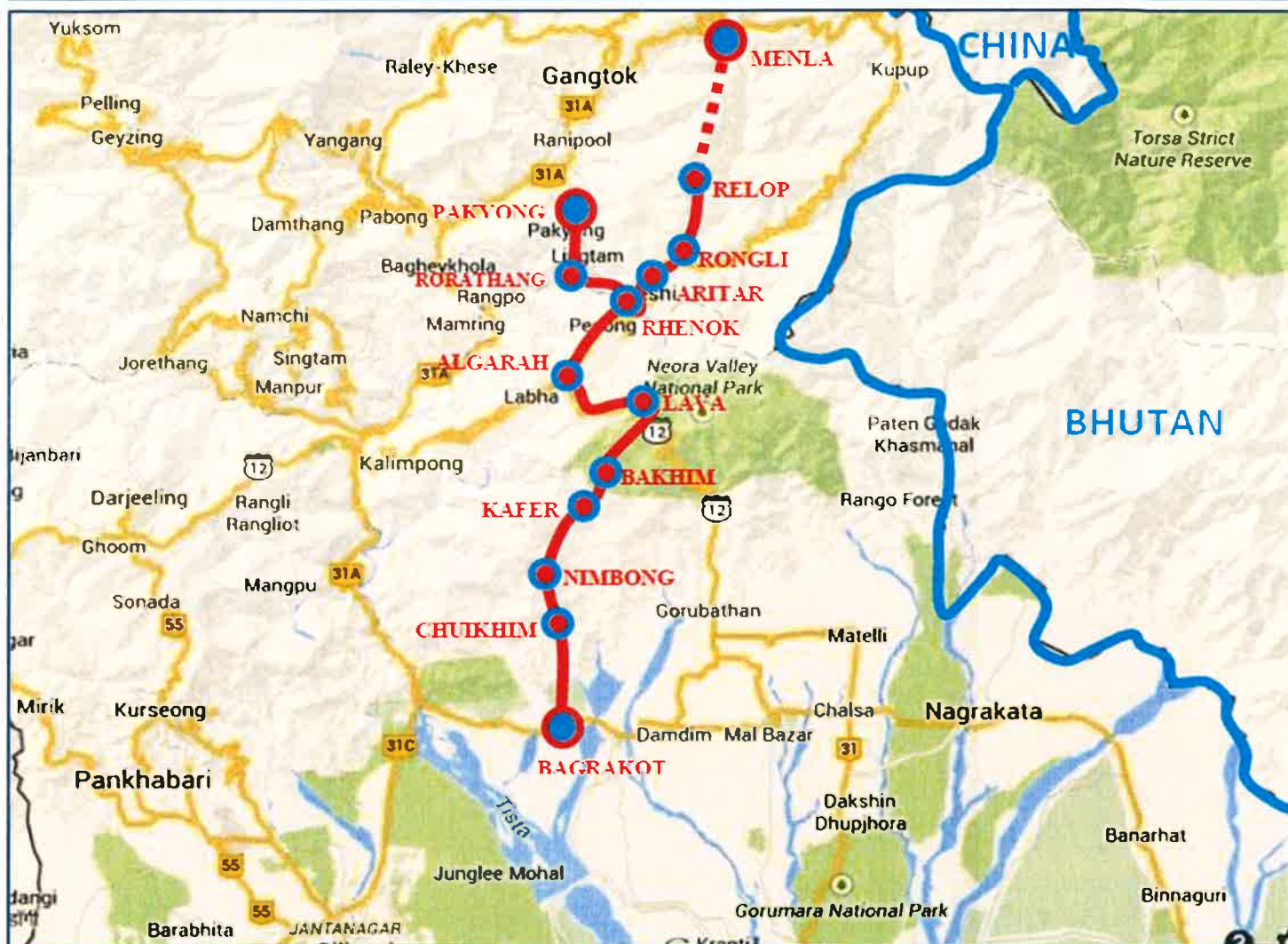


NATIONAL HIGHWAY AUTHORITY OF INDIA

(Ministry of Road Transport & Highways)

Consultancy for Preparation of Feasibility Report cum Preliminary Design for Alternative Highway to Gangtok in Sikkim via Bagrakot-Chuikhim-Nimbong-Kafer-Bakhim-Algarah-Rhenok in the State of West Bengal and from Rhenok-Rorathang-Pakyong along with Spur from Aritar-Relop-Menla in the State of Sikkim.

Package 4: BAGRAKOT TO KAFER (Km 0+000 To Km 40+000) MAIN REPORT



MARCH, 2017

SA INFRASTRUCTURE CONSULTANTS PVT. LTD.

IN ASSOCIATION WITH

SPECIALIZED ENGINEERING SERVICES PVT. LTD.

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CHAPTER - 0

EXECUTIVE SUMMARY

0. Executive Summary

0.1 Prelude

National Highways & Infrastructure Development Corporation Limited (NHIDCL), Government of India has decided to upgrade the newly declared National Highways to two lane/two lane with paved shoulder and /or strengthening of various sections of National Highways. The work would be taken up for up gradation on corridor concept. Therefore, corridors include strengthening (in adjoining stretches) in addition to widening to 2 lane with paved shoulder standards in order to have a better facility in a long continuous stretch.

In pursuance of the above, SA Infrastructure Pvt. Ltd, Noida (UP) have been appointed as Consultants to carry out the Feasibility Study and Detailed Project Report for rehabilitation and upgrading to 2 lane with paved shoulders configuration of Bagrakot to Kafer (Existing km 0+000 to 38+900) of NH-717A in West Bengal State. The Agreement was signed and the commencement of services commenced w.e.f from 08-10-2014 with the reference of NHAI letter no. NHAI/Tech/WB/FRCPD/Sikkim/2014/444/5726 dated 08-10-2014.

Scope of Study

The Project has to be completed in three stages as described herein below:

<u>Stage</u>	<u>Report and Deliverables</u>
1	QAP and Inception Report (IR)
2	Draft Feasibility Report (DFR)
3	Final Feasibility Report (FFR)

0.2 Socio - Economic Profile

The details on Socio-economic parameters will include per capita income, demographic

Details, growth of primary, secondary and tertiary sectors of economy, GNP, NSDP, traffic

Growth rates, number of villages connected with the roads, density of road network and other modes of transport in the region, achievement of five year plan outlays and sectors having more emphasis in plan outlays of the State government etc. These details will be collected for the State and project road influence area giving true picture of the socio-economic profile of the region. The details collected will be utilized for the traffic forecasting and social analysis.

0.3 Project Description

National Highways & Infrastructure Development Corporation Limited (NHIDCL), Government of India has decided to upgrade the newly declared National highways into 2 Lane configurations. The work would be taken up for up gradation on corridor concept. Therefore, corridors include strengthening (in adjoining stretches) in addition to widening to 2 lanes / 2 lanes with paved shoulder

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standards in order to have a better facility in a long continuous stretch. The entire proposed project road is located in the state of West Bengal. The state occupies a total area of 88,752 square kilometres. Currently the state comprises 1 district Darjeeling in West Bengal. The project road has significant influence on West bengal State and in particular on the Darjeeling district.

The key map of Project Road is given in Fig 1.1.

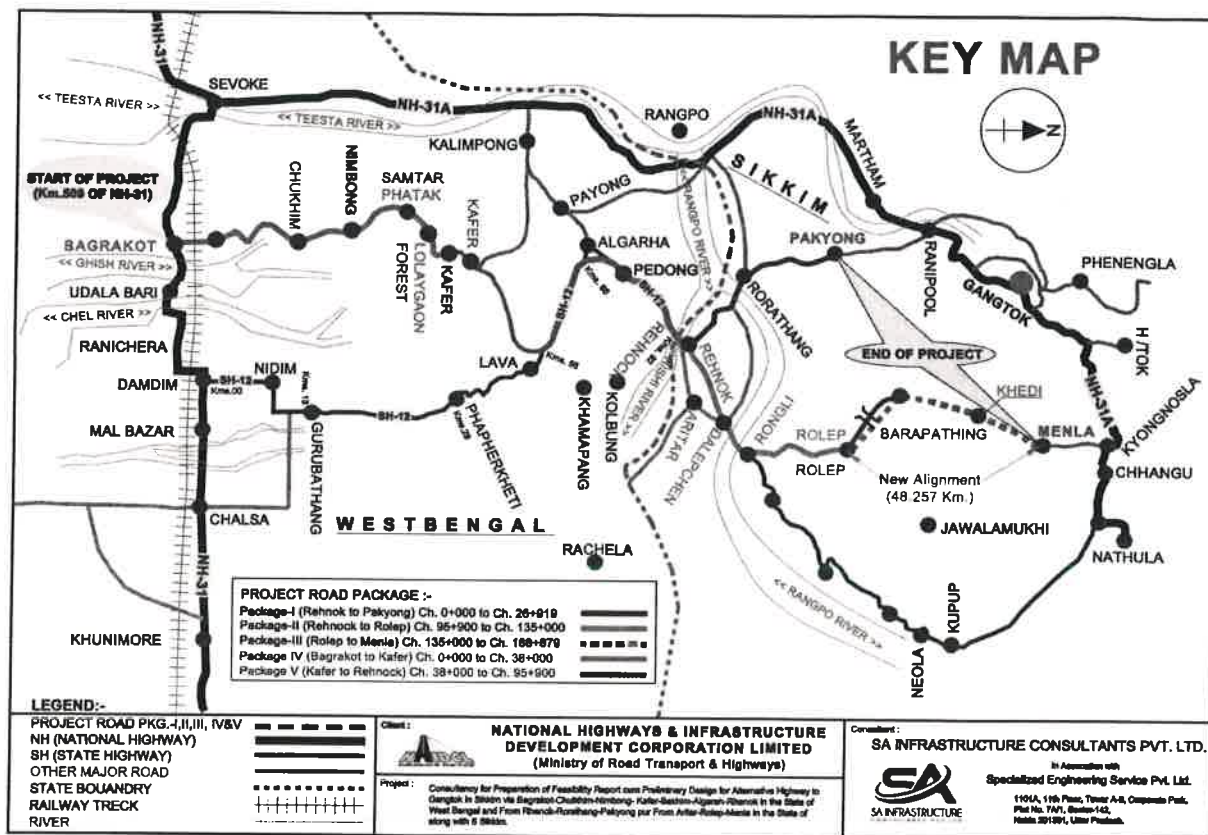


Fig 1.1

Table 0.1: Project Road Characteristics

Existing Chainage		Carriageway Width(m)	Surface Type	Shoulder Width	Shoulder Type	Terrain /Type
Start	End					
Bagrakot to Kafer						
0+000	38+900	3.5 - 5	BT	0.5-1	ER	Hilly

All major utilities follow the road alignment as the project road connects town namely Bagrakot.

0.3.1 Road Junctions

There is only one Major junction in the project stretch. At the location NH crosses the Project stretches. There are 1 major junctions and 14 minor junctions in the entire stretch.

Table 0.2: Details of Major Junction

Sr. No.	Design Chainage	Type	Link	Direction
1	0+000	T	Bagrakot	RHS & LHS

Table 0.3: Details of Minor Junction

SL. No.	Existing Chainage	Design Chainage	Type of intersection	Direction	Type of Road	Going to
				Left/Right	E/BT/CC	
1	-	2+000	Y	Left		Tea garden
2	-	2+220	Y	Left & Right		Tea garden
3	-	2+600	Y	Left & Right		Tea garden
4	12+600	13+560	Y	Right	E	Yalbong Village
5	15+510	16+610	Y	Left		Chuikhim Village
6	15+920	16+980	Y	Left	E	Chuikhim Village
7	21+730	23+130	y	Right	E	Lungret Village
8	24+340	25+500	Y	Right	BT	Ghantidara Village
9	24+960	26+120	Y	Left		Gyasok Village
10	25+300	26+440	Y	Right	E	Babangoan Village
11	26+120	27+220	Y	Left	R	Home
12	30+140	31+060	T	Right	BT	Pemlin
13	30+400	31+320	Y	Left	BT	Kalimpong
14	38+250	39+200	Y	Right	E	Forest Park

0.3.2 Existing Bridge & Cross Drainage Structures

There are 2 minor bridges, 56 slab culvert , 98 Causeway and no ROB on the project road section.

Table 0.4: Summary of Existing Bridges and Culverts

S. No	Type	Nos.
1	Major Bridges	0
2	Minor Bridges	2
3	Pipe Culverts	0
4	Slab Culverts	56
5	Causeway	98
Total		158

0.4 Traffic Survey Analysis and Forecast

It is very important, that the existing information on traffic flow, commodity movement and traffic pattern is required in order to assess the traffic behaviour on a project road. To collect such information to satisfy the Terms of Reference

(TOR) and project requirements, following various types of traffic surveys were carried out:

- Classified Traffic Volume Count Survey
- Origin – Destination (OD) Survey and commodity movement Surveys
- Axle Load Spectrum Survey
- Intersection Volume Count Survey
- Speed and Delay Survey

0.4.1 Classified Continuous Volume Count Survey

A comprehensive traffic survey plan has been prepared for the project road after considering traffic intensity on homogeneous sections and travel characteristics. Detailed site visit of project road and its influence/alternative transport network has been carried out between on 4th January to 16th January 2015. Traffic survey locations were finalised by consultation with client officials.

Table 0.5: Summary of Classified Volume Count Survey at all count stations

Sr. No.	Location	Justification/Rational
Classified Volume Count Surveys (CVC)		
1	Sevoke/Kalijhora	Sevoke/Kalijhora has been selected to get the idea of traffic in Siliguri to Gangtok Section
2	Baluakhani Check Post	Baluakhani Check Post has been selected to get the idea of traffic in Alagarah to Lava Section
3	3 rd Mile Check Post	3 rd Mile Check Post has been selected to get the idea of traffic in Gangtok to Nathula Section

0.4.2 Annual Average Daily Traffic (AADT)

The seasonal correction factors are used to convert Average Daily Traffic (ADT) to Annual Average Daily Traffic (AADT). The Annual Average Daily Traffic for all traffic survey locations is presented vide Table below:

Table 0.6: Summary of Annual Average Daily Traffic (AADT)

Sr. No.	Location	Fast Moving Vehicles	Slow Moving Vehicles	Total AADT in Nos.	AADT in PCU
1	Sevoke/Kalijhora	5740	0	5740	8100
2	Baluakhani Check	352	2	354	353

Sr. No.	Location	Fast Moving Vehicles	Slow Moving Vehicles	Total AADT in Nos.	AADT in PCU
	Post				
3	3 rd Mile Check Post	810	0	810	950

0.4.3 Turning Movement Count

There are Six major intersection in the project stretch. TMC count is conducted at all locations. The intersection volume count surveys have been carried out during identified peak periods for 8 hours. The category-wise traffic is counted for all direction in a 15 - minute interval. The counts were recorded in the specified survey formats.

The survey data have been analysed to obtain the morning and evening peak hours with flow of vehicles in each direction. The summary of peak hour traffic flow through intersections is given in Table below

Table 0.7: Peak Hour Traffic at Intersections

Sr. No.	Location	Type of Intersection	Peak Hour In Flow (PCU)		
			Morning	Evening	Total
1	Bagrakot Intersection	+	594	450	1044
2	Lava Intersection	+	41	35	76
3	Algarah Intersection	Y	6	7	13
4	Rhenock Intersection	+	123	119	242
	Rorathang Intersection	T	77	89	166
2	Rongli Intersection	T	56	52	108

0.4.4 Axle Load Survey

In order to estimate vehicle loading spectrum on project road, and to determine

vehicle damage factor for the commercial vehicles, the axle load surveys have been carried out at identified locations. The data collected from the Axle Load Survey has been compiled and analyzed through “Fourth power” pavement damage rule to arrive at the vehicles damage factor (VDF). The survey is analyzed to obtain Vehicle Damage Factor (VDF) and is presented below:

Table 0.8: Adopted VDF by Homogeneous Sections

Sr. No	Type of Vehicle	Kalijhora Near Sevoke (NH-31A)
1	LCV	1.6
2	2-Axle Truck	4.57
3	3-Axle Truck	1.36
4	Multi Axle Truck	1.49

The equivalent single axle loads (ESALs) have been calculated assuming that the project road will be opened to traffic in the year 2018.

Table 0.9: Summary of MSA

Section		Existing Chainage		Design MSA (2015-2032)
From	To	From	To	
Bagrakot	Kafer	0+000	38+900	25

0.4.5 Growth Rate

The various methods specified vide IRC 108: 2015 are taken in to consideration for arriving at reasonable growth rate for traffic in future. The results of such methods along with proposed growth rate for each type of vehicle are presented vide Table below:

Estimation of Traffic Growth Rates:

- Elasticity for Different Modes in West Bengal x Economic Indicator Average Growth Rate for West Bengal = Mode wise growth rate for West Bengal
- Mode wise Registered vehicle Average Growth Rate of West Bengal

Then, Weighted Traffic Growth Rates = adopted weighted Average of a & b item
Weighted traffic growth for project is presented in Table 0.4.11(a).

Table0. 4.10 Future Traffic Growth Rates for Motorized Vehicles (%) - WEST BENGAL

Mode	Upto 2015	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040	Beyond 2040
Car	7.70	7.32	6.98	6.68	6.40	6.15	5.93

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Buses	6.98	6.66	6.38	6.12	5.89	5.68	5.50
LCV	7.78	7.39	7.04	6.73	6.44	6.19	5.96
Truck	7.68	7.30	6.96	6.65	6.38	6.13	5.91
2-W	11.85	11.27	10.76	10.29	9.87	9.50	9.16

Table 0.4.11(a) WEIGHTED Traffic Growth Rates for Motorized Vehicles (%) – Realistic Scenario

Mode	Up to 2015	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040	Beyond 2040
Car	9.8	9.3	8.9	8.6	8.2	7.9	7.6
Buses	7.4	7.0	6.7	6.4	6.2	6.0	5.8
LCV	9.0	8.6	8.2	7.9	7.6	7.3	7.0
Truck	9.2	8.8	8.4	8.0	7.7	7.4	7.1
2-W	8.6	8.2	7.9	7.5	7.2	7.0	6.7

0.4.6 Capacity Analysis

Capacity analysis is fundamental to the planning, design and operation of roads. It is a valuable tool for evaluation of the investment needed for the future improvements. The capacity figures used for determining the desired carriageway width in differing terrain w.r.t. traffic volume and composition are as per IRC: 64-1990. As per IRC 64:1990, it is recommended that on major arterial routes LOSB should be adopted for the design purpose. On other roads under exceptional circumstances, LOS C could also be adopted for design. For LOS C, Design service volume can be taken as 40 % higher than those for LOS B.

For the purpose of augmentation of the facilities and up gradation of the project highway, the design service volume for the plain terrain condition and level of Service B & C is shown in Table

Table 0.12: Design Service Volume for Different Lane Configurations

Lane Configuration	Design Service Volume (PCUs per day) <i>Level of Service B</i>	Design Service Volume (PCUs per day) <i>Level of Service C</i>
2-Lane with 1.5m Paved Shoulder	18000	25200
4-Lane with 1.5m Paved Shoulder	40000	60000

0.5 Lane Requirements

The consultant has carried out the capacity analysis for 2 lane road without paved shoulder

TABLE - CAPACITY ANALYSIS OF PROJECT ROAD

Year	Section AB-BC-CD		Section DE		Section DF		Section FG	
	Volume (PCU)	Level of Service (LOS)	Volume (PCU)	Level of Service (LOS)	Volume (PCU)	Level of Service (LOS)	Volume (PCU)	Level of Service (LOS)
2015	1027	LOS 'B'	896	LOS 'B'	131	LOS 'B'	35	LOS 'B'
2016	1124	LOS 'B'	980	LOS 'B'	143	LOS 'B'	38	LOS 'B'
2017	1285	LOS 'B'	1121	LOS 'B'	164	LOS 'B'	44	LOS 'B'
2018	1400	LOS 'B'	1221	LOS 'B'	179	LOS 'B'	47	LOS 'B'
2019	1525	LOS 'B'	1330	LOS 'B'	195	LOS 'B'	52	LOS 'B'
2020	1661	LOS 'B'	1448	LOS 'B'	213	LOS 'B'	56	LOS 'B'
2021	1810	LOS 'B'	1578	LOS 'B'	232	LOS 'B'	61	LOS 'B'
2022	1964	LOS 'B'	1712	LOS 'B'	252	LOS 'B'	66	LOS 'B'
2023	2132	LOS 'B'	1858	LOS 'B'	273	LOS 'B'	72	LOS 'B'
2024	2314	LOS 'B'	2017	LOS 'B'	297	LOS 'B'	78	LOS 'B'
2025	2511	LOS 'B'	2189	LOS 'B'	323	LOS 'B'	84	LOS 'B'
2026	2726	LOS 'B'	2375	LOS 'B'	350	LOS 'B'	91	LOS 'B'
2027	2949	LOS 'B'	2569	LOS 'B'	379	LOS 'B'	98	LOS 'B'
2028	3190	LOS 'B'	2779	LOS 'B'	411	LOS 'B'	106	LOS 'B'
2029	3451	LOS 'B'	3006	LOS 'B'	445	LOS 'B'	115	LOS 'B'
2030	3733	LOS 'B'	3252	LOS 'B'	481	LOS 'B'	124	LOS 'B'
2031	4039	LOS 'B'	3518	LOS 'B'	521	LOS 'B'	134	LOS 'B'
2032	4356	LOS 'B'	3794	LOS 'B'	562	LOS 'B'	144	LOS 'B'
2033	4699	LOS 'B'	4092	LOS 'B'	607	LOS 'B'	156	LOS 'B'
2034	5068	LOS 'C'	4413	LOS 'B'	655	LOS 'B'	168	LOS 'B'
2035	5467	LOS 'C'	4760	LOS 'B'	707	LOS 'B'	180	LOS 'B'
2036	5897	LOS 'C'	5134	LOS 'C'	763	LOS 'B'	194	LOS 'B'
2037	6343	LOS 'C'	5522	LOS 'C'	821	LOS 'B'	209	LOS 'B'
2038	6824	LOS 'C'	5940	LOS 'C'	884	LOS 'B'	224	LOS 'B'
2039	7340	LOS 'D'	6389	LOS 'C'	952	LOS 'B'	241	LOS 'B'
2040	7897	LOS 'D'	6872	LOS 'C'	1024	LOS 'B'	259	LOS 'B'
2041	8495	LOS 'D'	7392	LOS 'D'	1103	LOS 'B'	278	LOS 'B'

Conclusion

This analysis suggest that the project road will have smooth traffic flow at LOS 'C' up to the horizon year 2040. Only in the year 2040, the LOS will drop this year, the road could be upgraded by adding a paved shoulder.

0.6 Results of Engineering Surveys and Investigations

0.6.1 Pavement Condition

It is the most important data needed for deciding upon the maintenance. The basic measurement of pavement condition is existing distresses. The information required is on the type, severity and amount of distress.

Pavement condition survey consists of observing and recording the various distresses like cracks, pothole, rutting, ravelling etc of the existing carriageway, pavement shoulders and embankment. The details collected from pavement condition survey form the basis to decide strategy for adequate strengthening / rehabilitation measure of Existing pavement.

Table 0.14
Percentage wise distribution of Good Fair and Poor Road

S.N.	Condition	No. Of Km	% Condition
1	Good	0	0
2	Fair	0	0
3	Poor	39+800	100

0.6.2 Benkelman Beam Deflection

Structural strength of existing pavement has been assessed by conducting Benkelman beam test as per procedure specified vide IRC 81: 1997 and in accordance with TOR set-forth vide consultancy agreement as well as for identified control sections.

0.6.3 Pavement Investigation

Summary of the layer thickness as recorded from test pits are as under:

Table 0.15: Summary of Crust Thickness in mm

Type of Layer	Range of Pavement Thickness (mm)	
	80 % Location	20 % Location
SDBC	25	25
BM	100	100
WMM	100	100
GSB I	150	200
GSB II	100	
Soiling		300
Total thickness	475	725

0.7 Proposed design standards

Following is a summary of the recommended design standards proposed to be adopted for the project road other than service road and intersections

Summary of Design Standards

(i)	Design Speed (Km/hr)		
a.	Plain Terrain	:	100 (Ruling), 80 (Minimum)
b.	Rolling Terrain	:	80 (Ruling), 65 (Minimum)
c.	Mountainous Terrain	:	50 (Ruling), 40 (Minimum)
d.	Steep Terrain	:	40 (Ruling), 30 (Minimum)
(ii)	Level of Service	:	B
(iii)	Roadway Widths (m)	:	10m for Two Lane Road
(iv)	Roadway Elements		
	Carriageway and Shoulders	:	Carriageway: 7m (Two lane) Shoulders:- Hill Side: 1.0m, Valley side: 2.0m
	Camber	:	Carriageway: 2.5%, Shoulder: 3%
	Right of Way	:	Open Area:- Normal: 24 m, Exceptional: 18 m Built up Area:- Normal: 20 m, Exceptional: 18 m
	Embankment/ Cutting Slope	:	In filling: 1V : 2 H In cutting: 1V : 1H
	Overtaking Sight Distance	:	640m for design speed of 100 km/hr 470m for design speed of 80 km/hr 235m for design speed of 50 km/hr
	Super-elevation	:	Maximum 7%
	Radii for Horizontal Curves	:	360 m for design speed of 100 km/hr 230 m for design speed of 80 km/hr 90 m design speed of 50 km/hr

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	Ruling Gradient	:	3.33% for plain and rolling terrain 5% for mountainous and steep terrain having elevation more than 3000m above MSL
	Minimum K- factor		
	Summit Curve	:	75 for Design speed of 100 km/hr 35 for Design speed of 80 km/hr 10 for Design speed of 50 km/hr
	Valley Curve	:	42 for Design speed of 100 km/hr 30 for Design speed of 80 km/hr 20 for Design speed of 65 km/hr 10 for Design speed of 50 km/hr
	Bridge Clearance		
	Railways	:	6.55 m for Electrified Railway
	Motor Vehicles	:	5.5 m
	Light Motor Vehicles	:	3.5 m
	Cattle (Camel) and Pedestrian	:	3.0 m
	Design Flood Frequency		
	Bridges	:	50 years
	Sewers and Ditches	:	10 years
	Minimum Drainage Channel Width	:	1.0 m
	Ditch Slopes (H:V)	:	1:1 (Fore slope or back slope)

0.8 Improvement Proposals

The improvement proposals for proposed widening include the provisions for the following major items:

- a) Widening Proposal
- b) Requirement of bypasses and realignment
- c) Geometric Improvement Design
- d) Proposed Pavement Design & Overlay Design
- e) Traffic Control and Safety Measures
- f) Bridge and Cross Drainage Structures

0.8.1 Widening Proposal

In order to meet future traffic requirement, the existing carriageway is proposed to upgrade to achieve high speed of travel with comfort and safety. Concentric widening scheme and Hill cutting is followed to minimise land acquisition issues and to ensure maximum utilisation of existing carriageway. **Table 0.17** shows widening improvement proposed for the project road.

0.8.1.1 Typical Cross-sections

Proposed cross-sections along with widening schedule is shown in table given below.

Table 0.17: Proposed Cross Section

Sr. No.	Proposed Chainage		Length in (Km)	Type of Cross Section	TCS
	From (Km)	To (Km)			
1	0	0.4	0.4	Type of Cross Section of 4-lane divided highway with raised median	4
2	0.4	3.8	3.4	Type of Cross Section of 2-lane with paved shoulder (Open country-plain/rolling terrain)	3
3	3.8	3.86	0.06	Two lane with paved shoulder Raised portion(Hill section)	1
4	3.86	3.915	0.055	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
5	3.915	3.97	0.055	Two lane with paved shoulder Raised portion(Hill section)	1
6	3.97	4.34	0.37	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
7	4.34	4.4	0.06	Two lane with paved shoulder Raised portion(Hill section)	1
8	4.4	4.69	0.29	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
9	4.69	4.725	0.035	Two lane with paved shoulder Raised portion(Hill section)	1
10	4.725	4.86	0.135	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
11	4.86	4.89	0.03	Two lane with paved shoulder Raised portion(Hill section)	1
12	4.89	5.05	0.16	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2

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13	5.05	5.13	0.08	Two lane with paved shoulder Raised portion(Hill section)	1
14	5.13	5.23	0.1	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
15	5.23	5.4	0.17	Two lane with paved shoulder Raised portion(Hill section)	1
16	5.4	5.59	0.19	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
17	5.59	5.66	0.07	Two lane with paved shoulder Raised portion(Hill section)	1
18	5.66	5.79	0.13	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
19	5.79	6.14	0.35	Two lane with paved shoulder Raised portion(Hill section)	1
20	6.14	6.27	0.13	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
21	6.27	6.38	0.11	Two lane with paved shoulder Raised portion(Hill section)	1
22	6.38	6.52	0.14	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
23	6.52	6.58	0.06	Two lane with paved shoulder Raised portion(Hill section)	1
24	6.58	7.16	0.58	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
25	7.16	7.28	0.12	Two lane with paved shoulder Raised portion(Hill section)	1
26	7.28	7.36	0.08	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
27	7.36	7.44	0.08	Two lane with paved shoulder Raised portion(Hill section)	1
28	7.44	8.12	0.68	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
29	8.12	8.18	0.06	Two lane with paved shoulder Raised portion(Hill section)	1
30	8.18	8.26	0.08	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
31	8.26	8.46	0.2	Two lane with paved shoulder Raised portion(Hill section)	1
32	8.46	8.52	0.06	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
33	8.52	8.62	0.1	Two lane with paved shoulder Raised portion(Hill section)	1
34	8.62	8.68	0.06	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
35	8.68	9.22	0.54	Two lane with paved shoulder Raised portion(Hill section)	1
36	9.22	9.26	0.04	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
37	9.26	9.4	0.14	Two lane with paved shoulder Raised portion(Hill section)	1
38	9.4	9.5	0.1	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
39	9.5	10.02	0.52	Two lane with paved shoulder Raised portion(Hill section)	1
40	10.02	10.24	0.22	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
41	10.24	10.34	0.1	Two lane with paved shoulder Raised portion(Hill section)	1
42	10.34	10.55	0.21	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
43	10.55	10.62	0.07	Two lane with paved shoulder Raised portion(Hill section)	1
44	10.62	10.82	0.2	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2

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Feasibility Report : EXECUTIVE SUMMARY

45	10.82	10.91	0.09	Two lane with paved shoulder Raised portion(Hill section)	1
46	10.91	11	0.09	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
47	11	11.09	0.09	Two lane with paved shoulder Raised portion(Hill section)	1
48	11.09	11.14	0.05	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
49	11.14	11.94	0.8	Two lane with paved shoulder Raised portion(Hill section)	1
50	11.94	12.08	0.14	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
51	12.08	12.2	0.12	Two lane with paved shoulder Raised portion(Hill section)	1
52	12.2	12.28	0.08	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
53	12.28	12.36	0.08	Two lane with paved shoulder Raised portion(Hill section)	1
54	12.36	12.5	0.14	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
55	12.5	12.57	0.07	Two lane with paved shoulder Raised portion(Hill section)	1
56	12.57	12.62	0.05	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
57	12.62	12.82	0.2	Two lane with paved shoulder Raised portion(Hill section)	1
58	12.82	12.96	0.14	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
59	12.96	13.16	0.2	Two lane with paved shoulder Raised portion(Hill section)	1
60	13.16	13.3	0.14	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
61	13.3	13.84	0.54	Two lane with paved shoulder Raised portion(Hill section)	1
62	13.84	13.98	0.14	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
63	13.98	14.1	0.12	Two lane with paved shoulder Raised portion(Hill section)	1
64	14.1	14.2	0.1	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
65	14.2	14.72	0.52	Two lane with paved shoulder Raised portion(Hill section)	1
66	14.72	14.91	0.19	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
67	14.91	14.98	0.07	Two lane with paved shoulder Raised portion(Hill section)	1
68	14.98	15.14	0.16	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
69	15.14	16.44	1.3	Two lane with paved shoulder Raised portion(Hill section)	1
70	16.44	16.58	0.14	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
71	16.58	16.9	0.32	Two lane with paved shoulder Raised portion(Hill section)	1
72	16.9	17.04	0.14	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
73	17.04	17.12	0.08	Two lane with paved shoulder Raised portion(Hill section)	1
74	17.12	17.34	0.22	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
75	17.34	17.42	0.08	Two lane with paved shoulder Raised portion(Hill section)	1
76	17.42	17.6	0.18	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2

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Feasibility Report : EXECUTIVE SUMMARY

77	17.6	17.8	0.2	Two lane with paved shoulder Raised portion(Hill section)	1
78	17.8	17.94	0.14	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
79	17.94	18	0.06	Two lane with paved shoulder Raised portion(Hill section)	1
80	18	18.27	0.27	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
81	18.27	18.36	0.09	Two lane with paved shoulder Raised portion(Hill section)	1
82	18.36	18.5	0.14	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
83	18.5	18.82	0.32	Two lane with paved shoulder Raised portion(Hill section)	1
84	18.82	18.93	0.11	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
85	18.93	19.34	0.41	Two lane with paved shoulder Raised portion(Hill section)	1
86	19.34	19.74	0.4	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
87	19.74	19.86	0.12	Two lane with paved shoulder Raised portion(Hill section)	1
88	19.86	20.14	0.28	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
89	20.14	20.24	0.1	Two lane with paved shoulder Raised portion(Hill section)	1
90	20.24	20.4	0.16	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
91	20.4	20.46	0.06	Two lane with paved shoulder Raised portion(Hill section)	1
92	20.46	20.52	0.06	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
93	20.52	20.66	0.14	Two lane with paved shoulder Raised portion(Hill section)	1
94	20.66	20.72	0.06	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
95	20.72	20.84	0.12	Two lane with paved shoulder Raised portion(Hill section)	1
96	20.84	21.46	0.62	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
97	21.46	22.58	1.12	Two lane with paved shoulder Raised portion(Hill section)	1
98	22.58	22.8	0.22	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
99	22.8	23.52	0.72	Two lane with paved shoulder Raised portion(Hill section)	1
100	23.52	23.78	0.26	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
101	23.78	23.98	0.2	Two lane with paved shoulder Raised portion(Hill section)	1
102	23.98	24.14	0.16	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
103	24.14	24.2	0.06	Two lane with paved shoulder Raised portion(Hill section)	1
104	24.2	24.4	0.2	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
105	24.4	24.7	0.3	Two lane with paved shoulder Raised portion(Hill section)	1
106	24.7	25.04	0.34	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
107	25.04	25.2	0.16	Two lane with paved shoulder Raised portion(Hill section)	1
108	25.2	25.4	0.2	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2

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Feasibility Report : EXECUTIVE SUMMARY

109	25.4	26.96	1.56	Two lane with paved shoulder Raised portion(Hill section)	1
110	26.96	27.2	0.24	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
111	27.2	27.72	0.52	Two lane with paved shoulder Raised portion(Hill section)	1
112	27.72	27.84	0.12	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
113	27.84	28	0.16	Two lane with paved shoulder Raised portion(Hill section)	1
114	28	28.54	0.54	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
115	28.54	30.07	1.53	Two lane with paved shoulder Raised portion(Hill section)	1
116	30.07	30.18	0.11	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
117	30.18	31.04	0.86	Two lane with paved shoulder Raised portion(Hill section)	1
118	31.04	31.15	0.11	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
119	31.15	31.32	0.17	Two lane with paved shoulder Raised portion(Hill section)	1
120	31.32	31.44	0.12	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
121	31.44	31.6	0.16	Two lane with paved shoulder Raised portion(Hill section)	1
122	31.6	31.74	0.14	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
123	31.74	32.56	0.82	Two lane with paved shoulder Raised portion(Hill section)	1
124	32.56	32.66	0.1	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
125	32.66	33.48	0.82	Two lane with paved shoulder Raised portion(Hill section)	1
126	33.48	33.56	0.08	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
127	33.56	33.7	0.14	Two lane with paved shoulder Raised portion(Hill section)	1
128	33.7	33.8	0.1	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
129	33.8	34	0.2	Two lane with paved shoulder Raised portion(Hill section)	1
130	34	34.18	0.18	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
131	34.18	34.28	0.1	Two lane with paved shoulder Raised portion(Hill section)	1
132	34.28	34.38	0.1	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
133	34.38	34.88	0.5	Two lane with paved shoulder Raised portion(Hill section)	1
134	34.88	35.02	0.14	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
135	35.02	35.36	0.34	Two lane with paved shoulder Raised portion(Hill section)	1
136	35.36	35.44	0.08	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
137	35.44	35.9	0.46	Two lane with paved shoulder Raised portion(Hill section)	1
138	35.9	35.98	0.08	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
139	35.98	39.54	3.56	Two lane with paved shoulder Raised portion(Hill section)	1
140	39.54	39.64	0.1	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2

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Feasibility Report : EXECUTIVE SUMMARY

141	39.64	39.88	0.24	Two lane with paved shoulder Raised portion(Hill section)	1
142	39.88	39.96	0.08	Two lane with paved shoulder Raised portion(Hill section), New Alignment	2
143	39.96	40	0.04	Two lane with paved shoulder Raised portion(Hill section)	1

TCS ON ROB APPROACH AND RAMP					
Sr. No.	Proposed Chainage		Length	Section	TCS
	From (Km)	To (Km)	in (Km)		
1	A+0.000	A+0.300	0.3	On ROB Approach	4
2	A+0.300	A+0.800	0.5	Ramp A-A	4A
3	B+0.300	B+0.700	0.4	Ramp B-B	4A
4	C+610.360	C+611.400	1.04	On NH-31	5
	Total		2.24		

TCS Details

Sr. No.	Detail	TCS	Length (m)	Length (Km)
1	Two Lane with Paved Shoulder Raised Portion (Hill Section)	I	24050	24.05
2	Two Lane with Paved Shoulder Raised Portion (Hill Section) in new alignment	II	12150	12.15
3	Type of Cross Section of 2-lane bypass (Open country-plain/rolling terrain)	III	3400	3.4
4	Type of Cross Section of 4-lane highway (Open country-plain/rolling terrain)	IV	400	0.4

0.8.2 Requirement of Bypasses

This part of chapter describes brief about the existing alignment, alignment options with their Evaluation matrix and their necessities to upgrade the existing carriageway facility of project road into 2-lane paved carriageway in accordance to the Indian standard configuration. These improvement proposals are based on the findings from various engineering features carried out on the project roads such as Reconnaissance Survey, future traffic requirement, Inventory Data and Pavement Investigations. There is one bypass required in this section from the start(km0+000) of the road upto km3+800 .

0.8.3 Pavement Design

The flexible pavement is adopted for proposed new carriageway, widening and reconstruction. Design period of 15 years considered for new carriageway as well as overlay design. The Pavement improvements proposal for entire project road is presented in **Table 0.18**.

Table 0.18(a): Improvement Proposal for Existing Pavement

Crust Composition For Overlay as per IRC 81 - 1997									
H. Section	Chainage		Characteristic Deflection	MSA	BM	Crust			Total Crust Thickness
	From	To				BC+DBM	BC	DBM	
1	0+000	39+978	1.35	25	150	105	40	65	105

Table 0.18(b): Improvement Proposal for New Pavement

Crust Composition For New Pavement as per IRC 37 - 2012										
H. Section	Chainage		CBR	MSA	Crust				S.Grade	Total Thickness
	From	To			BC	DBM	WMM	GSB		
1	0+000	39+978	9	25	40	90	250	200	500	1080

Consultant proposed pavement based on 25 MSA 9 % CBR.

0.8.4 Traffic Control and Safety Measures

0.8.4.1 Road Marking & Traffic Signs

Road markings will be made for centre and edge lines using reflective thermoplastic paints. Appropriate road markings will also be provided at junctions and crossings. Road signs are to place according to IRC: 67-2012. The signs are to be placed on embankment so that extreme edge of sign would be 2.0m away from the edge of the carriageway. The location of each sign is to be decided in accordance with the guidelines there in.

0.8.4.2 Proposal for Truck Lay byes/Parking cum Rest Area

As per the detailed field surveys and reconnaissance, truck lay bye/ Parking cum rest areas are proposed at the following two locations. The rest area will provide common facilities like petrol pump, first aid medical facilities, police office, restaurant and vehicle parking etc.

Table 0.19: Truck lay byes/ Parking cum Rest Area Location

Sr. No.	Existing Chainage	Proposed Chainage
1	Near Navgaon 20+450 to 20+580	Near Navgaon 21+940 to 22+060

0.8.5 Major Bridge/ Minor Bridge & Cross Drainage Structures

0.8.5.1 Bridges

There are 4 minor bridges (2 New+2 Reconstruction), 0 major bridge has been proposed.

0.8.5.2 Culverts

All type of culverts is to be replaced.

Table 0.20: Summary of structures

SI. No.	DESCRIPTION	No. Of Structures	REMARKS
1	HUME PIPE CULVERTS		
(i)	Retaining & Widening	0	-
(ii)	Dismantling & Reconstruction Pipe Culvert With Box Culvert	0	-
(iii)	New Proposals	0	-
(iv)	Abandoned	0	
2	SLAB CULVERTS		
(i)	Retaining & Widening	0	-
(ii)	Dismantling & Reconstruction	56	-
(iii)	New Proposals	26	-
(iv)	Abandoned	0	
3	BOX CULVERTS		
(i)	Retaining & Widening	0	-
(ii)	Dismantling & Reconstruction	0	-
(iii)	New Proposals	0	-
(iv)	Abandoned	0	
4	CAUSEWAY		

Sl. No.	DESCRIPTION	No. Of Structures	REMARKS
(i)	Retaining & Widening	0	-
(ii)	Dismantling & Reconstruction to slab culvert	98	
(iii)	New Proposals	0	
(iv)	Abandoned	0	-
5	MINOR BRIDGES		
(i)	Retained	0	-
(ii)	Dismantling & Reconstruction	2	-
(iii)	Abandoned	0	
(iv)	New proposals	2	-
6	MAJOR BRIDGES		
(i)	Retained	0	
(ii)	New proposal	0	
(iii)	Flyovers	0	
(iv)	New proposal	0	-
8	ROAD OVER BRIDGES WITH LOOP		
(i)	To be Widened	0	-
(ii)	New Proposals	1	
RAMP SECTION			
(i)	New Proposals	0	

0.9 Cost Estimate

Preliminary cost estimate for the project Road is finalised based on the improvement proposed. The preliminary cost estimate is worked out based on the quantities calculated for major items of work to be executed in the project and also rates derived after detail analysis.

Table 0.23 : Cost of Civil Works

Section	Proposed Length (km)	Base Cost in cr
Bagrakot to Kafer	40.000	674.58

0.10 Environmental Impact Assessment

The data collected as part of the environmental impact assessment was analyzed for:

- Identification of direct and indirect and natural environmental impacts, positive as well as negative, likely to result from the proposed project. Since the proposed project is an important infrastructure project, the assessment also considered the environmental impacts from the secondary / induced development that the project might generate.
- Appraisal of natural hazards and social risks during construction and operation of the project.
- Exploration of opportunities for enhancement of environmental, aesthetic and socio-economic quality through the proposed project.
- Suggesting requisite feasible and cost effective mitigate measures for each potentially adverse environmental impact, including relocation or rebuilding of the cultural properties, rehabilitation of borrow areas / quarries from where the construction materials are to be procured; and computation of the cost estimates in implementing these measures.
- Delineation of impacts that are unmanageable, or cannot be avoided or mitigated.
- Determining any significant economic and environmental issues requiring additional studies and analysis.
- Estimation of quality of available data, key data gaps, if any, and levels of uncertainty of environmental impact predictions.

The results of this analysis was quantified, tabulated and plotted on maps to identify any major environmental risks / conflicts, which the proposed road is likely to generate, and show the resultant classification of highway sections as:

- Those with minor or no potential impacts and hence requiring a limited social and environmental analysis, for all the civil works components of the project to determine mitigatory measures.

Those with major socio-environmental issues which should either be excluded from the road programme or is the subject of a full and detailed EA to determine appropriate mitigation measures.

A reconnaissance survey has been undertaken to ascertain the aspects of the social structure, religious and cultural composition, occupational pattern, vulnerability of the people, which cannot be ascertained through the secondary sources of data. While conducting the sample survey, the care has been taken to select people for survey in such a manner so that the real situation of the area could be ascertained.

0.11 List Clearances required for the Project

Following clearances are required before the commencement of construction work. Out of these, few are critical and need to be obtained immediately to avoid the time lag at later date.

Table 0.24: Project Clearances

Sl. No.	Law/ Regulation/ Guidelines	Relevance	Applicable Yes / No	Reason for Application	Implementing / Responsible Agency
1	The EIA Notification, 14th September 2006 and subsequent amendments	Identifies "(i) New National Highways; and (ii) Expansion of National Highways greater than 30 Km involving additional right of way greater than 20m involving land acquisition" under (item 7 (f) of schedule) as one of the projects requiring prior clearance.	Not required	New National Highway NH - 717A (Category of project - A)	MoEF&CC
2	Notification for use of Fly ash, 3rd November 2009	Reuse fly ash discharged from Thermal Power Station to minimise land use for dispersal and minimise borrow area material. The onus shall lie with the implementing authority to use fly ash unless it is not feasible as per IRC.	NO	If Projects within power 500 km of plant will cover under this notification (SO 1396 (E). 25 March 2015	MoEF&CC, SPCB
3	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 construction/operation of certain facilities.	NO	Consent required if ground water is being used for consent purpose	CPCB /SPCB
4	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	State pollution control board

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Sl. No.	Law/ Regulation/ Guidelines	Relevance	Applicable Yes / No	Reason for Application	Implementing / Responsible Agency
				construction	
5	Forest (Conservation) Act, 1980	Conservation and definition of forest areas. Diversion of forest land follows the process as laid by the act	Yes	For diversion of forest land for road construction	State forest department, MoEF&CC
6	Coastal Regulatory Zone Notification, 2011	Protect and manage coastal areas	No	The project area is not within designated coastal zone	MoEF&CC, State forest department,
7	Wild Life Protection Act, 1972	Protection of wild life in sanctuaries and National Park	NO		
8	Ancient Monuments and Archaeological sites and Remains Act 1958	To protect and conserve cultural and historical remains found.	No	For world heritage sites and monuments	Archaeological Survey of India, Dept. of Archaeology
9	The Motor Vehicle Act. 1988	Empowers State Transport Authority to enforce standards for vehicular pollution. From August 1997 the "Pollution Under Control Certificate is issued to reduce vehicular emissions.	Yes	All vehicles used for construction will need to comply with the provisions of this act.	State Motor Vehicles Department
10	The Explosives Act (& Rules) 1884 (1983)	Sets out the regulations as to regards the use of explosives and precautionary measures while blasting & quarrying.	Yes	If new quarrying operation is started by the concessionaire / contractor	Chief Controller of Explosives
11	Public Liability And Insurance Act, 1991	Protection to the general public from accidents due to hazardous materials	Yes	Hazardous materials shall be used for road construction	Project Implementation Unit/ Contractor
12	Hazardous Wastes (Management and Handling) Rules, 1989	Protection to the general public against improper handling and disposal of hazardous wastes	Yes	Hazardous wastes shall be generated due to activities like	CPCB/SPCB

Sl. No.	Law/ Regulation/ Guidelines	Relevance	Applicable Yes / No	Reason for Application	Implementing / Responsible Agency
				of maintenance and repair work on vehicles	
13	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
14	Mines and Minerals (Regulation and Development) Act, 1957 as amended in 1972	Permission of Mining of aggregates and sand	Yes	Permission of Sand Mining from river bed & aggregates	Department of Mining for state and central level
15	The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996	Employing Labour / Workers	Yes	Employing Labour/ workers	District labour Commissioner

0.12 Economic and Financial Analysis

0.12.1 Economic Analysis

The economic evaluation for the project has been undertaken separately considering linkages of network, and also for the project as a whole, using HDM-4 model. The economic feasibility has been determined by utilizing the discounted cash flow technique, over a period of 20 years. The economic evaluation has been carried out for both "with" and "without" project situations.

0.12.2 Vehicle Operating Cost

The unit vehicle operating costs (VOC) for respective vehicles have been worked out based on IRC: SP 30-2009 Manual on Economic Evaluation of Highway Projects in India (Second Revision).

0.12.3 Assessment of Economic Benefit

The economic benefits likely to result by construction of alternative highway to Gangtok has been identified and quantified in monetary values. These are expected in terms of savings in road user costs comprising the cost of vehicle operation on different options / alternatives, value of travel time and accident losses.

In order to assess economic benefits, vehicle operating costs (VOC) for cars, buses and trucks and road users' time costs for passengers and goods in transit have been worked out in economic terms for vehicle mix and user groups under different traffic flow conditions for "without" and "with" the project situations. The VOC model has been run for alternate traffic scenarios. The model produces total VOC benefits under "with" and "without" scenarios. The congestion level due to proposal has also been considered and the committed plans for improvement of other links of the existing road network in the region. The net VOC savings under "with" and "without" project situations has been considered as economic benefits.

The savings in passenger time has been determined by making use of the income method for passengers using private and public modes of transport. The savings in freight consignment cost have been determined based on the accounting rate of return on the value of goods in transit, estimated from the commodity composition, average pay-load by vehicle type, and current price level of selected commodities.

The accident costs arising out of injuries and death of victims and damages to vehicles have been determined by using the 'ex-post' methodology (cost incurred by the community due to accident having taken place). The cost elements include such items as

- (i) Cost to the injured party,
- (ii) Cost to the insurance company due to damage of vehicles and fatalities,
- (iii) Administrative expenses of courts and Police Departments,
- (iv) Damage to property, etc.

The savings in accident costs is related to the net change in accident rates due to improved traffic flow condition.

0.12.4 Assess Economic Cost

The total project cost, estimated in financial terms at perceived market prices, will be converted into economic cost to reflect the resource cost to the national economy. The financial cost of the project distributed among major cost

components. The principal elements of economic cost estimates mainly comprises of:

- a) Civil works and construction (including cost of land and ROW, environmental and social impact mitigation) ;
- b) Capital cost - initial cost of machinery and equipment required;
- c) Consulting services and training;
- d) Incremental administrative costs (including cost of staffing and auditing);
- e) Initial working capital.

To the base cost, contingency allowances (reflecting physical and price changes that can reasonably be expected to increase a base cost estimate), interest during construction, and other financial charges have been added.

0.12.5 EIRR and Sensitivity Analysis

The economic analysis worked out based on economic internal rate of return (EIRR) and Net Present Value (NPV) using cost - benefit approach. The annual streams of project benefits and costs computed for 20 years have been used in this analysis. The sensitivity analysis has also been carried out by varying cost and benefit independently as well as in combination. The end results of this study are presented in a series of NPVs.

0.12.6 Risks on DBFO Projects

The project would involve a number of identifiable risks. The primary risks are:

- Construction risks (time and cost overrun)
- Financing risks (adequacy, interest rate fluctuation, exchange parity, etc.)
- Traffic and revenue risks (traffic volume and toll collection)
- Political risks (stability of government policy and socio-political scenario).

All the above factors have been carefully examined and evaluated while assessing the financial viability of the project on DBFO basis.

0.13 Recommendations

- Based on the lane capacity analysis results, the project road requires 2 lanes with Paved shoulder for capacity augmentation and efficient movement of traffic up to project common concession period of 15 years i.e. horizon year 2033.
- The project road can be improved without causing significant adverse environmental impacts to the natural, social, economic or cultural environments.
- Ribbon development is observed on the project road near Pedong town. To segregate local traffic and traffic travelling on national highway and also considering the future traffic projections, the raised footpath cum drain is proposed.
- The process of land acquisition has to be initialised immediately after the approval of the alignment, to expedite construction of bypass and widening sections.
- The project can be constructed within 24 months period with strategic planning and through one construction package. The construction work may begin from November 2016. The estimated basic cost is give below table (Amount in Crores)

Section	Proposed Length (km)	Base Cost In Cr
Bagrakot to Kafer (0+000 to 40+000)	40+000	674.58

- On the basis of preliminary analysis, nature of impacts and observations of the various affected groups due to project, it is concluded that the proposed National Highway can be developed without causing significant adverse environmental impacts to the natural, social, economic agricultural environment of the study area, assuming the mitigation measures identified in EIA report will be incorporated into design and implementation stage. The important points are:
- Appropriate mitigation measures as suggested in environmental assessment report shall be incorporated. Construction of National Highway in the state of West Bengal is not expected to result in any significant adverse environmental impacts.
- Forest clearance will be applicable for diverting reserved and protected forest for road construction. All the necessary clearances will be required from concern departments at different stage of the project implementation.

CHAPTER - 1

INTRODUCTION

1. Introduction

1.1 General

National Highway Authority of India (Ministry of Road Transport and Highways, Government of India) represented by the Chairman is engaged in the development of National Highway and as part of this endeavour, the Authority has decided to take up the development of alternative Highway to Kafer in West Bengal via Kafer – Bakhim –Lava – Algarah - Pedong –Reshi Border in the State of West Bengal through Engineering, Procurement and Construction (EPC) mode and accordingly taken up Feasibility Study cum Preliminary Design Report.

In pursuance of the above, M/s SA Infrastructure Consultants Pvt. Ltd. in association with Specialized Engineering Services Pvt. Ltd has been appointed as consultant to carry out the Feasibility Study cum Preliminary Design Report for alternative Highway to Kafer in West Bengal via Kafer – Bakhim –Lava – Algarah – Pedong – Reshi Border in the State of West Bengal by the Authority.

The Agreement was signed and the commencement of services has been started from dated 08-10-2014 with the reference of NHAI letter no: NHAI/Tech/WB/FRCPD/Sikkim/2014/444/5726, dated 08-10-2014.

1.2 The Consultants

The Consultancy services for preparation of Feasibility Report cum Preliminary Design for Alternative Highway to Kafer in West Bengal via Kafer – Bakhim –Lava – Algarah – Pedong – Reshi Border in the State of West Bengal has been entrusted to M/s SA Infrastructure Consultants Pvt. Ltd. in association with Specialized Engineering Services Pvt. Ltd. The field studies shall be carried out from the site office however report finalisation shall be carried out from the corporate office. The address of the corporate office is given hereunder:

Corporate Office:-

**SA Infrastructure Consultants Pvt. Ltd.
In Association With
Specialized Engineering Services Pvt. Ltd.
1101A 11th Floor, Tower A/2, Corporate Park, Plot No.7A/1
Sector-142, Noida-201301(Uttar Pradesh)
Tel. No-0120-6148000,6148031**

1.3 Objective of Consultancy

The objective of this consultancy (the “Objective”) is to undertake Feasibility Study cum Preliminary Design and prepare a Feasibility Report of the Project Highway for the purpose of firming up the Authority’s requirements in respect of development and construction of the Project Highway and Project Facilities and enabling the prospective bidders to assess the Authority’s requirements in a clear and predictable manner with a view to ensuring:

- (i) Enhanced safety and level of service for the road users;
- (ii) Superior operation and maintenance enabling enhanced operational efficiency of the Project Highway;
- (iii) Minimal adverse impact on the local population and road users due to road construction;
- (iv) Minimal adverse impact on environment;
- (v) Minimal additional acquisition of land; and
- (vi) Phased development of the Project Highway for improving its financial viability consistent with the need to minimise frequent inconvenience to traffic.

1.4 Scope of Services

As per the Terms of Reference (TOR), the general scope of Work will include the following primary tasks to be performed by the Consultants:

- (i) Traffic surveys and demand assessment
- (ii) Engineering surveys and investigations
- (iii) Location and layout of toll plazas
- (iv) Location and layout of truck lay byes
- (v) Location and layout of bus bays and bus shelters
- (vi) Social impact assessment
- (vii) Environment impact assessment
- (viii) Preliminary Designs of road, bridges, structures, etc.
- (ix) Preparation of Land Plan Schedules and Utility Relocation Plans
- (x) Preparation of indicative BOQ and rough Cost Estimates
- (xi) Preparation of Schedules A, B, C, D, H and I of the Contact Agreement.

Revised Final Feasibility Report : INTRODUCTION

1.5 Project Stages

The Project has to be completed in stages as described herein below:

Sl. No.	Description of Deliverables
A	Inception Report and QAP
B	Report on Alignment and First Traffic Survey
C	Land Plan Schedules
D	Utility Relocation Plans
E	Reports on Environment and Social Impact Assessment
F	Report on Indicative GAD of structures (bridges, grade separators, ROB/RUBs)
G	Draft Feasibility cum preliminary design Report and Schedules to the Contract Agreement(EPC)
H	Final Feasibility cum preliminary design Report
I	Completion of Services including assistance during Bid Process

1.6 The Draft Feasibility cum Preliminary Design Report (DFR)

The Draft Feasibility Report consists of two parts as described herein below:

- Part - A : Main Report
Part - B : Drawings

1.6.1 The Part - A: Main Report consists of the following chapters

Chapter No	Name of Chapter
0	Executive Summary
1	Introduction
2	Project Appreciation
3	Detailed Methodology
4	Mobilisation and Work Programme
5	Draft Design Standards

Revised Final Feasibility Report : INTRODUCTION

1.6.2 The Part - B: Drawings consists of the following

- Location Plan
- Alignment Plan
- Typical Cross Sections
- General Arrangement Drawings

Sr. No.	Detail	TCS	Length (m)	Length (Km)
1	Two Lane with Paved Shoulder Raised Portion (Hill Section)	I	24050	24.05
2	Two Lane with Paved Shoulder Raised Portion (Hill Section) in new alignment	II	12150	12.15
3	Type of Cross Section of 2-lane bypass (Open country-plain/rolling terrain)	III	3400	3.4
4	Type of Cross Section of 4-lane highway (Open country-plain/rolling terrain)	IV	400	0.4

CHAPTER - 2

DESCRIPTION OF THE ENVIRONMENT

CHAPTER – 2

Preliminary Environmental Assessment

2.0 Introduction

The Environmental Impact Assessment (EIA) has been carried out as per ADB/IRC guidelines and for the purpose of Environmental Assessment 10 km area from project boundary was considered for study. The objective of environmental impact assessment study is to identify the adverse and positive impacts due to project implementation and to suggest avoidance, mitigation and enhancement measures in project design and to prepare environmental management plan for pre-construction, and construction and operation phases of the project.

This section deals with the description of existing environmental set-up of the proposed study area in the State of West Bengal. The environmental baseline data comprises the salient features present within the surrounding of project area. The study area includes environmental features like forest cover, protected areas, water bodies (rivers, ponds, wetlands, lakes and reservoirs), industries, tourisms, and other valued environmental components (VECs), common property resources (CPRs) etc. The scope of this chapter is limited to only those issues, which are of major concern in the environmental impact assessment. The data and existing environmental features documented here under have been collected through field investigations, interactions with local people and communities, review of published data.

The environmental impact study includes all areas where physical, biological and chemical changes may be expected. The field studies have been carried out to substantiate projected effects and develop mitigation plans to protect the biota and natural integrity along the proposed project corridor. In this regard, the baseline environmental setup covers the following environmental attributes.

2.1. Physiography

West Bengal is located in East India on the Bay of Bengal. It is India's fourth-most populous state, with over 91 million inhabitants. It has a total area of 34,267 sq mi (88,752 km²). A part of the ethno-linguistic Bengal region, it borders Bangladesh in the

east and Nepal and Bhutan in the north. It also has borders with five Indian states, including Odisha, Jharkhand, Bihar, Sikkim and Assam .

A major agricultural producer, West Bengal is the sixth-largest contributor to India's net domestic product.^[4] It is noted for its cultural activities and the presence of cultural and educational institutions; the state capital Kolkata is known as the "cultural capital of India"

The lands along the project roads are mostly forest land and at few locations have habitation, commercial and cultivated (tea garden) areas in West Bengal. The project road alignment traverses through mountainous and steep terrain throughout the stretch from the start point of the project which traverses through hilly terrain in the west bengal.

Darjeeling hill areas are unique from environmental Eco-perception. The relief varies from 100 m above sea level to the mighty Kanchanjungha peak. The Darjeeling hills are formed of comparatively recent rock structure that has a direct bearing on landslides. The causes of the landslides vary from one locality to another. Heavy monsoon precipitation is however a very common cause of these disasters. More over soils of Darjeeling hill areas are extremely varied, depending on elevation, degree of slope, vegetative cover and obviously geo-lithology.

The natural system of erosion in the hill gets more complicated when man interferes. As the mountains serve as the source of resources for the population residing in the hills as well as in the plains, the form of environmental degradation is quite extensive other particularly is applied to the extraction of timber and other forest produces, mining and agriculture are taken into account. Due to unprecedented growth of population during the last few decades in the Darjeeling hill areas, nature has started reacting sharply to the accumulated human guilt.

Landslide hazards, especially during rainy season have become a common factor to the people of the hill. The Hill areas of Darjeeling District are located within the Lesser and Sub - Himalayan belts of the Eastern Himalayas. The area is bounded by the Sikkim Himalaya in the north, the Bhutan Himalaya in the east and Nepal Himalaya in the west. The southern foothill belt is demarcated by a highly dissipated platform of terrace deposits extending along the east west axis. The inner belt is defined by a ridgeline stretching from the Darjeeling Hill to the west and Kalimpong Hill to the east, overlooking the southerly flowing Tista valley in between. Prominent rivulets contributing to the

Rammam - Rangit basin, dissipate the northern slope of Darjeeling Hills. The Kalimpong Hill is rather rugged in topography and is dissipated by radically descending gullies and streams that contribute to the Teesta and Jaldhaka River system.

2.2 Climate

These regions have five seasons: winter, summer, spring, autumn, and monsoon. This region has a temperate climate (subtropical highland climate) with wet summers caused by monsoon rains. The annual mean maximum temperature is 15.98 °C (60.76 °F) while the mean minimum temperature is 8.9 °C (48.0 °F), with monthly mean temperatures range from 5 to 17 °C (41 to 63 °F). The lowest temperature recorded was -24 °C (-11 °F) in February 1905. The average annual precipitation is 373.6 cm (147.08 in), with an average of 126 days of rain in a year. The highest rainfall occurs in July. The heavy and intense rainfall is experienced in the region, aggravated by deforestation and haphazard planning, often causes devastating landslides, leading to loss of life and property. Fog affects most parts of the region during winter and the monsoons, making transportation perilous. Despite its small area, the climate ranges from sub-tropical to high alpine. Kangchenjunga, the world's third-highest peak, is located on the border of Sikkim with Nepal.

The amount of rainfall plays a very important role in causing instability of slopes. A very high intensity of rainfall within a short span of time is not uncommon in Darjeeling and sikkim hill areas. Besides seasonality, another climatic feature in the Darjeeling hills is created by orographic factor; causing the vertical zonation of temperature and decline of precipitation. Thus the mountain front is exposed to heavy rainfall, especially the middle parts of the southern hills. The mean annual temperature fluctuate from 24°C in the plains and drops below 12°C on the ridge. During summer month the temperature reaches 16°C-17°C on the ridge and during winter drops at 5°C-6°C.

There is no distinct relation between total rainfall and altitude. The southern slopes of the ridges get much higher (4000-5000 mm) precipitation than the leeward sides (2000-2500 mm). The next main ridge with Tiger Hills gets 3000 mm while to the north the Great Rangit valley receives about 2000 mm of rainfall. The annual total rainfall in Darjeeling town fluctuates between 1870-3690 mm.

2.3 Geology and Seismicity

2.3.1 Geology

The Darjeeling Himalaya has never been and will never be free from ubiquity of weak geology, slope instability, frequent seismicity, soil erosion etc. mainly due to natural causes and partly as a result of accelerated degradation. These adverse conditions in tandem can exacerbate the existing fragile, vulnerable and multi-functional mountain ecosystem. So far disasters caused by landslides, earthquakes, floods etc. have not lead to large scale human tragedy in Darjeeling in recent history. However, there is ever increasing human demand of natural resources, especially land for urban development and mega dams in an apparently unsustainable manner, making some of the denizens to adapt and survive at dangerous margins. The emerging crisis can perhaps be minimized by indigenous knowledge based and modern technological interventions. To safeguard against accelerated degradation and improve the living standards of the hill people, the Governments (Centre and State) need to address hill specific issues through systematic and effective integration of the ecosystem services and development, highland and lowland linkages etc. Without a replicable and hill specific developmental policy, the ever present threat from devastating landslides, earthquake, floods *etc.* remains and the options and the opportunities of the progeny in jeopardy.

The hilly terrain of project area mainly consists of gneissose and half-schistose rocks, producing generally poor and shallow brown clay soils. The soil is coarse, with large concentrations of iron oxide; it ranges from neutral to acidic and is lacking in organic and mineral nutrients. This type of soil tends to support evergreen and deciduous forests. Most of this region is covered by precambrian rock, which is much younger in age than the hills. The rock consists of phyllites and schists, and is highly susceptible to weathering and erosion. This combined with the heavy rainfall, causes extensive soil erosion and the loss of soil nutrients through leaching. As a result, landslides are frequent, often isolating rural towns and villages from the major urban centres.

2.3.2 Seismicity

The tectonic frame work and the seismicity of the northern eastern states including Sikkim and west Bengal are considered as a result of collision tectonics in the Himalayan arc and sub-duction tectonics below the Myanmarese arc. Studies have indicated a very

complex tectonic setting of the region due to constant movement of the Indian plate from South to North & Myanmarese from East to West. The two major structural elements in the Eastern Himalaya are the Main Central Thrust (MCT) and the Main Boundary Thrust (MBT). The MCT is shown passing through Gangtok to Mangan and then to lower Tolung to north of Sada from where it cuts through North of Labdang-Tashiding to Gyalshing and then to Kaluk to Soreng before coming out of Sikkim border at an area where it meets the MBF (India-Nepal border). The existing unsafe and non-engineered building stock still remains and is practically impossible to address the entire such building stock. The alternative left is to retrofit only the life line buildings such as hospitals, schools, cinema halls, multi-storied hostel/apartments *etc.*

The Foot Hill Thrust (FHT)/Main Frontal Thrust (MFT) along the Southern edge of the Himalayan bring the Siwaliks in Juxta-position with the thick recent sediments of the Indo-gangetic plain. There are also a large number of prominent lineaments in this region, some of which are reported to extend for several kilometers beneath the Himalayan Foredeep. The Teesta lineaments which pass through Parbatipur area of Bangladesh to Bhadrapur area of Nepal, is considered to demarcate the Western limit of Eastern Himalayan seismicity.

The magnitude, intensity and frequency of Himalayan landslides vary from East to West and from South to North. The variation is controlled, mainly by climate, neo-tectonism and seismicity. The eastern Himalaya including Sikkim is a hot-spot for natural hazards, particularly landslides and earthquakes. Landslides of all types and size occur in almost all types of rocks and quaternary formations of Sikkim. The Daling Group of rocks, especially, Gorubathan Formation appears more prone to landslides than the inhomogeneous quaternary deposits and gneisses and schists of Higher Himalaya. The high landslide susceptibility of the Daling Group of rocks has been attributed to their severe shear distortion due to loading and unloading during orogenesis, higher rate of weathering and mineral composition.

Almost all the landslides in West Bengal occur after prolonged exposure to monsoon rains and occasionally during or just after cloudbursts or precipitation intensity exceeding 135-145 mm in 24 hours. Natural hazardous events such as earthquakes, landslides, floods *etc.* in the Himalayas are a reality. Man and man-made structures stand no chance

against the awesome power and fury of such events when they strike. Therefore, a mechanism is needed to safeguard against massive and unwarranted loss of life and property in the event of a calamity. In August 2004, the Government of India came out with a detailed status report on Disaster Management in India. The report specifies various programmes and strategies of the Nation to tackle and mitigate all forms of destructive natural events. The seismic zones of India have been depicted in **Table – 2.1** and **Figure – 2.1** as given below. Earthquake hazard map for West Bengal is provided in **Figure 2.2**

Table – 2.1: Showing intensity and area of seismic zones of India

Seismic Zones	Intensity on Modified Mercalli Scale	% of Total Area
Zone–II (Low intensity zone)	VI (or Less)	43
Zone–III (Moderate intensity zone)	VII	27
Zone–IV (Severe intensity zone)	VIII	18
Zone–V (Very severe intensity zone)	IX (and above)	12
	Total	100%

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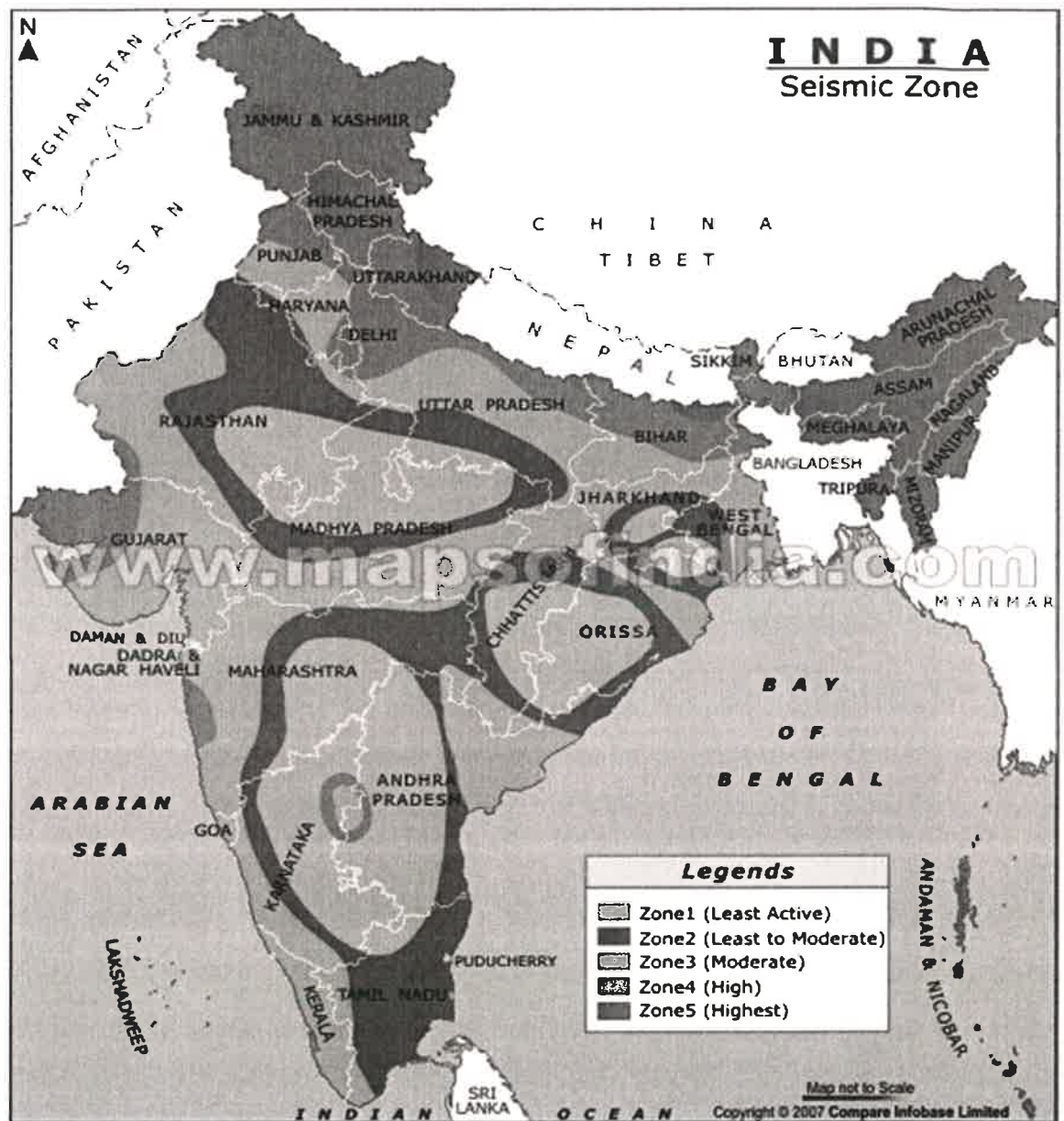


Figure – 2.1: Map showing major seismic zones in India

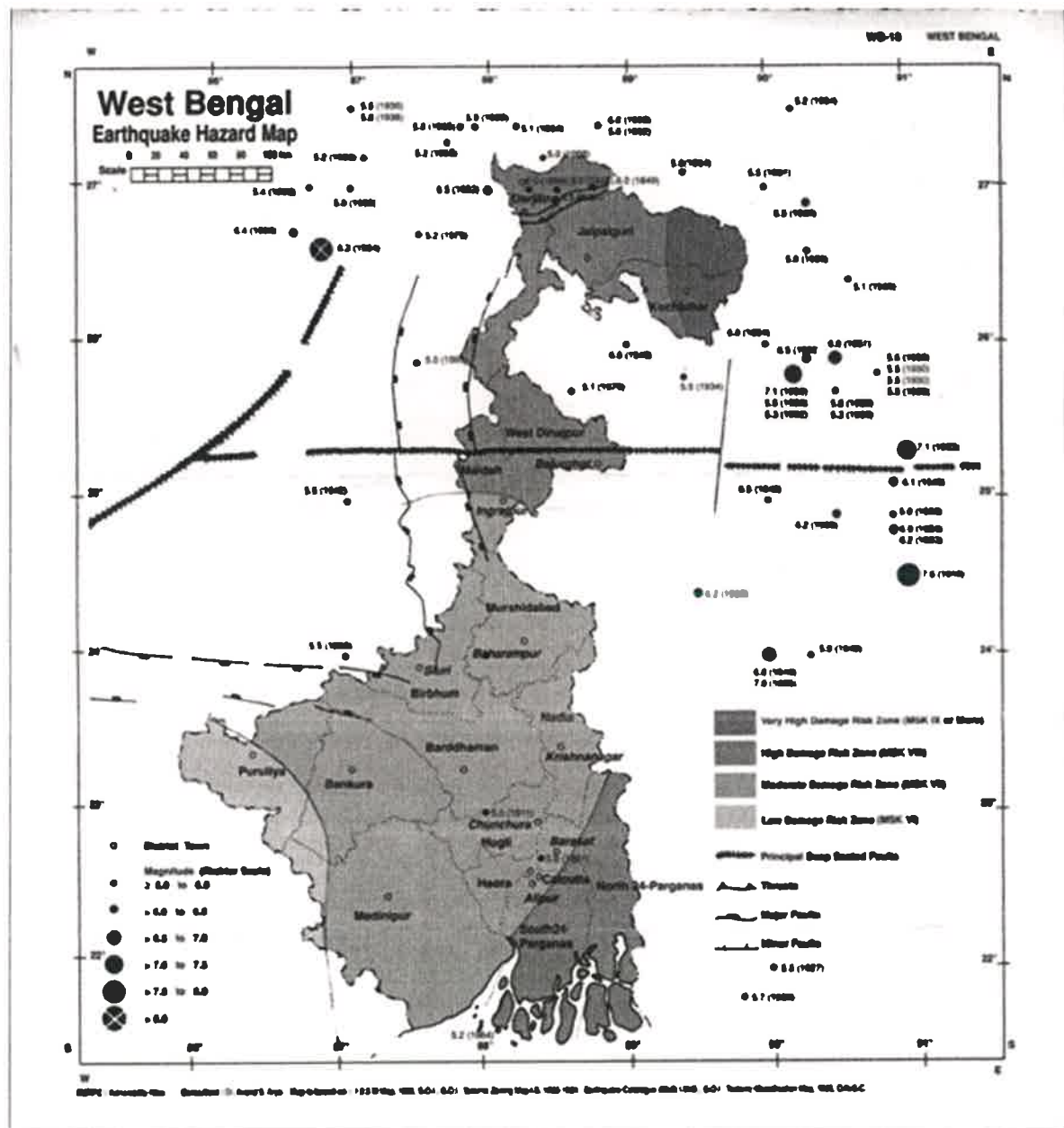


Figure 2.2 Earthquake Hazard map of West Bengal

2.4 Soil and Minerals

2.4.1 Soil

The soil of Darjeeling Hill Area is developed depending upon the underlying geological structure. But, in general, the soils have been developed by both fluvial action and lithological disintegration. The soils that have developed in the Kalimpong area are predominantly reddish in colour. Occasional dark soils are found due to extensive presence of phyllitic and scists. Soils in the high lands stretching from the west to the east to the district along most of the interfluvial areas are mainly mixed sandy loam and loamy, while those on the southern slopes of Mirik and Kurseong are mainly clayey loam and reddish in colour. Sandy soils are mainly found in the east of the river Tista.

All the soils are definitely acidic in nature with the tendency to increase slightly in depth in most cases indicating the lacking of bases from surface and accumulation in the lower horizons. The weathering of lateritic type is the substantial mechanism in the transformation of the substratum. The variable thickness of the regolith and soils depend on the rate of weathering and gradient of the longitudinal slope profiles and intensity / gravity of mass movements. The basic soil types are yellow soils, red brown soils and brown forest soils. Red and yellow soils have developed on gneiss while brown on schists and shales. Coarse pale yellow to red brown soils are found on the Siwaliks while clayey dark soils are developed on Daling series.

The character of the bedrock is reflected only in the grain size composition of the soil. On the Darjeeling gneiss, very coarse-grained (50%-80%) particles are found. In Damuda and Daling series percentage of sandy and coarse particles in the soils are high. On the Siwaliks, silty – clay fraction is higher. The chemical content of the soil over Darjeeling gneiss is characterized by a high proportion of potassium derived from feldspar and muscovite mica. This soil is poor in lime, magnesium, iron oxides, phosphorous and nitrogen. Therefore lime is used in the tea plantation areas.

2.4.2 Mineral Resources

West Bengal stands third in the country in terms of mineral production. The state contributes about one-fifth to the total production of minerals in the country. Major minerals which are found in this state are fireclay, china clay, limestone, copper, iron, wolfram, manganese and dolomite are mined in small quantities. There are good possibilities of obtaining mineral oil and natural

gas in the areas near the Bay of Bengal, in Purba Medinipur, Sundarbans, South 24 Parganas and North Bengal plains. Research is undergoing for finding natural gas in various places.

West Bengal is the third largest state for coal production, accounting for about half of India's total. Coal is extracted from about 228 mines in the Raniganj and Asansol region of Bardhaman district.

Highgrade bituminous coal is mined at Raniganj, Dishergarh, Santaldih, Kulti, Barakar, Ghushik, Kajora. Coalfields stretch over an area of about 1,550 km² (598 sq mi). The coalfields of Raniganj support the Asansol-Durgapur industrial belt by providing fuel to the industries as well as generation of thermal power. Lignite mined in Darjeeling is used to make briquettes. Coal deposits are also found along the Ajoy river in Birbhum district.

West Bengal ranks next to Bihar and Madhya Pradesh in production of fireclay. Most of this mineral is extracted in the Raniganj region along with few amount is also extracted from Birbhum and Purulia. China clay used

in the pottery, paper, textile, rubber and paint industries is unearthed at Mohammad Bazar in Birbhum and Mejia in Bankura. Rest of the production comes from Purulia, Bardhaman, Darjeeling and Jalpaiguri. In 1993-94 1.24 lakh metric tons of fireclay were produced in West Bengal.

Limestone which is used in cement industry is mined in Bankura, Purulia, Darjeeling and Jalpaiguri. There are copper mines in Jalpaiguri and Darjeeling. Small quantities of low quality iron-ore are mined in Bardhaman, Purulia, Birbhum and Darjeeling. There are manganese in the Jhargram region of Paschim Medinipur, Purulia and Bardhaman. Wolfram is mined at Jhilimili in Bankura. The state's production of dolomite comes from the Dooars region of Jalpaiguri. 38.5 thousand tonnes of dolomite were raised in 1993-94.

2.5 Physical Environment

2.5.1 Metrology

The proposed project area is located in north east of west Bengal. Metrological data of IMD station at Gangtok, Sikkim has been used for the study for macro scale metrological information. Data was collected from state pollution control board website. Mean monthly minimum temperature (°C), maximum temperature (°C), rainfall in mm, mean monthly relative humidity at

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830 IST (%), mean monthly relative humidity at 1730 IST (%), and mean monthly wind speed of Gangtok are shown here in tabular format.

Table No. 2.2 Mean Monthly Maximum and Minimum temperature of Gangtok

Mean monthly Maximum and Minimum temperature of Gangtok (°C)												
Month /Year	2008		2009		2010		2011		2012		2013	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
JAN	06.0	11.8	07.6	13.5	06.9	15.0	04.8	11.2	04.4	10.2	05.2	13.3
FEB	05.3	12.8	09.0	16.6	07.6	15.4	08.1	15.0	07.2	14.5	08.2	16.7
MAR	10.3	17.9	10.7	18.4	12.2	19.0	10.8	18.3	09.9	17.4	11.2	19.2
APR	12.9	20.3	13.5	20.7	14.5	22.0	12.3	20.6	12.6	20.3	12.5	19.6
MAY	14.6	21.6	14.7	21.2	15.4	22.1	15.0	21.8	15.1	22.9	15.0	20.6
JUN	17.0	21.1	17.1	22.8	17.1	22.3	17.1	22.2	17.5	21.6	17.7	22.1
JUL	17.7	21.9	18.2	22.3	17.9	21.8	17.7	21.1	17.9	21.6	18.0	21.5
AUG	17.6	21.3	18.0	21.7	18.0	21.9	17.5	21.7	17.8	22.4	17.6	21.8
SEP	16.4	21.6	17.0	22.8	17.0	21.0	17.1	21.6	16.9	21.2	17.1	22.0
OCT	13.7	20.9	14.4	21.1	14.5	20.2	14.0	20.6	13.1	19.9	14.1	19.2
NOV	10.5	17.9	10.7	17.0	11.1	16.2	10.0	105.3	09.4	17.0	10.0	17.4
DEC	09.0	13.9	07.6	13.3	07.0	14.6	07.6	13.7	07.0	13.9	07.2	12.9

Table No. 2.3 Monthly cumulative rainfall (mm) of Gangtok

Monthly cumulative rainfall (mm) of Gangtok						
Month/ Year	2008	2009	2010	2011	2012	2013
JAN	017.7	011.3	000.0	027.8	028.6	006.0
FEB	006.8	007.5	017.4	045.6	042.6	047.3
MAR	155.3	107.5	224.6	073.8	047.9	168.2

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APR	350.1	300.6	444.9	172.1	458.9	372.3
MAY	179.0	365.0	431.7	375.2	227.9	669.7
JUN	786.5	463.5	623.3	706.8	859.5	570.4
JUL	661.9	502.4	746.5	744.7	687.0	666.8
AUG	628.9	546.9	601.2	638.8	557.5	395.7
SEP	437.4	248.4	445.3	451.6	522.6	319.8
OCT	106.2	221.7	141.3	060.7	127.0	368.9
NOV	029.0	002.7	064.0	100.9	000.2	084.8
DEC	018.5	009.1	000.2	004.7	003.2	008.4

Table No. 2.4 Mean Monthly Relative humidity of Gangtok

Mean monthly relative humidity at 830 Hrs and 1730 Hrs IST (%) of Gangtok												
Month/Year	2008		2009		2010		2011		2012		2013	
	0830 Hrs	1730 Hrs	0830 Hrs	1730 Hrs	830 Hrs	1730 Hrs	0830 Hrs	1730 Hrs	0830 Hrs	1730 Hrs	0830 Hrs	1730 Hrs
JAN	84	81	84	78	74	66	85	76	83	81	76	63
FEB	83	76	82	74	83	72	84	76	83	76	71	66
MAR	80	80	68	65	81	78	75	73	76	68	76	74
APR	82	81	81	79	79	84	75	77	80	83	80	81
MAY	85	84	85	81	87	84	88	84	80	78	90	88
JUN	96	93	93	88	93	89	93	88	94	93	93	90
JUL	96	93	95	92	94	92	96	93	95	94	95	93
AUG	95	93	95	92	95	93	94	92	93	91	94	92
SEP	92	90	91	88	93	91	93	91	93	91	94	91

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Feasibility Report : Environmental Assessment

OCT	77	79	82	79	86	85	83	82	84	80	87	86
NOV	76	73	80	78	87	84	82	81	78	73	75	73
DEC	83	83	87	81	76	71	81	75	80	74	85	82

Table No. 2.5 Mean Monthly Wind Speed (KM/Hr) of Gangtok

Mean Monthly Wind Speed (KM/Hr) of Gangtok						
Month/Year	2008	2009	2010	2011	2012	2013
JAN	002	002	002	001	002	002
FEB	002	002	002	002	002	003
MAR	003	003	002	003	002	003
APR	003	003	003	004	003	003
MAY	003	004	003	002	003	002
JUN	001	002	002	002	002	002
JUL	001	001	001	001	001	001
AUG	001	001	001	001	001	001
SEP	002	001	001	001	001	001
OCT	003	002	002	002	002	002
NOV	002	002	001	002	002	002
DEC	001	001	002	001	001	002

2.5.2 Water Resources

West Bengal covers 2.7 per cent of the national territory and renders home to 8 per cent of the Indian population. The State is endowed with 7.5 per cent of the water resource of the country and that is becoming increasingly scarce with the uncontrolled growth of population, expansion of irrigation network and developmental needs.

The Irrigation and Waterways Department (1987) of the Government of West Bengal made an assessment of the available water resource within the State in 1987. The Expert committee made a detailed exploration in the 26 river basins and stated that though the surface water in this state is estimated to be 13.29 Mham, only about 40 percent of it is utilizable. On the other hand, the available ground water though being 1.46 Mham only, is totally utilisable. The Central Ground Water Board estimated the annual available ground water as 1.76 m.ham while the Irrigation Commission of Government of India put it as 2.38 m.ham. (Goswami, 1995, 2002).

2.5.3 Ambient Air Quality

The ambient air quality monitoring data was collected from secondary sources of state pollution control board official website. To control, prevent and abate air pollution in the country, the Government of India enacted Central legislation called the Air (Prevention & Control of Pollution) Act 1981. Every polluting industry must obtain a consent from the State Pollution Control Board for discharge of air pollutants in any form through chimney or otherwise. The State Board may lay down suitable conditions while giving consent to discharge air pollutants in the light of emission standards developed by the Central Board, subsequently notified through the rules framed under the Environment (protection) Act, 1986 Rules.

Air Quality monitoring data as per state of Environment Pollution Report 2004 are represented in the **Table 2.6**

Table 2.6 Ambient Air Quality in and around Gangtok (Yearly Average conc.) in $\mu\text{g}/\text{m}^3$

Sl. No.	Name of sites	Category	SPM	SO ₂	NO ₂
1	Tadong	Residential	108	16.2	15.7
2	Indira bye-pass	Commercial	137	17.4	22.6
3	Deorali	Residential	118	18.6	16.1
4	Bazar area (near metro point)	Commercial	145	22.3	20.4
5	Hospital point	Sensitive	122	19.6	18.6
6	Zero point	Sensitive	98	10.2	12.3

Reference: State of Environment Pollution Report 2004

- Oxides of Sulphur**

Eight hourly Sulphur dioxide concentration of the sample shows that Bazar area with 22.3 $\mu\text{g}/\text{m}^3$ has highest concentration on yearly average while the zero point shows minimum concentration with 10.2 $\mu\text{g}/\text{m}^3$. The other stations viz: Tadong (16.2 $\mu\text{g}/\text{m}^3$), Indira bye-pass (7.4 $\mu\text{g}/\text{m}^3$) Deorali (16. $\mu\text{g}/\text{m}^3$), and Hospital Point (18.6 $\mu\text{g}/\text{m}^3$). All the values are, however, within the prescribed limit.

- **Oxides of Nitrogen**

The Eight hourly averages of Nitrogen oxides samples were collected and further analyzed in the lab. The result is presented in the table above. The highest concentration of oxides of Ni-trogen as NO_2 was recorded from Indira Bye-pass with 22.6 $\mu\text{g}/\text{m}^3$ followed by Bazar area (20.4 $\mu\text{g}/\text{m}^3$), Hospital Point (18.6 $\mu\text{g}/\text{m}^3$), Deorali (16.1 $\mu\text{g}/\text{m}^3$), Tadong (15.7 $\mu\text{g}/\text{m}^3$) and lowest was recorded from zero point with 12.3 $\mu\text{g}/\text{m}^3$. All the values are however, within Indian standard.

- **Suspended Particular Matter (SPM)**

The yearly average of suspended particulate matter is presented in table above. It can be inferred that Bazar area (near metro point) with 145 $\mu\text{g}/\text{m}^3$ of SPM has highest concentration while zero point with 98 $\mu\text{g}/\text{m}^3$ shows minimum concentration of SPM. The highest value in Bazar area is mainly due to heavy vehicular movement in this area. Tadong monitoring site recorded 108 $\mu\text{g}/\text{m}^3$ of SPM and like-wise Indira bye-pass (137 $\mu\text{g}/\text{m}^3$), Deorali (118 $\mu\text{g}/\text{m}^3$) and Hospital point (122 $\mu\text{g}/\text{m}^3$).

2.5.4 Water Quality Monitoring

Sikkim is bestowed with abundant hydrological resources primarily because of its geomorphology and its location in the Eastern Himalayas. The Himalayas obstruct the rain bearing winds of the south-west monsoon resulting the Himalayas to receive annual rainfall which ranks as the highest in the world, making the Himalayas a source of a large number of mighty rivers perennial streams and snow cover mountains. Of all the Lakes of Sikkim the study on the Environment status of the three revered lakes of East Sikkim, Viz., Changu, Menmoitso, & Kupuk Lakes have been carried out under the Central sponsored scheme Prevention & Abatement of Pollution. The Changu, Menmoitso, Kupuk Lakes are regarded as extremely sacred & are places of Tourist interest

besides military base is situated in their vicinity. These lakes form an important stopover for various ducks besides being home to resident brahminy ducks (*Tendora ferruginea*). These lakes also form the habitat for introduced browntrout (*Salmo trutta*). Comparative Water analysis of lakes is shown in the following Table 2.7

Table 2.7: Comparative water analysis of Mirikh and Sinchal lake in Darjeeling district.

Parameter	Mirikh Lake	Sinchal Lake	Unit
Ammonia-N	0.36	BDL	mg/l
BOD	5.3	2.5	mg/l
Conductivity	88.8	30.9	μS/cm
Dissolved (DO)	10	8.9	mg/l
Fecal Coliform	4000	2000	MPN/100ml
Nitrate-N	0.49	0.6	mg/l
pH	6.61	7.18	-
Temperature	8	8	°C
Total Coliform	8000	4000	MPN/100ml

- **pH**

The annual average pH of Mirikh was lowest with 6.61 compared to Sinchal which had approximately the 7.18 value in average. Lower pH value in Mirikh may be attributed to religious offerings and the impact of flow of tourists during tourist season whereas in sinchal lake flow of tourist is comparatively low.

- **Dissolved oxygen**

The highest annual average of dissolved oxygen was observed at Mirikh with 10 mg/l and the lowest no. at sinchal with 8.9 mg/l. The low no Value of sinchal shows the tendency towards eutrophic condition of the lake. In all the sites no content shows a marked seasonality with oxygen levels decreasing during winter months which might be due to cumulative influence of low insulation, low temperature, over turn of lake water and minimal photo synthetic activity.

- **B.O.D & C.O.D**

The annual average B.O.D value of mirikh was 5.3 mg/l which is comparatively higher than other study site. Sinchal shows 2.5mg/l whereas lowest BOD. Maximum values of B.O.D and C.O.D was observed during rainy season which may be due to heavy input of Variety of

nutrients along with eroded material and prevalence of favourable environmental conditions for microbial activities. The higher B.O.D and C.O.D values infer to the pollution potential. Thus it can be inferred that Changu lake has suffered undesirable change than the other two lakes.

2.5.5 Noise Quality Monitoring

Noise has rapidly become a source of environmental pollution with increasing industrialization, urbanization and the rapid expansion of the means of transportation. The Ambient noise level termed as the total noise associated with a given environment and usually comprise of sounds from many sources both near and far.

The measurement of Ambient Noise level was done by noise level meter. The measurements which were taken for seven consecutive days in each sites were in three slots i.e. morning 8.00 am to 10 am, afternoon 14.00 to 16.00 pm, and night 18.00 to 20.00 pm. The average measurements are represented below.

Table 2.8 Average Ambient Noise Level at Various Places in Gangtok			
Sl. No.	Place	Day Average leq in dB (A)	Night Average leq in dB (A)
Silence Zone			
1.	Hospital Point	62	63
2.	District Court	50	44
Residential Zone			
1.	Tadong	61	58
2.	Deorali Govt. Quarter	61	57
3.	Development area	66	50.7
Commercial Zone			
1.	M.G. Marg	70	62
2.	Indria Bye-Pass	73	69
<i>Reference : SPCB, Government of West Bengal</i>			

2.6 Agriculture System

Agriculture is the major economic activity. Economy of the State broadly depends on agriculture, which provides livelihood and productive engagement to the majority of the population. However, its progress has remained limited due to difficult topography and other natural barriers. More than 64% of the population is dependent on agriculture and related activities for their livelihood. The agriculture system followed in project area is economically viable for individual farmer and environmentally sound. Such a system enhances farmers' quality of life and provides gainful engagement for the rural population. The main crops grown in project districts are maize, rice, millet, buckwheat, pulses and oilseeds. Paddy is grown in rain fed condition. In view of hilly terrain and wide range of agro-climatic condition in project district (Sub-tropical type to alpine) no single variety of the crop can suit to all elevation ranges. The agro-ecological condition of the area is conducive for loss of soil and nutrients from the farming systems. Low yielding traditional cultivars continue to dominate the agrarian scenario while the department is exerting sincere efforts to replace them with the improved varieties. The agriculture is dominated by high dependency on organic sources of nutrients. All this leads to low per unit productivity as compared to national average. In such hilly terrain and small size of land holding, the most suited farming system is the mixed farming. It is envisaged to enhance farm production and productivity with sustainable development, providing adequate attention toward management of natural resources.

The land use practices play the most important role in determining the stability factors in respect of landslide hazards. The land use map of Darjeeling Hill Areas explains that there are agricultural activities, tea and medicinal plant plantations, construction works along with forests, rivers, jhoras etc. The main problem in respect of land use in the Darjeeling Hill Areas is related to high density of population. There is very limited scope for extension of agricultural land to cope up with increasing pressure of population. As a result pressure on forested and other restricted areas is gradually increasing.

Another problem related to land use and consequent landslide is that in Darjeeling Hill Areas, roads have never been examined with its carrying capacity respect with geology etc. Along with new road construction the vehicular movements have increased to a great extent with the rapid growth of trade and commerce. Heavy traffic movements along with heavy rainfall are responsible for most of the landslide occurrences especially on the roads. In recent years, it has been observed that there is a constant increase in the vehicular traffic, especially heavy vehicles like trucks and buses.

2.7 Irrigation System

Darjeeling is wholly a mountainous district and is rich in water resources. The major portion of the state is covered by forest and snow.. It falls within high rainfall zone and especially during the monsoons the state receives high precipitation. The annual rainfall ranges from 2,000 mm to 4,000 mm. It receives high precipitation from May to September. However, the rainfall is not scattered evenly all over the state and also time of occurrences of the precipitation and the time of irrigation do not coincide for a variety of crops. Some crops like vegetables, flowers, fruits, cereals, root and tuber crops *etc.* need frequent irrigation and these crops are grown round the year and for these crops perennial supply of irrigation from assured source is essential. Hence, the need to have assured irrigation system for the cultivation of number of crops like vegetables, flowers, spices *etc.* that are more profitable and viable for the State is important. Besides, the soil condition and steep terrain do not permit retention of the rain water for longer period. Therefore, to intensify or to enhance the agriculture produce, it is important to properly harness or augment water resources available in the rivers and rivulets to boost the agri-horticulture production in the state.

The state has fertile land and varied altitudes and climate conditions favourable for growth of large varieties of crops. But the growth in farm sector can be intensified and achieved only through assured irrigation system. The availability of assured irrigation system would increase the cropping intensity and the



coverage under high yielding and improved varieties thereby enable to enhance the production and improve the Gross Domestic Products of the state, besides improving the living condition of the masses in the rural areas. The state Government is emphasizing on the improvement of the living condition of rural population and their self-sustainability. The vision of the State Government can be achieved through the improvement in the farm sector vis-à-vis irrigation. Horticulture and Floriculture are in the top agenda of the State Government and both these sectors need assured irrigation system for development.

2.8 Livestock

The livestock population of the Darjeeling district is 116684 (Livestock Census 2014). Animal Husbandry is the major source of the supplementary income of the rural households. Livestock production had always been an integral part of the rural livelihood in West Bengal. The livestock wealth of West Bengal still constitutes a natural resource base with immense livelihood implications. West Bengal's Agriculture economy depends upon symbiosis of crop and livestock production. However, in view of the limited cultivable land holdings and decline in soil fertility, livestock production is the ultimate answer to provide sustainable economic upliftment of the rural masses.

2.9 Forests

The forest cover, based on interpretation on State of forest report, 2015, Total recorded forest land in the state is **11,879 sq.km.**, of which **7,054 sq.km. is Reserved Forest**, **3,772 sq.km. is Protected Forest** and **1,053 sq.km. is Unclassed State Forest**, thus constituting 13.38% of the geographical area of the state. District wise forest cover of the state is given below in the **Table-2.9**. Growth rate of forest cover in West Bengal from 1998-2006 given in **Table 2.10**.

Table - 2.9: District wise forest cover in West Bengal

District	Geographical Area	Recorded Forest Area	% age of Recorded
	(Sq. Km.)	(Sq.Km.)	Forest Area
Darjeeling	3,149	1,204	38.23%
Jalpaiguri	6,227	1,790	28.75%
Cooch Behar	3,387	57	1.68%
Bankura	6,882	1,482	21.53%
Midnapur	14,081	1,709	12.14%
Burdwan	7,024	277	3.94%

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District	Geographical Area	Recorded Forest Area	% age of Recorded
	(Sq. Km.)	(Sq.Km.)	Forest Area
Purulia	6,259	876	14.00%
Birbhum	4,545	159	3.50%
Hooghly	3,149	3	0.10%
Nadia	3,927	12	0.30%
Mushidabad	5,324	8	0.15%
Malda	3,733	20	0.54%
Uttar Dinajpur	3,140	10	0.32%
Dakshin Dinajpur	2,219	8	0.36%
Calcutta	104	-	0.00%
Howrah	1,467	-	0.00%
24-Parganas (S)	10,159	4,221	41.54%
24-Parganas (N)	3,997	43	1.08%
Total	88,752	11,879	13.38%

Table - 2.10: Growth rate of forest cover in West Bengal from 1998-2006

Survey Period	Recorded Forest Land	% Forest cover
1988	13.38%	14.32%
1991	13.38%	14.97%
1994	13.38%	15.06%
1997	13.38%	15.16%
2000	13.38%	15.30%
2004	13.38%	15.52%
2006	13.38%	15.68%

(Source: Govt. of West Bengal, Forest Department)

2.9.2 Forest Type in West Bengal (Darjeeling Hills)

The principal economy of Darjeeling Hill Area depends on tea production, horticulture, agriculture and forestry. The major portions of the forests are today found at elevations of 2000 m and above. The area located in between 1000 – 2000 m is cleared either for tea plantation or cultivation. The four major forest types according to altitudinal variation found in Darjeeling Hill Areas are:

1. *Tropical moist deciduous forest (300 – 1000 m)*

2. *Tropical evergreen lower montane forest (1000 – 2000 m)*
3. *Tropical evergreen upper montane forest (2000 – 3000 m)*
4. *Temperate forest (3000 – 3500 m)*
5. *Sub temperate forest (above 3500 m)*

About 30% of the forest covers found in the lower hills are deciduous. Evergreen forest constitutes only about 6% of the total forest coverage. The Sal (*Shorea robusta*) remains the most prominent species of Tropical moist deciduous forest along with heavy under growth. In the slopes on southern portion of the Teesta and the Great Rangit valley and in the Goke forests, this type is found. These species cannot thrive in areas of lower precipitation.

Tropical lower montane evergreen forests are found on steep higher slopes, where drainage condition is good; Dhupi (*Cryptomaria Japonica*) is a known variety. The impact of man on this variety is very conspicuous.

Tropical upper montane evergreen forests are found in the areas where high humidity along with dense fogs and less sunlight is available. Undergrowth is dense and contains Nettles, Raspberries, Ferns and bamboos. On the steep ridges, Rhododendrons and bamboos are abundant.

The hilly areas of Darjeeling District is divided into 3 forest divisions viz.,

1. Darjeeling, 2. Kurseong and 3. Kalimpong Forest Division but the proposed project exists in Kalimpong Forest Division of West Bengal and East (Territorial) Forest Division of West Bengal states. The growing pressure of population during the last two decades has left clear marks on the forest resources of the region. Marked decline in forest cover were observed in Takdah-Ghoom-Simana- area of Darjeeling Sadar, Sukhna, Pankhabari regions of Kurseong, and Chel, Jaldhaka catchments of Kalimpong division.

2.10 Protected Areas (National Park and Wild Life Sanctuaries)

India has at present four categories of protected area (PAs), these are 1. National Parks, 2. Wildlife Sanctuaries 3. Conservation Reserves and 4. Community Reserves, which are provided legal sanctity by the Wildlife (Protection) Act 1972. However, there are six categories specified by the IUCN (International Union for Conservation of Nature & Natural

Resources) and different countries have different categories of PAs as per their requirements and norms laid by their Governments.

With reference to Project state West Bengal, there are 21 Protected Areas (Pas), which comprises of 6 National Park and 15 Wildlife Sanctuaries that covers almost 4.54% of the total geographical area of the state. Within 10 km radius from project boundary Pangolakha Wild Life Sanctuary is exists as protected area in northeast direction of the project.

2.11 Biodiversity (Flora & Fauna)

India is recognized as one of the 12 mega diversity centres of the world. Out of the 12 Biodiversity hot-spots in the world, India owns 2, namely the Western Ghats and the Eastern Himalayas. West Bengal covering just 0.2% of the geographical area of the country has 26% of the country's total biodiversity and has been identified as one of the 'HOT-SPOT' in the Eastern Himalayas.



- There are 10 bio-geographic zones & 25 biotic provinces--- which have 16 major forests types & > 200 sub types as per (Champion & Seth 1968).
- West Bengal falls under Himalayan (2) Bio-geographic zone & Central Himalaya (2c) biotic province----having about 9 types of forests types (Champion & Seth).

Nature has been particularly generous in her gift of sylvan treasures to the state of West Bengal. Luxuriant forest, abound in all part of state and variety of medicinal plants, herbs, shrubs, bamboos and trees growing in state is truly rich. In the forest, there are number of plants whose medicinal values have been well recognized by local people as well as by different pharmaceutical, insecticidal and perfumery sectors. Medicinal plants ought to be given the status of a "National Resources" because their sustained availability is essential to sustain one of the world's oldest medicinal traditions, a priceless legacy of the Indian people. The local inhabitants for treatment of various ailments use numerous herbal

remedies. Furthermore, modern medicines owes to the flora of these mountains. Many inhabitants for treatment of various ailments use numerous herbal remedies. Many species of Himalayan origin have revolutionized the allopathic systems of medicine.

2.12 Biodiversity of West Bengal

West Bengal is an eastern State of amazing extreme stretches from the Himalayas through the gangetic plains to the bay of Bengal over the course of about 483 km and displays almost all the geographical features and its associated biodiversity. The northern most district , Darjeeling , is called the lap of the colossal Himalayas, followed by tarai region which supports a huge diversity of biodiversity.

Nature has bestowed the state of West Bengal with a treasure house of Biodiversity, covering only 2.7% of the geographical area of the country it is home to 12.27% of Indian biodiversity till date. The state has almost 7000 species of described flora including bacteria, algae, fungi, bryophytes, pteridophytes and angiosperms and more than 10000 species of described fauna.

The forest of west bengal is classified into seven categories; Tropical Semi Evergreen Forest, Tropical Moist deciduous Forest, Tropical Dry Deciduous Forest, Littoral and swamp Forest, Sub Tropical Hill forest, Eastern Himalayas wet temperate forest and alpine forest.

Table 2.13 : Major Forest Types In West Bengal

Type of the Forest	Location	Area	Major Species
NORTHERN TROPICAL WET EVERGREEN FORESTS	Plains of North Bengal upto 150 m. altitude.	167 sq.km.	Sal, Nageshwar, Jam, Kainjal, Lator, Malagiri, Lali & Canes.
NORTHERN SUB-TROPICAL SEMI- EVERGREEN FORESTS	North Bengal, Sumbong, Peshok, Buxaduar	25 sq.km.	Champ, Panisaj, Gokul, Angare .
NORTH INDIA MOIST DECIDUOUS FORESTS	North Bengal, Almost entire duars and terai area	1757 sq.km.	The most important forests of the State are in this sub-montane belt consisting of Sal with Champ, Chilauni, Chikrassi, Gamar etc. representing succession from riverian to climax sal.

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Type of the Forest	Location	Area	Major Species
LITTORAL & SWAMP FORESTS - THE MANGROVES	The tidal mangrove forests of Ganga-Brahmaputra delta (Sunderbans):	4263 sq.km.	Important species are : Goran (Ceriops roxburghiana), Gnewa (Excoecaria agallocha), Sundari (Heritiera minor), Baen (Avicennia officinalis), Dhundal (Carpa obovata)
LITTORAL & SWAMP FORESTS-TROPICAL SEASONAL	Malda & Dinajpur (N & S)	20 sq.km	Hijal (Barringtonia acuteangula)
NORTHERN TROPICAL DRY DECIDUOUS FORESTS	Bankura, Purulia, Midnapur, Birbhum, Burdwan	4527 sq.km.	Sal (Shorea robusta), Peasal (Pterocarpus marsupium), Kend (Diospyros melanoxylon), Mahul (Madhuka latifolia), Kusum (Schleicheria trijuga), Karam (Adina cordifolia
NORTHERN SUB-TROPICAL BROAD-LEAVED WET HILL	North Bengal hills 300m-1650m altitude.	800 sq km	The species commonly found are Mowa, Chilaune, Katus, Panisaj, Lampate, Phaleado, Saur, Tarsing, Angare, Melo Kapasi, Utis, Toon and Malagiri along with Kutmero, Jhingni,
NORTHERN MONTANE WET TEMPERATE FORESTS	North Bengal hills 1650m-3000m.altitude.	150 sq.km.	The principal species found here are Pipli(Bucklandia populnea), Utis, Saur, Katus, Kapasi, Arkula, Mowa, Khankpa etc.
EAST HIMALAYAN MOIST TEMPERATE FORESTS	North Bengal hills 1500m-1800m	150 sq.km.	The species commonly found are Mowa, Chilaune, Katus, Panisaj, Lampate, Phaleado, Saur, Tarsing, Angare, Melo Kapasi, Utis, Toon, and Malagiri
SUB-ALPINE FORESTS	North Bengal hills 3000m-3700m	20sq.km.	Important spp. are Putli, Lakh Kapasi, Lakh Pipli, Kapasi, Arupate, Sindure Katus(Castanopsis sp.) , Yew (Taxus bacata) , Rhododendrons,

2.12 Symbols of Project States (West Bengal)

The state symbols of West Bengal have been depicted in **Plates – 1 to 4** as given below.

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Plate-1: State Animal – Fishing Cat Zoological Name – <i>Prionailurus viverrinus</i>	Plate-2: State Bird – White throated Kingfisher Zoological Name – <i>Halcyon smyrensis</i>
	
Plate-3: State Flower – Night-flowering Jasmine Botanical Name - <i>Nyctanthes arbor-tristis</i>	Plate-4: State Tree - Chatim tree Botanical Name - <i>Alstonia scholaris</i>

State Symbols of West Bengal

2.13 Land use of West Bengal

District and category wise distribution of Land use / Land Cover in West Bengal as per Bhuvan data base 2011-12 provided in **Figure 2.3** and Description has been provided in **Table 2.14**.

Figure 2.3 Land use pattern of West Bengal

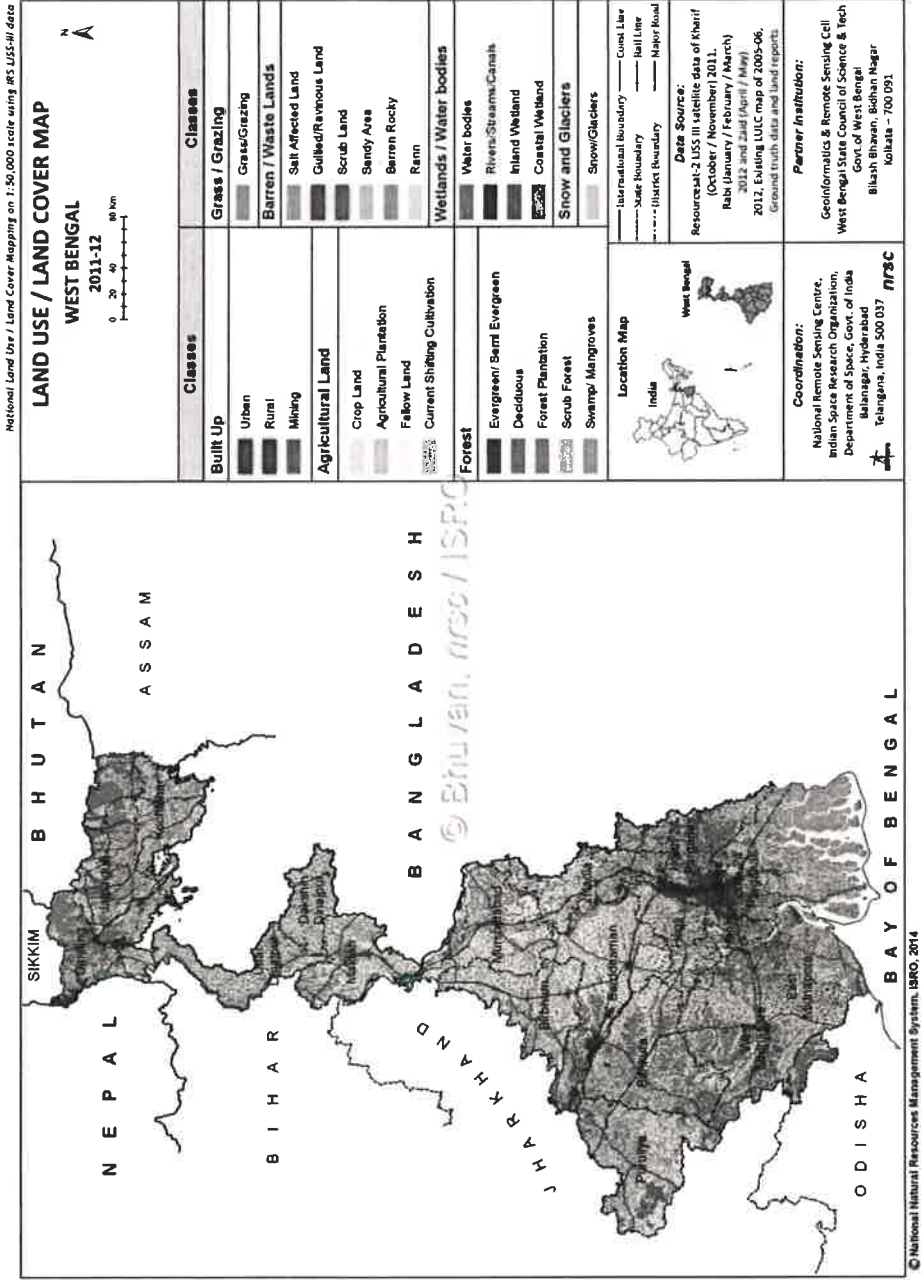


Table 2.14 Details of Land Use District Wise

Land use type	Description of land	District Darjeeling (sq. km.)
Agriculture	Crop land	1790.49
	Plantation	653.90
	Fallow	2.38
	Current shifting cultivation	-
Barren/ unculturable/ Waste lands	Sandy Area	0.07
	Gullied/ Ravinous land	-
	Barren Rocky	3.13
	Rann	-
	Salt Affected Land	-
	Scrub Land	24.60
Built-up	Urban	61.14
	Rural	191.26
	Mining	0.37
Forest	Evergreen/Semi evergreen	184.63
	Deciduous	1354.22
	Forest Plantation	4.26
	Scrub Forest	19.81
	Swamp / Mangroves	-
Grass / Grazing	Grass / Grazing	0.75
Snow and Glacier	Snow and Glacier	-
Wet lands/ water bodies	Inland Wetland	1.09
	Coastal Wetland	-
	River/ Stream/ Canals	94.23
	Water Bodies	1.87

2.14 Potential Impacts on Environment and Mitigation measures

The anticipated impact due to project activities is likely to arise in three phases of the project.

1. Impact due to design / pre-construction phase
2. Construction phase
3. Operational phase

Impact due to design / pre-construction phase (Mitigation measures)

Impact due to land acquisition

The major impact due to pre-construction and design phase are related with the land acquisition, since widening needs land area throughout the corridor. Mitigation measures due to land acquisition are suggested below:

Mitigation measures for land acquisition

- A separate R&R policy has been framed after identified different category of entitlement and benefits to each category to address the issues pertaining to the Project Affected People and their rehabilitation & resettlement depending upon the Entitlement.
- The acquisition of land and private properties will be carried out in accordance with the RAP and entitlement framework for the project.
- Early identification of entitlement for Compensation and Advance planning of Resettlement and Rehabilitation Action Plan to Compensate the Losses.
- All the affected people will be compensated as per NPRR, 2007 before commencement of Construction works and the cost of compensation will be finalized by the Competent Authority and the Project Proponent will pay the compensation at all the entitles persons through the Competent Authority.
- It will be ensured that all R & R activities including implementation of Environment Management Plan are completed before the start of work.
- PIU has to ascertain that any additional environmental impacts resulting from acquisition of land are addressed and integrated into the EMP and other relevant documents.
- The NHAI has appointed Competent Authority in each affected districts. The Competent Authority is from District Revenue Department. The Competent Authority will assess the cost of the losses and then decides the compensation for each properties and assets as well as identifies the affected persons as per records. The NHAI accordingly will pay the compensation to the affected persons through the competent authority.
- All the affected hand pumps, wells and water tanks will be relocated at suitable locations before commencement of construction activities.

Impact due to tree felling

The present project will have varying levels of impact on the roadside plantations throughout the entire stretch of the road. This impact is viewed critical due to long duration required for its reversal and sometimes it is irreversible. Roadside plantations not only provide a healthy aesthetics to the road users but also provide shade and protect the users from harmful effects of contaminants by absorbing them through vegetation canopy.

Effort will be made to minimize the tree felling by restricting tree felling within the formation width only. The baseline studies showed that there is no any endangered or rare tree species located within the project area. The predominant tree species are Babool (*Acacia nilotica*), Neem (*Azadirachta indica*), Siris (*Albizia lebbeck*), Goldmolar (*Delonix regia*) and Shisam (*Dalbergia sissoo*), etc.

Mitigation measures for tree felling

- Permission of Roadside cutting will be obtained from the line department, i.e. Forest Department.
- All efforts will be made to preserve trees by restricting tree cutting within the formation width. Special attention will be given for protecting giant trees, and locally important trees (having cultural importance)
- Compensatory plantation will be carried out along the space available within the proposed ROW in the ratio of at least 3 times as much the trees are proposed to cut as per Forest (Conservation) Act in consultation with local Forest Department
- A general guideline for tree plantation will be followed as per IRC: SP: 21:2009
- Median plantation has also been proposed. These plantation will not only compensate the loss but at the same time will enhance the aesthetic along the highway and enhance the pollution alleviation capacity of the area.
- The avenue plantation programme will be promptly adopted to restore and further enrich the loss of vegetation.

Impact due to construction phase (Mitigation measures)

The construction phase, in general, has adverse influence on all the components of environment. Most of these impacts are primarily due to negligent practices but are short lived and reversible in nature. A proper care is essential to minimize the adverse impacts to the possible extent to facilitate the restoration of the environment and can be discussed under following sub-heads.

The standard road construction works involve are site clearance, excavation, filling of earth materials and sub grade materials, laying of bituminous mixtures, handling of hazardous materials like bitumen, diesel, etc, dumping of unusable debris materials,

transportation of materials from production site to construction site, and other constructional activities and associated works like mobilization of constructional equipments, setting up of different construction plants, setting up of workforce camps, quarrying, transportation of materials, material storage etc. These activities have certain impacts of various magnitudes on different components of environment. The anticipated impacts due to all these activities have been described below:

Impact on land resources

Clearing and grubbing and excavation of the land within the extent of formation width of the proposed alignment as well as the proposed bypasses are the primary activity to prepare the bed for road construction. The excavation activity will lead into generation of excavated materials which would mainly soil mixed with pebbles and rocks in the project area. Most of these materials will be re-used as fill materials, aggregates and for construction of retaining walls. However still about 10 percent of the excavated material will need to be disposed off due to non-suitability for use in road fill materials. The disposal of debris materials in haphazard manner will not only hamper the aesthetic look of the area but at the same time they are potential contaminant for the surrounding land.

Some land would be needed to establish site offices and construction camps worker/labour camps. These will require temporary land acquisition for a short period. Substantial amount of land would also be required for extraction of borrow materials. For fulfilling the requirement of soil and aggregates certain land acquisition will be required followed by excavation of that land area. Such type of activity can lead into disfiguration of topography of the area. Water stagnation in the borrow pit provides ideal breeding sites for mosquitoes and thereby can spread malaria and dengue if borrow pit is not properly managed. Pits near settlements can pose health risk.

Mitigation measures for land resources

- The Construction camps will be located preferably on barren land and sufficiently away from settlements and water bodies.

- The Construction camp will be provided with necessary sanitation arrangements and basic facilities.
- After dismantling of Camp the natural condition of the land will be restored.
- No scare will be left unattended after excavation activity.
- The Borrow area will be located preferably on barren land or unirrigated land.
- The Borrow pits will not be dug within 800 m of town or village settlement or within ROW
- After excavation is over, the borrow area will be suitable rehabilitated either by backfilling it or by dressing the sides of the borrow pit to create slope consistent to the adjoining land.
- Where pit can be developed as water recharging pond depending upon the terrain of the area
- Proper reclamation of pits will be done
- Cut face of the pit will be merged with the slope of the adjoining terrain
- Bottom of the pits will be graded towards natural outfalls to prevent water accumulation
- The reclaimed area will be seeded to provide grass coverage.
- Quarrying of metal will be done only at licensed quarry and the area will be suitable rehabilitated after quarrying is over.

Impact on soil

The site clearance process includes excavation and vegetation clearance which ultimately induces vegetation loss as well as loss of top soil. Since vegetation clearance shall be confined to the minimum area required for widening activities beyond the ROW, the area affected would be very less. The activities associated with the site preparation and excavation plus movement of vehicles and equipments can disturb the surrounding lands.

Soil Contamination during construction stage is anticipated primarily due to construction and allied activities. The sites where construction vehicles are parked and serviced are likely to be contaminated because of leakage or spillage of fuel and lubricants. Pollution of soil can also occur in hot-mix plants from leakage or spillage of asphalt or bitumen. Refuse and solid waste from labour camps can also contaminate the soil. Contamination of soil during construction might be a major long-term residual negative impact. Unwarranted disposal of construction spoil and debris will add to soil contamination. This contamination is likely to be carried over to water bodies in case of dumping being done near water body locations.

However, by following mitigation measures such as maintenance of vehicles and machines and fuel refilling is carried out in a confined area can avoid contamination of soil to a great extent. The provision for oil interception chamber is suggested in EMP for treating the waste water generated from vehicle washing, refilling and maintenance areas. Fuel storage and refilling sites should be kept away from cross drainage structures and important water bodies. All spoils shall be disposed off as desired and the site shall be fully cleaned before handing over. These measures are expected to minimize the impact on soil contamination.

Mitigation measures to conserve soil

- The excavation activities and vegetation clearance will strictly be limited to formation width only.
- All the usable excavated materials will be re-used as fill materials and aggregates.
- Fill materials for the embankments are to be arranged from places located outside RoW.
- The movement of construction vehicles and equipments will be restricted to only designated route.
- Designated storage site for fill materials and adequate stockpiling to prevent erosion and runoff related problem.
- Construction of temporary berms, sediment basins, slope drains and use of temporary mulches fabrics or other control measures necessary to control soil erosion and sedimentation will be done at site

Impact on water resources

The proposed widening will result in increase of surface run-off. It will have adverse impact on ground water recharging if measures are not taken during the design and construction of longitudinal drainages. As the depth of the ground water table is very high no adverse impact is anticipated on ground water. Lying of pavement within the formation width may lead to reduction in the ground water recharge capacity. But as the area involved in the road construction is very less, the chances of this influence will be non-significant.

The water and soil quality monitoring results revealed no contamination with vehicular emission. Due to increasing traffic i.e. increasing emission, the adjoining soil and receiving water bodies may get contaminated with vehicular emission and spillages.

The Source of water for construction shall be identified by the Concessionaire depending upon the location of construction sites, construction camp and plant site locations in consultation with line department and NHAI and will obtain all necessary statutory permits for usage of water before start of abstraction of water.

Mitigation measures for water resources

- Longitudinal drains of sufficient capacity will be provided on both sides of the road to accommodate increased run-off.
- In urban stretches, the lined drains will be provided with cut in between to facilitate ground water recharging. The cut will be made of granular coarse material, which will increase the infiltration rate.
- In rural stretches the unlined drains will be connected with ponds. New small ponds will be dug if necessary. It will help in rainwater harvesting.
- Rainwater Harvesting pits will be provided in consultation with Ground Water Boards at an average interval of 500 m covering the entire project stretch including in new proposed bypasses depending upon the water table status (The recharge pit can only be provided at those locations where the water table is greater than 5 m deep) .
- The Contractor will arrange separate water supply arrangement for construction work and will not interfere with the normal public water supply.
- All water and liquid wastes arising from construction activities will be properly disposed off and will not be discharged into any water body without adequate treatment.
- Littering or unauthorized discharge will not be permitted.
- Permission of the engineer and the concern regulatory authorities will be obtained for disposal of the waste as the designated disposal point.
- The stream course and drain will be kept free from dumping of solid wastes and earth materials.
- The construction materials and debris will be stored away from water bodies or water ways and only on the designated sites along the construction zones.

Impact on Ambient Air Quality

The air quality parameter is the most common environmental feature, which is being affected by any road improvement projects at different stages i.e. during constructional as well as operational

phase. The major indicators of Ambient Air Quality relevant to the road project are the concentration of suspended particulate matters (SPM), Particulate matters of size less than 10 μ (PM10), particulate matters of size less than 2.5 μ (PM2.5), sulphur dioxide (SO₂), nitrogen oxides (NO_x), carbon monoxide (CO) in the atmosphere. The majority of the air pollutants are emitted from the traffic as there is no major activity along the project road except for few small scale industries. The result of the measurement of these parameters in the atmosphere along the project road showed that the concentration of these air pollutants are well below the safe limit as prescribed for the National Ambient Air Quality laid by Ministry of Environment and Forests, Government of India at all the places.

Significant amount of dust would be generated due to site clearance and excavation activities, exhaust of mobile and stationary construction equipment, crushing plant, batching plant, HMP, demolition, embankment and grading activities, transportation of earth materials and dumping of spoils, which have potential deterioration of air quality during the process. This can increase the localized concentration of fugitive during construction phase. During asphalt preparation, operation of hot mixing plants needs burning of fuels that result into release of significant amount of gaseous pollutants into the atmosphere like oxides of sulfur, hydrocarbons and particulate matters. These are likely to deteriorate the air quality in general and also cause occupational exposure in particular. These impacts are, however, temporary one that will remain only upto the period of clearance and excavation processes. Besides this, air quality deterioration is also expected at deposits and borrows sites, materials treatment areas, quarries, access roads and the site where facilities provided for project workers due to dust generation and gaseous pollutant emission. Additional vehicular emission is expected during the mobilization of construction equipments, transportation of materials, etc. due to the increased vehicular number at the project sites but that will be minor in extent as there will not be significant increase in vehicle numbers.

The improper sanitation at work camps and waste disposal usually lead to odour problem. Foul odour may also cause during lying of pavement. The abovementioned problems related to the deterioration of air quality, however, will be temporal in nature till the construction period only. Further, the activities will not be confined to any one place rather, it will progressively move along the ROW, so prolonged deterioration in air quality will not occur at any one site. The minor volume of dust generated will cause a short-term localized problem through settlements.

Mitigation measures for Ambient air quality

Dust control measures

- Water will be sprayed during construction phase, in earth handling sites, asphalt mixing sites and other excavation areas for suppressing fugitive dust.
- Water sprinkling and transporting construction materials with tarpaulin coverage during the construction stage.
- During the sub-grade construction, sprinkling of water will be carried out on regular basis during the entire construction period especially in the winter and summer seasons.
- In case fly ash is used, dust emission during its loading and unloading, storage at open place and handling for road construction shall be suppressed by regular water sprinkling.
- Dust emission from stock piles of excavated material will be controlled either by covering the stockpiled materials or water spraying over it.
- Special attention will be given when working near educational institutions and health centers and settlement areas.
- As soon as construction is over all the surplus earth will be utilized properly all loose earth will be removed from the site.

Measures for plants & Equipments

- The Stone crusher plant, Hot mix plant and Wet Mix Plant will be located sufficiently away from settlement towards downwind direction and will conform to the siting and operation requirements under Environmental (Protection) Rules, 1986.
- Proper management of all Plant sites having stone crusher unit, Hotmixplants, Batchmix plant, stockyards.
- All the vehicles used during the construction stage to have valid PUC certificate
- Provision of effective air pollution control systems in stone crushers, Hotmix Plant, Batchmix plants such as Dust containment cum suppression system for the equipment, Construction of wind breaking walls along periphery of plant sites, construction of the metalled roads within the premises, regular cleaning and wetting of the ground within the premises, etc.

Measures for Gaseous pollution

All the Construction vehicles and machineries will be regularly maintained to conform to the emission standards stipulated under Environment (Protection) Rules, 1986.

- Asphalt mixing /Stone Crusher plans should be located at least 800 m away from any habitation or sensitive environmental site and at least 250 m away from highway towards downwind direction.
- All the DG sets will conform to the emission standards as stipulated under Environment (Protection) Rules, 1986.
- The workers working at asphalt mixing and subsequent application of asphalt mix on road surface will be provided with heat resistant shoes and masks.

Impact on Ambient Noise level

Operation of heavy machineries; movement of heavy vehicles, stone crushing aggregate mixing activities generates high noise increasing the ambient noise level in the surrounding. The behavior of truck drivers also plays roles in increasing the noise level by the injudicious frequent use of blow horns. Especially in the settlement area this can pose a problem.

Workers working near the noise generating equipments and plants are likely to be exposed to high noise level. The acceptable limit (for 8 hour duration) of the equivalent noise level exposure during one shift is 90 dB (A). Hence, noise generated due to various activities in the construction camps may affect health of the workers if they are continuously exposed to high noise level. For reasons of occupational safety, exposure to impulses or impact noise should not exceed 140 dB (A) (peak acoustic pressure). Exposure to 10,000 impulses of 120 dB (A) are permissible in one day. The noise likely to be generated during excavation, loading and transportation of material will be in the range of 90 to 105 dB (A) and this will occur only when all the equipment operate together and simultaneously. This is however, is a remote possibility. The workers in general are likely to be exposed to an equivalent noise level of 80 to 90 dB (A) in an 8-hour shift, for which all statutory precautions should be taken into consideration. However, careful planning of machinery selection, operations and scheduling of operations can reduce these levels. A typical Noise generation due to different activities has been given in the **Table 2.15**

Table 2.15 Typical Noise Levels of Principal Construction Equipment

CLEARING	
Bulldozer	80
Front end loader	72 - 84
Dump truck	83 - 94
Jack hammer	81 - 98
Crane with ball	75 - 87

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EXCAVATION AND EARTH MOVING	
Bulldozer	80
Backhoe	72 - 93
Front end loader	72 - 84
Dump truck	83 - 94
Jack hammer	81 - 98
Scraper	80 - 93
STRUCTURE CONSTRUCTION	
Crane	75 - 77
Welding generator	71 - 82
Concrete mixer	74 - 88
Concrete pump	81 - 84
Concrete vibrator	76
Air compressor	74 - 87
Pneumatic tools	81 - 98
Bulldozer	80
Cement and dump trucks	83 - 94
Front end loader	72 - 84
Dump truck	83 - 94
Paver	86 - 88
GRAND AND COMPACTING	
Grader	80
Roller	73
PAVING	
Paver	86
Truck	83
Tamper	74
LANDSCAPING AND CLEAN UP	
Bulldozer	80
Backhoe	72 - 93
Truck	83 - 94
Front end Loader	72 - 84
Dump Truck	83 - 94
Paver	86 - 88

Source: CPCB, Govt. of India

It is clear from the above table that the operation of construction machinery e.g. hot-mixer, bulldozer, loader, backhoes, concrete mixer, etc will lead to rise in noise level to the range between 80-95 dB (A). Vehicles carrying construction materials will also act as the noise sources. The magnitude of impact from noise will depend upon types of equipment to be used, construction methods and also on work scheduling. However, the noise pollution generated due to different construction activities is a temporary affair. Each type of activity can generate different

type and levels of noise that continue for a short period during the operations of those activities. Implementing proper mitigation measures can reduce a lot of problem associated with noise pollution due to construction activities.

Mitigation measure for Noise Quality

- All noise generating equipments will be installed sufficiently away from settlement areas.
- The main stationary noise producing sources such as generator sets shall be provided with noise shields around them. The noise shields can either be a brick masonry structure or any other physical barrier which is effective in adequate attenuation of noise levels. A three meter high enclosure made up of brick and mud with internal plastering of a non-reflecting surface will be very effective in these regards.
- The plants and equipment used for construction will strictly conform to CPCB noise standards.
- Vehicles and equipments used will be fitted with silencer and maintained accordingly.
- Noise to be monitored as per monitoring plan and if the noise level at any time found to be higher than immediate measure to reduce noise in that area will be ensured.
- Noise standards of industrial enterprises will be strictly enforced to protect construction workers from severe noise impacts. All the workers working very close to the noise generating machinery shall be provided Earplugs to avoid any ill impacts on their health.
- An awareness programme will be organized for drivers and equipment operators to make them aware of the consequences of noise and to act properly at site

Impact on Ecological Resources

The baseline study of the biological environmental within the project area did not show any endangered or significant flora or fauna and within the corridor of impact and there is no wildlife migration route reported, therefore, any potential direct impact on biological environmental characteristics such as, loss of rare or endangered species, habitat fragmentation and wild life migrations is not envisaged. The area is not characterized by any significant ecosystem so loss of habitat is not there. Moreover, the alignment of proposed road widening is mostly along the existing road, the potential for habitat fragmentation negligible. Similarly, since the road improvement is proposed for the already existing one the extent of impact is minimum. The temporary impact may be in the visual appearance of the trees and shrubs as construction activity may lead to deposition of dust cover over the leaves and foliage. This is limited to construction period and gets washed away with the first monsoon shower.

During Construction it shall be ensured that the Contractor shall be abide by all the rules and regulations pertaining to Forest Protection as well as Wild life Protection. Strict monitoring will be done to ensure that there is no trespassing within the boundary of Wildlife Sanctuary. No labour camp or plant site will be established in the vicinity of the Wildlife Sanctuary and siting criteria for establishing the construction plants as per CPCB and MPCB norms will be strictly followed.

Aesthetics impacts

Disturbance of landscape aesthetics due to excavation of borrow pits, extensive quarrying, disposal site of spoils, is expected during the constructional phase. However, it is only temporary one and it can be restored with proper management plans within a short period such as roadside plantation, etc. During operational phase this will be enhanced with the activities associated with the maintenance of landscape such as plantation programme, by providing road side amenities, parks etc.

Mitigation measures for Aesthetics

- The site will be cleaned immediately after the construction activity is over.
- The debris materials will be disposed off only at identified area for disposal and proper leveling will be done after disposing the materials and shall be covered with top soil and some plantation will be done at the disposal site.
- The borrow area will be rehabilitated as per site condition. It can either be developed as ponds, backfilled and leveled matching with the surrounding terrain.

Construction camps

Construction workers are a very neglected group in the country. Unless the workers are provided proper amenities to live at the construction site the environmental issues of road construction cannot be properly met. Apart from labour camps, separate construction Camps also established where various plants and equipments as well as offices and residential unit for technical and non technical staff are located and often labour camps are also provided in the same premises. Location of the Construction camp also has certain impacts on surrounding environment if not properly managed.

At labour and construction camps lot of wastes are generated. These wastes are refuge from the plants, and equipments, waste water and other domestic waste. These wastes are solid as

well as liquid waste mainly refuse water and kitchen waste. The disposal of such waste material to the surrounding land can potentially damage the land and would generate health risk to not only surrounding area but within the premises itself. Improper drainages system within the premises also creates insanitation condition thereby enhancing health risk.

Mitigation measures

- The Construction/labour camps will be established only on area approved by Supervision Consultant.
- The worker's/labour camp will be located away from water bodies, schools and residential areas. The camp will be constructed with proper accommodation facilities.
- The workers camp will be provided with drinking water supply system so that local water sources are not disturbed.
- The camp should be provided with fuel for cooking like kerosene and /or LPG to avoid any cutting of trees for fuel wood.
- All camps will be provided with proper sanitation facilities, separate toilets and bathrooms for female and male workers, septic tanks with soak pits of sufficient size, dust bins etc.
- Waste water from domestic uses and solid wastes will be disposed of without violating environmental norms. The measures will be site specific.
- The labour camps will be provided with crèche, first aid facilities, etc as required under Factory Act.
- After completion of construction, the contractor will dismantle the camp and restore it to the original condition of the area before handing over the site to the land owner.

Impact due to Operational phase (Mitigation measures)

During operation stage, the main sources of environmental impacts are the increased traffic volume and speeds and better access to forest lands. The increase in traffic volume and speed may enhance the safety risk especially in the rural area. The better access to the forest area can stimulate the human interference in these areas. No sudden change in the traffic volume is expected due to this road as the road is already existing one and opened for public traffic. The project also provides the opportunities of the restoration of vegetation around the vicinity of the worksite and roads by implementing the compensatory plantation programme, which will not only enhance the aesthetic view but can also help in reclamation of soil. During

operational phase this will be enhanced with the activities associated with the maintenance of landscape such as plantation programme, by providing roadside amenities, parks etc.

During the operational phase when the plantation works will be adequately implemented will enhance the aesthetic as well as hygienic environment thereby reducing the chances of diseases due to vehicular emission. Widening will ensure smooth plying of the vehicles and also will help in reducing the congested zone and thus will reduce the emission rate of vehicles. Various impacts during operation phase are discussed below:

Impacts on water quality

During the operation phase, the possibility of degradation of water quality is very less.

The impact on the surface water quality during operation can be expected due to accidental spillage. However the probability of such accidents is minimal since enhancement of road safety measures such as improvement of curves and widening of the roads and other pedestrian facilities are taken care of in the design stage.

Impact on Ambient Air Quality

The baseline data shows that the major air pollutants are well within permissible limit at all monitoring locations except for fine dusts in terms of PM10 and PM2.5. The dry condition and exposed area, earthen shoulders along the highway sections is the main reason behind the high concentration of PM10 and PM2.5 in the ambient air. Improvement in road surface condition such as roughness, pot, patch, congestion, etc., improvement of curves and junctions, provisions of organized parking, segregation of local traffic and through traffic will ensure the smooth traffic flow and reduce idling time of engines thus will reduce the emission rate of vehicles and also the vehicle maintenance cost thereby reducing the magnitude of air quality degradation. Further, roadside avenue plantation with pollution abating tree species will also help in reducing the ambient pollution levels. Moreover, widened road will provide more space for dispersion and thereby the concentration of pollutants will be diluted faster.

Thus the net air quality impact following construction of new road is anticipated to be beneficial. The project will not stimulate the traffic flow significantly as this road is already in use. The traffic will however rise with the current growth rate and the number of vehicles plying over will certainly be increased whether the project will come or not. Although the emission rate per

vehicle will reduce as stated earlier, but the total emission can increase in future with the increase in traffic.

Mitigation Measures

During the initial years after the implementation of the project, the air quality of the study area will improve due to increased traffic speed all along the project road. For congested areas a single row of plantation will be provided on both sides of the road to act as a sink for pollutants. Special care will be taken to avoid the location of truck parking and bus bays in congested areas. Further technical improvement in form of superior engine design in order to meet the stringent Government regulations will also reduce emissions in the years to come.

Impact on Noise Quality

Noise level is a matter of concern. Interrupted movement of heavy and light vehicles at high speeds and movement in upward direction increase ambient noise levels along the roadway.

Noise produced by vehicles using the road can be attributed to the engine, vibration, friction between tires and the road, and horns. Increased levels of noise depend upon volume of traffic, road condition, vehicle condition, vehicle speed, congestion of traffic and the distance of the receptor (home, store etc.) from the source. The friction caused due to contact between tires and pavement increases the traffic noise. The proposed work includes smoothening of pavement, reduction of gradient and curves at several places that will reduce the overall noise level.

2.15 Clearances Required

Clearances required for the project are provided in **Table 2.16**

Table 2.16 Clearances required for the project

Sl. No.	Law/ Regulation/ Guidelines	Relevance	Applicable Yes / No	Reason for Application	Implementing / Responsible Agency
1	The EIA Notification, 14th September 2006 and subsequent amendments	Identifies "(i) New National Highways; and (ii) Expansion of National Highways greater than 30 Km involving additional right of way greater than 20m involving land acquisition" under (item 7 (f) of schedule) as one	Not required	New National Highway NH - 717A (Category of project - A)	MoEF&CC

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Sl. No.	Law/ Regulation/ Guidelines	Relevance	Applicable Yes / No	Reason for Application	Implementing / Responsible Agency
		of the projects requiring prior clearance.			
2	Notification for use of Fly ash, 3rd November 2009	Reuse fly ash discharged from Thermal Power Station to minimise land use for dispersal and minimise borrow area material. The onus shall lie with the implementing authority to use fly ash unless it is not feasible as per IRC.	NO	If Projects within power 500 km of plant will cover under this notification (SO 1396 (E). 25 March 2015	MoEF&CC, SPCB
3	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 construction/operation of certain facilities.	NO	Consent required if ground water is being used for consent purpose	CPCB /SPCB
4	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
5	Forest (Conservation) Act, 1980	Conservation and definition of forest areas. Diversion of forest land follows the process as laid by the act	Yes	For diversion of forest land for road construction	State forest department, MoEF&CC
6	Coastal Regulatory Zone Notification, 2011	Protect and manage coastal areas	No	The project area is not within designated coastal zone	MoEF&CC, State forest department,
7	Wild Life Protection Act, 1972	Protection of wild life in sanctuaries and National Park	NO		

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Sl. No.	Law/ Regulation/ Guidelines	Relevance	Applicable Yes / No	Reason for Application	Implementing / Responsible Agency
8	Ancient Monuments and Archaeological sites and Remains Act 1958	To protect and conserve cultural and historical remains found.	No	For world heritage sites and monuments	Archaeological Survey of India, Dept. of Archaeology
9	The Motor Vehicle Act. 1988	Empowers State Transport Authority to enforce standards for vehicular pollution. From August 1997 the "Pollution Under Control Certificate is issued to reduce vehicular emissions.	Yes	All vehicles used for construction will need to comply with the provisions of this act.	State Motor Vehicles Department
10	The Explosives Act (& Rules) 1884 (1983)	Sets out the regulations as to regards the use of explosives and precautionary measures while blasting & quarrying.	Yes	If new quarrying operation is started by the concessionaire / contractor	Chief Controller of Explosives
11	Public Liability And Insurance Act, 1991	Protection to the general public from accidents due to hazardous materials	Yes	Hazardous materials shall be used for road construction	Project Implementation Unit/ Contractor
12	Hazardous Wastes (Management and Handling) Rules, 1989	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 on vehicles	CPCB/SPCB
13	Chemical Accidents (Emergency Planning,	Protection against chemical accident while handling any hazardous chemicals resulting	Yes	Handling of hazardous (flammable, toxic and	District & Local Crisis Group headed by the DM and SDM

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Sl. No.	Law/ Regulation/ Guidelines	Relevance	Applicable Yes / No	Reason for Application	Implementing / Responsible Agency
	Preparedness and Response) Rules, 1996			explosive) chemicals during road construction	
14	Mines and Minerals (Regulation and Development) Act, 1957 as amended in 1972	Permission of Mining of aggregates and sand	Yes	Permission of Sand Mining from river bed & aggregates	Department of Mining for state and central level
15	The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996	Employing Labour / Workers	Yes	Employing Labour/ workers	District labour Commissioner

2.16 Environmental Management Plan

An environmental management plan (EMP) will be proposed along with institutional arrangement for effective implementation, monitoring and reporting in the next stage of submission. It is envisaged that all stake holders i.e. the NHIDCL, forest department, supervision consultant, design consultant, contractor, environmental consultant and public/NGOs will play their role in effective implementation of EMP. The efforts of all the agencies will be brought together by the 'Environmental management Unit' proposed to be setup under the project implementation unit of NHIDCL. This unit will also arrange training of the staff involved in monitoring of the implementation of Environmental Management Plan beside taking steps to create awareness amongst the public and stakeholders.

2.17 Conclusions and Recommendation

On the basis of preliminary analysis, nature of impacts and observations of the various affected groups due to project, it is concluded that the proposed National Highway can be developed without causing significant adverse environmental impacts to the natural, social, economic agricultural environment of the study area, assuming the mitigation measures identified in EIA report will be incorporated in to design and implementation stage. The important points are:

Appropriate mitigation measures as suggested in environmental assessment report shall be incorporated. Construction of National Highway in the state of west bengal is not expected to result in any significant adverse environmental impacts.

Forest clearance will be applicable for diverting reserved and protected forest for road construction. All the necessary clearances will be required from concern departments at different stage of the project implementation.

CHAPTER - 3

ENGINEERING SURVEY, INVESTIGATION & ANALYSIS

3.0 Engineering Survey, Material Investigation & Pavement Design

3.1 General

A sound engineering approach has been developed based on the requirement enumerated in Terms of Reference for conducting the required field surveys. Following data were collected from site and detailed desk study has been carried out to formulate a systematic and meticulous approach towards the present assignment. Following primary field surveys and investigations have been carried out on the project road: Inventory.

- Road
- Bridge and Cross Drainage Structures
- ♦ Condition Surveys
 - Pavement condition and Roughness survey
 - Bridges and Cross Drainage Structures
- ♦ Topographic Survey
 - Longitudinal alignment
 - Cross sections at 50m interval
 - Cross section of Bridges & Cross Drainage Structures
- ♦ Pavement Investigations
 - Trial Pit Investigation
 - Sub-grade Investigation
 - Benkelman Beam Deflection Test
 - Axle load Survey
- ♦ Material Survey
 - Soil Borrow Area
 - Aggregate Sources
 - Sand Sources
 - Other construction Material like Cement, Bitumen etc.

3.2 Inventory and Condition Survey of Road and Pavement

The scope of improvement measures and economic justification thereon depend on the condition of the existing road and its associated inventory. To collect the inventory of the existing road and allied features of road and structure, inventory surveys were carried out.

3.2.1 Road Inventory Survey

While conducting Inventory Survey of Road the existing physical features and surrounding condition of the project road was ascertained. Road Inventory of this report. Some of the salient features of the existing road has been described under following paragraphs.

The information collected, analysed and cross-checked, constitute the core database for formulating improvement proposals for further validation and finalisation in light of results of detailed topographical survey and investigations. The information has been utilised to decide the following:

- Decision on the widening of the carriageway is concentric for throughout the project road.
- Formulate the best-fit cross section with due consideration to terrain conditions, available land width and roadside features.
- Treatment to be given to congested built-up stretches.
- Number of trees to be affected by road improvement/construction works, the anticipated environmental impacts and extent of rehabilitation and resettlement.
- Provision of wayside amenities.
- Existing utility lines by type, location and extent that would require relocation.

3.2.2 Existing Carriageway

Project stretch is generally Single Lane to Intermediate Lane having 3.5 to 5.50 m width in project road. The existing road has earthen shoulder of about 0.5 m to 1 m on either sides of the project road. ROW available for most of the length of the project road is 4m - 6m as per the data provided by PWD.



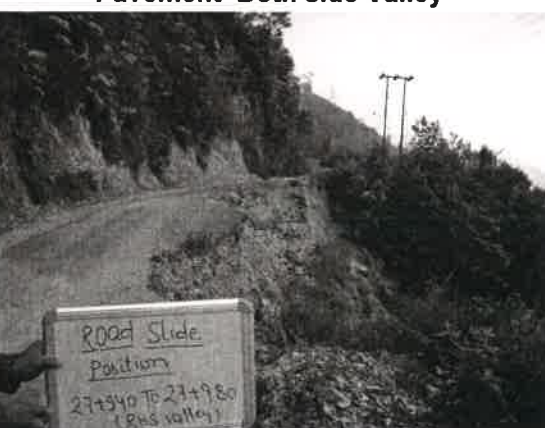
Pavement From km 5+500 to 6+000



Pavement Both side Valley



Pavement From km 16+000 to 16+500



Pavement At km 27+940(Land Slide)

3.2.3 Alignment and Geometry

An average travel speed is 45-60 km/hr can be achieved in the project stretch but in pedong there geometry and gradient is so poor. There are number of hair pin bend, which reduces the speed of the vehicle. Poor geometry can be observed in the locations like pedong.

3.2.4 Terrain and Land Use

The existing road passes through predominantly agricultural, govt land, forest and built-up areas (urban settlements). Project road passes through hilly and mountainous terrain in entire length.



At Navgaon

At Sonisidara

3.2.5 Existing Major and Minor Junctions

The project road traverses through various habitations and towns. Many other important cross roads join the project road at different locations. There is zero major intersection and 39 minor intersections sighted on the road. List of major intersection is given in **Table 3.1 & 3.2** below. In general no safety arrangements viz. road signs, markings, etc are provided at these intersections. no junction development has been observed in these junction.

Table 3.1: Existing Major Intersections

Sr. No.	Existing Chainage	Type	Link	Direction	Remarks
NIL					

Table 3.2: Existing Minor Intersections

SL. No.	Existing Chainage	Type of intersection	Direction	Type of Road	Going to
			Left/Right	E/BT/CC	
1	0+130	+	Both	Gravel Road & BT Road	L.H.S- Tea Garden, R.H.S- Railway Station
2	0+563	T	R.H.S	BT Road	R.H.S-Military Campus
3	0+650	+	Both	BT Road & BT Road	L.H.S- Tea Garden, R.H.S- Railway Station
4	0+871	T	L.H.S	BT Road	R.H.S-Bagrakot Tea Campus
5	1+014	+	Both	BT Road & BT Road	L.H.S- Danken Tea Factory, R.H.S-Chandbari vasti

PROJECT: Feasibility Report cum Preliminary Design for Alternative Highway to Gangtok in Sikkim via Bagrakot-Chuikhim-Nimbong-Kafer-Bakhim-Algarah-Rhenok in the State of West Bengal and from Rhenok-Rorathang-Pakyong along with Spur from Aritar-Relop-Menla in the State of Sikkim.

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SL. No.	Existing Chainag	Type of intersection	Direction	Type of Road	Going to
6	1+290	Y	R.H.S	BT Road	R.H.S-Bagrakot village
7	1+434	T	L.H.S	BT Road	R.H.S-Bagrakot Local
8	1+558	T	L.H.S	BT Road	L.H.S-Bagrakot Local
9	2+125	Y	R.H.S	BT Road	Army Camp
10	2+806	+	Both	BT Road	L.H.S- Bagrakot, R.H.S-Army Camp
11	2+977	T	R.H.S	BT Road	HQ27 mtn (MOUNTAIN ARMY BDE GATE)
12	2+310	T	R.H.S	BT Road	Army office 3m
13	3+063	T	R.H.S	BT Road	Local Bagrakote
14	3+069	T	L.H.S	BT Road	Local Bagrakote
15	12+500	Y	R.H.S	Earthen road	Ylbhoung village
16	15+515	Y	L.H.S	Stone Solling	Chukhim village
17	15+922	T	L.H.S	Gravel Road	Chukhim village
18	16+315	Y	L.H.S	Gravel Road	Chukhim village
19	19+185	Y	R.H.S	Gravel Road	Navgaon
20	19+825	Y	L.H.S	Gravel Road	Navtol Village
21	20+548	Y	L.H.S	Gravel Road	Navgaon
22	21+050	Y	R.H.S	Gravel Road	Sanisiyadara Ground
23	21+734	Y	R.H.S	Gravel Road	Sanisiyadara Ground
24	21+770	Y	L.H.S	Gravel Road	Mungpal
25	23+475	T	R.H.S	Gravel Road	Barbot village
26	23+530	Y	R.H.S	Gravel Road	Barbot village
27	23+585	Y	L.H.S	CC Road	
28	24+970	y	R.H.S	GR	Ghantidara
29	25+286	y	R.H.S	GR	Jasok village
30	26+140	y	L.H.S	GR	Nimbong
31	27+083	T	L.H.S	GR	Nimbong
32	29+603	y	R.H.S	GR	Nimbong phatak
33	30+145	y	L.H.S	BT	Pemling
34	30+409	y	L.H.S	BT	Charkhola/Kalimpong
35	35+984	y	L.H.S	GR	Sunrise point
36	38+354	y	R.H.S	GR	Heritage forest,Loleygaon(View point)

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SL. No.	Existing Chainag	Type of intersection	Direction	Type of Road	Going to
37	38+805	T	L.H.S	GR	Loleygaon forest resort
38	39+530	T	L.H.S	GR	Forest
39	39+733	y	R.H.S	GR	Loleygaon

3.2.5.1 Embankment and Surface Drainage

The project road runs generally at ground profile and at generally high embankment is available in the some stretch. In Built-up stretches the project road is generally at the same level of the ground .There are few built-up drains in the project stretches like in Pedong etc , Project road requires an efficient drainage network. Also it is observed during rainy season water is logged in the built-up location due to poor condition of the drainage work. Proper built-up drainage work should be provided in these locations ,if bypasses are not proposed.

3.2.5.2 Existing Railway Crossings/ROB

There is no existing Railway Level crossing in the project road.

3.2.6 Pavement Condition Survey

3.2.6.1 Condition Survey of Pavement

It is the most important data needed for deciding upon the maintenance. The basic measurement of pavement condition is existing distresses. The information required is on the type, severity and amount of distress. The most commonly occurring distress forms are:

1	Bleeding	6	Patch deterioration
2	Block cracking	7	Polishing of aggregate
3	Corrugation	8	Ravelling
4	Depressions	9	Rutting
5	Pot hole		

Pavement condition survey consists of observing and recording the various distresses like cracks, pothole, rutting, ravelling etc of the existing carriageway, pavement shoulders and embankment. The details collected from pavement condition survey form the basis to decide strategy for adequate strengthening / rehabilitation measure of Existing pavement.

3.2.6.2 Pavement Condition Survey by Visual Inspection

a) General observation

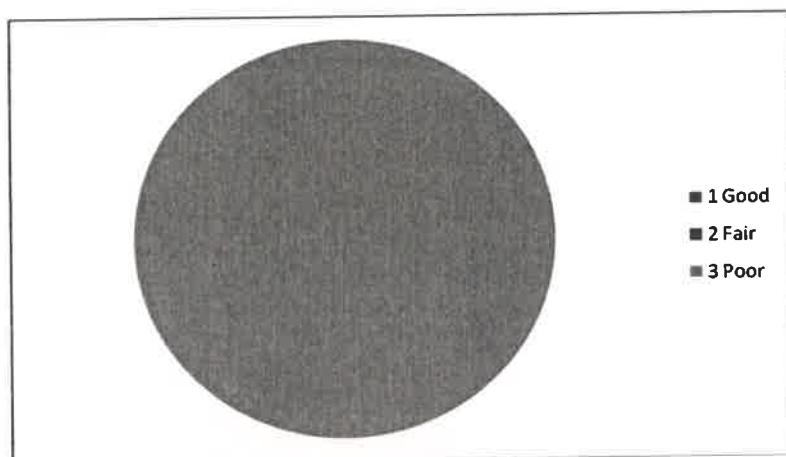
Pavement condition of the Project stretch can be summarized as given below

Table 3.3: Percentage wise distribution of Good Fair and Poor Road

Sr.	Condition	Nos of Km	% Condition
1.	Good	0	0

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2.	Fair	0	0
3.	Poor	39+800	100%



According to Maintenance Manual of Primary, Secondary and Urban Roads, Published by MoRTH, pavement condition data can be analyzed in terms of Good, Fair and Poor with the following criteria.

3.3 Topographic Survey

Topographical surveys have been carried out as per IRC: SP 19-2001, "Manual for Survey, Investigation and Preparation of Road Project" and as per TOR, for the preparation of alignment plans, strip plans, longitudinal sections, cross sections and other details like drainage works, earth retaining structures, control points and reference pillars required in view of consideration of vertical and horizontal alignments. Surveys were carried out as follows:

(a) Planimetric Control

The co-ordinates of basic plan control points were established by GPS in interval of 5km on RCC pillars as primary control station. Between two control points, bench marks were fixed in interval of 250m on RCC pillars, which serve the purpose of starting and closing bearings for Total Station Traverse.

(b) Height Control

Double tertiary levelling was done along the entire stretch with precision automatic level connecting bench marks and reference control points established near the project road. The misclosures were all seen to be below the tolerance limit of $0.12\text{mm } k$, where k is the length of the levelling line in km in between the starting and closing bench marks. The misclosures were adjusted and height available at, given to all bench marks were connected to BMs established by contracting GTS Benchmark available in the vicinity of the project road.

(c) Detailed Survey

The detail of project influence area is up to minimum (building line) in case of urban area and 60m in case of realignments. The limit was extended further in case of anticipated junction improvement along the finalised centre line which were surveyed by running Total Station Traverse X, Y and Z coordinates of relevant points of survey to establish ground

profile captured by this Total Station Traverse besides other details like electric/telephone poles, tree, building, well, visible property line etc.

(d) Creation of DTM

Data collected through topographical survey clubbed with the findings of inventory surveys have been used to develop a Digital Terrain Model (DTM) in Mx_Roads Software. Supplemented with the silting of important cross drainage structures along with their desired deck levels, horizontal and vertical profile of each road has been finalised after the careful application of the relevant design standard.

Traverse and LS/CS surveys were fed into computer to carry out the followings:

- (i) Sort out the geometric (horizontal) deficiencies in the existing alignment.
- (ii) Design the best fit centre line of the existing alignment considering all obligatory/nodal points with relevant design standards.
- (iii) Examine the feasibility of proposed laning requirement within existing available ROW or proposal of bypass if any.
- (iv) As far as possible obviate existing buildings, functional infrastructure facilities within the proposed ROW to minimise utility relocation.
- (v) Examine each existing junction for its usefulness and determine the improvement measures.

3.4 Pavement Investigation

3.4.1 General

Pavement Investigation comprise of carrying out Sub grade characteristics and strength, investigation of required Sub-grade and sub soil characteristics, Pavement composition by excavating trial pits, evaluate Sub-grade strength, Pavement condition Surveys, Pavement Structural strength by conducting Deflection test by Benkelman Beam on existing road, DCP test and various laboratory tests.

3.4.2 Benkelman Beam Deflection Test

3.4.2.1 Pavement Structural Strength

There are several design methods used to determine the thickness of flexible overlay required. The most common procedures are:

- Based on deflection testing; and
- Effective thickness procedure

Above two methods are empirical in nature and are liable to produce different results. Therefore, it is important that a consistent methodology backed by experience and sound engineering judgment to be used. However, Deflection method is widely used in India.

3.4.2.2 Deflection Method

The structural strength evaluation by deflection method had been carried out by following scheme:

- Main line testing.

3.4.2.3 Mainline line Testing

In the mainline testing, BBD survey had been carried out at every 500m interval all along the project road in staggered manner. Ten reading in each 100m section has been taken in staggered manner. The collected data had been analysed separately as per procedure given in IRC: 81-1997 to find out the Characteristic Deflection.

Characteristic deflection is calculated using the initial, intermediate and final readings according to the IRC Guidelines by applying temperature correction of $0.01 \text{ mm}/0^{\circ}\text{C}$ and seasonal correction as per codal provision.

The characteristics deflection computed in main line survey has been further determined for the homogeneous section. Project Road is divided into three homogeneous section.. Homogeneous Deflection sections, project road are divided in seven number of homogenous section as presented in **Table 3.5**.

Figure 3.2: Homogeneous Section Worked out by Cumulative Difference Approach

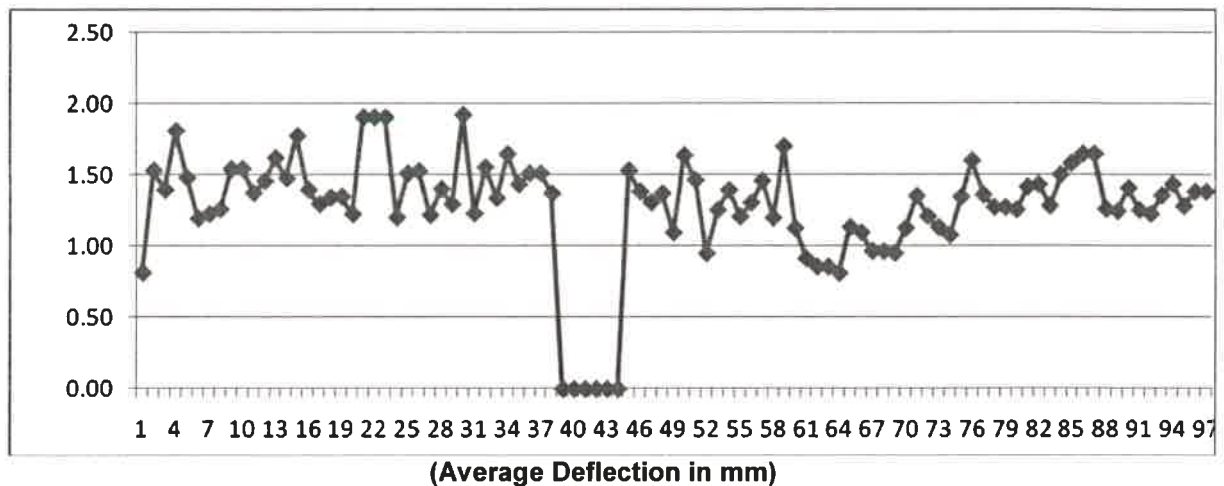


Table 3.5 : Homogeneous Section based Deflection

Section	Deflection	Avg. defection	Total length(km)
1	1.2-1.60	1.40	38.900

Characteristics Deflection obtained from analysis for each kilometre is further analysed as per homogeneous section given in **Table 3.5** using IRC: 81-1997 for overlay determination. A detail of overlay is given in Pavement Design chapter.

3.4.2.4 Sub grade Investigations

Investigations of existing sub grade were carried out to assess the adequacy of the existing pavement layers apropos to present sub grade strength so that the strengthening and reconstruction requirement can be established for the design traffic loadings. Objectives of investigations also included evaluation of the existing pavement composition; characteristics of existing sub grade for design of pavement by means of in-situ and

laboratory tests as well as need for further investigations along the widened part / proposed new alignment.

The requirements of TOR were met the rough the following steps:

- Collection of minimum three Sub-grade soil samples in each identified homogeneous section;
- Recording the existing pavement crust composition at every 500 m intervals;
- Conducting tests on in-situ properties and characteristics of sub grade soils;
- Conducting laboratory tests on collected samples;
- Analysis of field and laboratory test results;
- Providing specific recommendation for existing Pavement; and
- Evaluation of problematic sub soil, if any.

Methodology

Project road was divided into suitable number of homogenous sections during field investigation. Minimum three large test pits has been dug out in each homogenous section to evaluate sub grade characteristics and strength while small test pits were excavated at every 500m interval. Test pits were excavated manually up to sub grade level at the pavement shoulder interface.

3.4.3 Test Pits for Sub grade Investigation

3.4.3.1 Large Pits

Large pits of size about 1.5 m x 1.5 m were excavated manually at pavement shoulder interface, extending through the pavement layers down to the sub grade level. The sub grade soil was tested for in situ density test using sand replacement method as per IS: 2720, Part 28. Dynamic Cone Penetration test using Dynamic Cone Penetrometer was carried out from the top of Sub-grade to Bottom level of Sub grade to evaluate in situ sub grade strength. Sub grade soil sample (about 40 kg) was taken from each pit for detailed laboratory test.

Following test were carried out on the sub grade soil sample in the laboratory.

- | | |
|---|-----------------------------------|
| • Atterberg's limits | As per IS: 2720, Part- V - 1985 |
| • Grain size analysis | As per IS: 2720, Part- IV- 1985 |
| • MDD (heavy compaction) | As per IS: 2720, Part- VIII- 1983 |
| • Optimum Moisture Content | As per IS: 2720, Part- VIII- 1983 |
| • CBR (4 days soaked at 3 energy level) | As per IS: 2720, Part- XVI- 1987 |

3.4.3.2 Small Pits

Small pits (0.7 m x 0.7 m) were excavated at an interval of 500 m between two consecutive large pits and staggered similar to large pits. The existing pavement composition were measured and recorded, sub grade soil sample (about 10 kg) was taken

Following test were carried out on the sub grade soil sample in the laboratory.

- | | |
|-----------------------|---------------------------------|
| • Atterberg's limits | As per IS: 2720, Part- V- 1985 |
| • Grain size analysis | As per IS: 2720, Part- IV- 1985 |

3.4.4 Existing Pavement Composition

In order to meet TOR requirement detailed layer composition of the existing pavement was recorded at every 500 m interval by digging test pits of size about 0.70 m x 0.70 m. The test pits were excavated manually at pavement shoulder interface, dug up to the sub grade level. When sub grade layer reached thickness of various pavement layers were measured at exposed face and recorded.

During investigation of crust composition namely three types of layers were observed i.e. wearing coarse ,base course and Sub-base course . The wearing course consists of bituminous material termed as Bituminous Top (BT). The base course comprises of Water Bound Macadam (WBM). The total thickness of the pavement varies from 400 mm to 470 mm with an average of 448 mm.

3.4.4.1 Sub grade Characteristics and Strength

In Situ Tests

Large pits were excavated on the project road extending through the pavement layers down to the sub grade level. At this level, Various field tests are conducted to determine their in-situ properties of existing sub-grade soils namely field dry density, sub-grade moisture content (at sub-grade level), and in-situ CBR from TRL-DCP test. The samples from Pits were collected to determine the soil characteristics and engineering properties of sub-grade soil. The excavated trial pit was backfilled with the same material with thorough compaction and the surface was made good. All field test results are tabulated in along with laboratory results.

DCP - CBR

Field CBR Test using Dynamic Cone Penetrometer method was conducted to assess the in-situ CBR at sub-grade and below sub-grade level as per TRL - Road Note 8. The CBR value was determined for the various soil layers encountered by using Penetration v/s Number of Blows graph. Change in Slope, penetration v/s number of blows. From the graph, layer thickness from respective slopes (penetration mm / blow) could be worked out.

DCP-CBR value was calculated using the following formula (TRL - Road Note 31 using 60° cone)

$$\log_{10} (\text{CBR}) = 2.48 - 1.057 \times \log_{10} (\text{mm / blow})$$

The DCP - CBR value was converted to an overall or equivalent CBR value using the material depth data.

3.4.5 Laboratory Test on Test Samples

Various laboratory tests are conducted on collected Sub-grade soil samples from pits. The results and corresponding interpretation along with in-situ condition were influential to carry out the actual pavement design.

The laboratory test results comprise of determination of Atterberg's Limits, compaction characteristics, 4 days soaked CBR at three energy level, gradation analysis etc. The test results for sub-grade soils are discussed below:

3.4.5.1 Classification

The soil samples have been primarily classified on the basis of Bureau of Indian Standards (BIS), which is based on the Unified Soil Classification System. Soil samples are containing clayey as well Silt particle along with low to intermediate plasticity. As per

soil classification systems majority samples are classified as ML (Silt with intermediate plasticity), SM (Sand with Silt), and CL (Clay with Low Plasticity).

3.4.5.2 Atterberg Limits

From the test results it is noted that liquid limit varies from 28% to 36%, and PI varies from 14% to 24%, the results are within the limit of MoRT&H specification (V^{th} revision) (LL should be <70% and PI should be < 45%). This implies that sub-grade soil along the existing alignment is clayey with intermediate plastic in nature.

3.4.5.3 Compaction Characteristics

The collected soil samples from large test pits were compacted with different moisture content in the laboratory in order to obtain dry density v/s moisture content relationship. The method of heavy compaction in accordance with IS: 2720 (Part- 8) was used to determine Maximum dry density. The maximum dry density varies from 1.88 gm/cc to 2.12 gm/cc.

3.4.5.4 Laboratory California Bearing Ratio (CBR) Test

Laboratory CBR test was conducted on samples obtained from Test Pit as per IS: 2720 (Part- 16). CBR moulds prepared by compacting the soil in five layers giving 10, 30 and 65 blows of heavy rammer, and soaked CBR value with swelling factor, was worked out. Quantity of water taken during remoulding CBR specimen is added equal to optimum moisture content. The dry density of soil compacted at various blows was determined. The graph of dry density versus soaked CBR value was drawn and CBR at corresponding value of 97% of MDD was calculated.

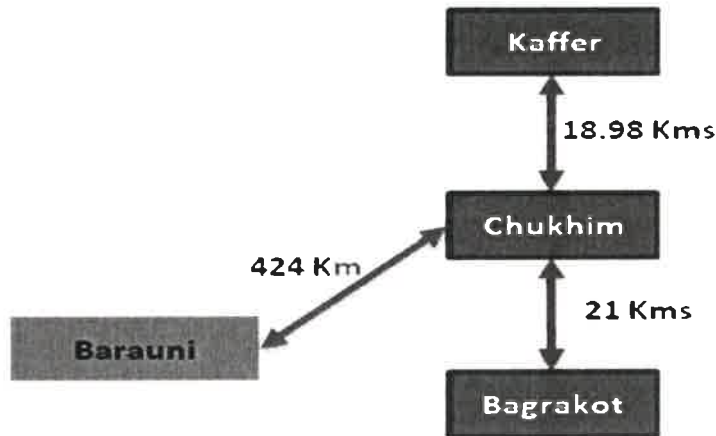
Table 3.7 : Summary of Test Results of Sub grade Soil

Type of Test	Maximum	Minimum	Average
Liquid Limit %	36.45	27.50	32.07
Plastic Limit %	23.81	14.74	20.10
Plasticity Index%	15.39	8.55	11.97
MDD gm/cc	2.120	1.854	1.946
OMC %	12.52	8.37	10.86
Soaked CBR %	13.10	10.10	11.6

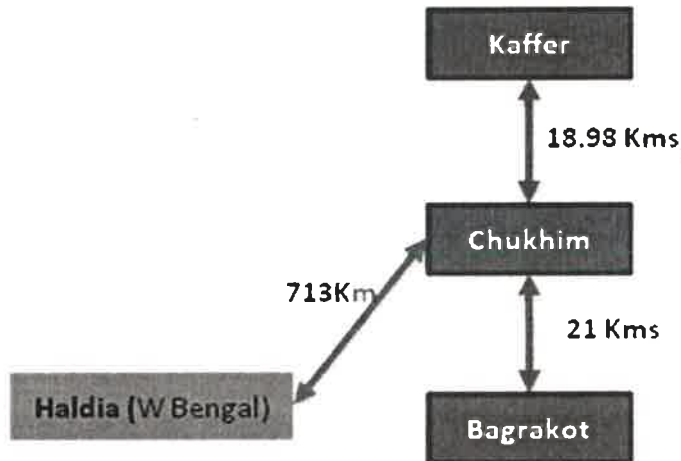
3.5 Source of Material

1- Bitumen : for this project Bitumen is taken from Barauni.

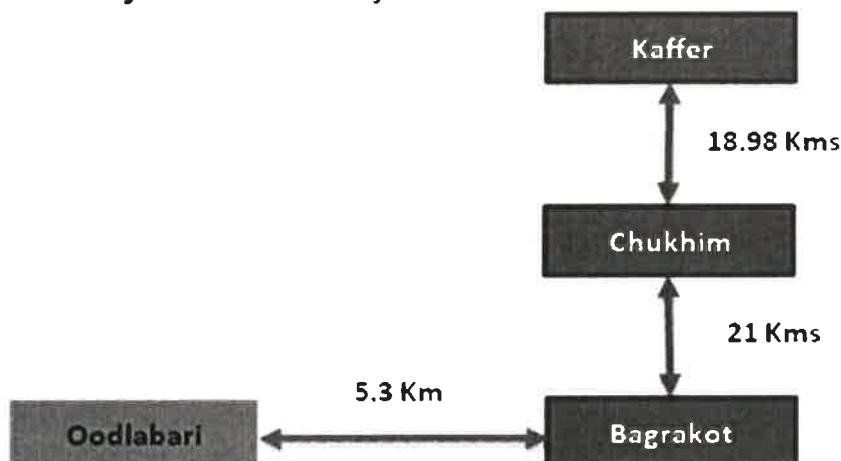
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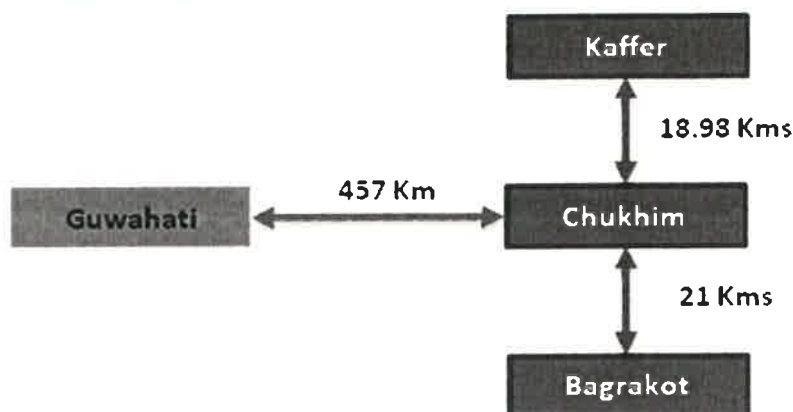
2-Emulsion: for this project emulsion is taken from Haldia.



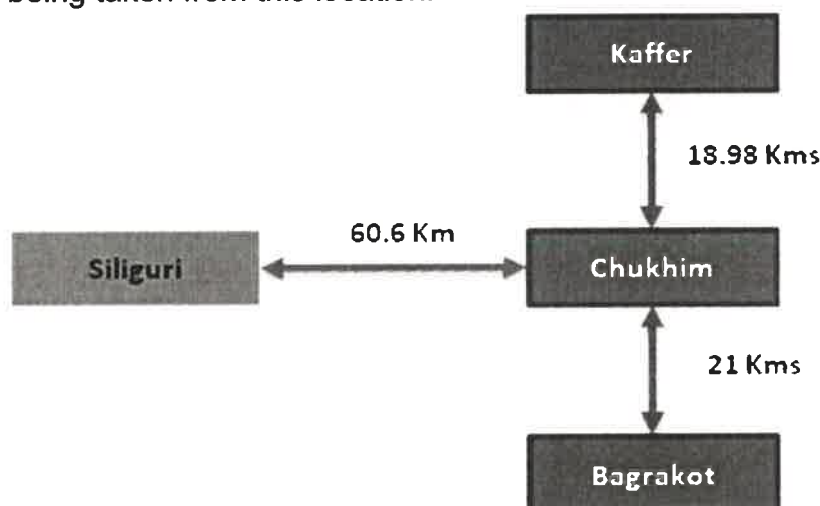
3-Quarry Material: Quarry material has been taken from Oodlabari.



4- Cement: Cement is been taken from Guwahati because of the nearest manufacturing plant of star cement.



5- Steel: Due to availability of SAIL authorised dealers in siliguri steel is being taken from this location.



3.5.1 Type of Materials

The various construction materials are listed below.

- Metal
- Sand
- Bitumen
- Steel
- Cement

3.6 Axle Load Survey

Axle Load Survey is required to know the existing loading characteristics of the vehicles. The road side direct interview method was adopted. A portable wheel load weighing pad, duly calibrated was used for measuring the axle loads. Axle Load measuring points were arranged on shoulder approaches with adequate sight distance to the on coming and going vehicles. These approaches were away from the main carriageway and wide enough to accommodate the lined up sampled vehicles for questioning and allow safe passage for un-sampled vehicles during the progress of the survey. The vehicles were stopped systematically at random based on their arrival with the help of police. These Vehicles were guided to mount on the axle load pad, axle-wise, in the order of front most

axle to the rear most axles. Axle load of commercial vehicles, i.e. LCVs, 2-Axle, 3-Axle, Multi Axle Trucks and Buses were recorded in approved formats. Representative samples were captured uniformly over the entire period of survey for each category of goods vehicles.

3.6.1 Analysis of Axle Load Survey

In order to estimate vehicle loading spectrum on project road, and to determine vehicle damage factor for the commercial vehicles, the axle load surveys have been carried out at three identified locations.

The consultant carried out sample survey for "Axle Loading Pattern" using Haenni wheel load WL 103. These are new axle pads which were calibrated on 08.01.2015 by the manufacturer, Haenni of Switzerland. Sufficient trucks were stopped at surveyed locations to have different category of goods vehicles with different types of commodities loaded.

In order to have a safe and durable pavement design, the VDF in each direction of traffic was calculated as shown in **Table 3.8**. The data collected from the Axle Load Survey has been compiled and analysed through "Fourth power" pavement damage law to arrive at the vehicles damage factor (VDF).

Design of Pavement is based on the cumulative number of 8.16 tonne equivalent standard axle (ESA) that will pass per lane during the analysis period. The categories of traffic which apply significant loads to the pavement are bus, minibus 2-Axle, 3-Axle and multi-axle vehicles. In calculating ESA, the standard axle loads taken are as under:

- i) Single Axle dual type = 8.1 tonnes
- ii) Tandem Axle dual type = 15.1 Tonne

The ESA for each axle has been calculated using the fourth Power law, as under

$$ESA = \left[\frac{\text{Actual Axle Load}}{\text{Standard Axle Load}} \right]^4$$

The Vehicle Damage Factor is a multiplier to convert the number of commercial vehicles of different axle loads and axle configuration to the number of standard axle load repetitions.

**Table 3.8: Adopted VDF by Homogeneous Sections
Estimation of Vehicle Damage AT KALIJHORA NEAR SEVOKE (NH-31A)**

MODE	Silliguri-Sikkim			Sikkim-Siliguri			Recommended
	Equivalence Factor	No. of Vehicles	VDF	Equivalence Factor	No. of Vehicles	VDF	
LCV	164.72	142	1.16	17.98	110	0.16	1.16
2 - AXLE	849.87	186	4.57	68.52	115	0.6	4.57
3 Axle	2.73	2	1.36	14.07	4	3.52	3.52
MAV	1.49	1	1.49	3.65	1	3.65	3.65

3.7 Inventory and Condition Survey of Bridges and Culverts

It is observed that the land along the existing alignment are open land ,agricultural land,

passing through major Towns and Terrain is mostly hilly. It is observed that all along the alignment most of the structures like buildings, substructures for bridges, village roads etc., constitute of brick and stone masonry

Brief details of existing CD structures along the project alignment are as below.

Table 3.9: Existing CD structures

Sr. No.	Type	No's of structures	Retained	Reconstruction	Widened	New Proposed
1	Major Bridges	0	0	0	0	0
2	Minor Bridges	2	0	2	0	2
3	Pipe Culverts	0	0	0	0	0
4	Slab Culverts	56	0	146	0	26
5	ROB	0	0	0	0	0
6	Causeway	98	0	0	0	0
Total		158	0	148	0	28

Salient features of major structures are described as below.

3.7.1 Bridges

There are 2 minor bridges at both are at nalah. Photographic representations are some of minor bridge is described as below.

The super structure of minor bridge is with RCC solid slab only. The sub structures of most of the minor bridges are in CR masonry. But many of them have been plastered with cement mortar. Probably to cover up distress found in CR masonry plastering the surface has been done. The major bridge is proposed to be Retained with some repair and rehabilitation.



Bridge At km 13.500



Bridge At km 14+199

3.7.2 Inventory of Culverts

There are 56 culverts and 98 causeway on project road . Photographic views of existing culverts are described as below.



At km 3+330



At km 4+652



At km 9+400

CHAPTER - 4

TRAFFIC SURVEY & ANALYSIS

4.0 Traffic Surveys and Analysis

4.1 General

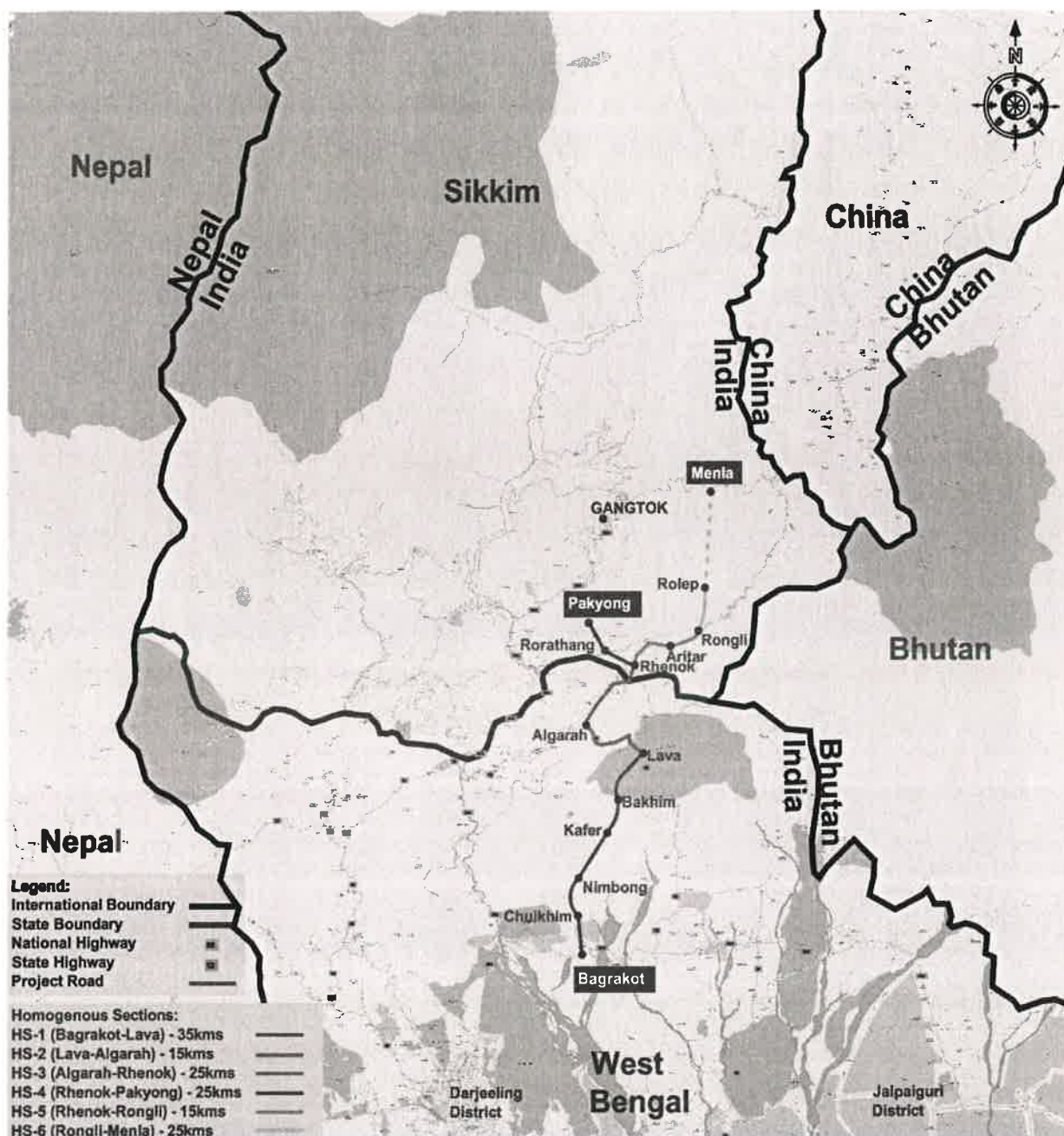
Traffic surveys, analysis and demand forecast are an important element of any feasibility /detailed project report preparation. Traffic analysis and demand forecasting are directly related to several important aspect of project road planning and design i.e. capacity augmentation proposals, geometric design features, planning and design of toll plaza, pavement design, economic and financial analysis etc. Towards this the consultant has undertaken detailed traffic surveys, analysis, forecasting and carry out lanning requirements. Various steps followed in this regard are described in the subsequent paragraphs.

4.2 Objectives

- To carry out traffic surveys and estimation of base year traffic demand
- Identification of travel pattern and influence area of project road
- Traffic demand forecasting up to project life
- Assess capacity requirement of project road, to estimate tollable traffic & to identify toll plaza locations.

4.3 Project Road & Alternate Transport Network

The project road passing through the two Indian States (West Bengal and Sikkim), Jalpaiguri and Darjeeling district in the West Bengal and East Sikkim district in the state of Sikkim. The project road starts from NH-31 near Bagrakot in the district of Jalpaiguri and ends at two points in the district of East Sikkim (Pakyong and Menla). The length of project road is about 75kms (Bagrakot – Rhenok) in the state of West Bengal, 25 kms (Rhenok-Pakyong) and about 40 kms (Rhenok-Menla) in the state of Sikkim. The project road passes through hilly terrain road and serves Military, civil as well as tourist traffic. The road is proposed to be built on DBFOT pattern and the users of this facility have to pay toll to use the entire length or part of it.



4.4 Traffic Homogeneous Section

The project road is divided into six homogeneous sections for better demand assessment of traffic in each section.

The homogeneous sections are:

- | | |
|---------------------------|--|
| Homogenous Section (HS)-1 | Bagrakot (Start of the project road) to Lava
- Length – 35kms approx. (West Bengal) |
| Homogenous Section (HS)-2 | Lava to Algarah – Length – 15 kms approx.
(West Bengal) |

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Homogenous Section (HS)-3	Algarah to Rhenok – Length – 25 kms approx. (West Bengal)
Homogenous Section (HS)-4	Rhenok to Pakyong – Length – 25 kms approx. (Sikkim)
Homogenous Section (HS)-5	Rhenok to Rongli – Length – 15kms approx. (Sikkim)
Homogenous Section (HS)-6	Rongli to Menla – Length – 25kms approx. (Sikkim)

4.5 Traffic Surveys Schedule

It is very important, that the existing information on traffic flow, commodity movement and traffic pattern is required in order to assess the traffic behaviour on a project road. To collect such information to satisfy the Terms of Reference (TOR) and project requirements, following various types of traffic surveys were carried out:

- 1) Classified Volume Count (CVC) Survey
- 2) Origin –Destination and Commodity Movement Surveys
- 3) Axle Load Spectrum Survey
- 4) Intersection Volume Count Survey
- 5) Speed and Delay surveys
- 6) Pedestrian/Cattle Crossing Surveys
- 7) Truck Terminal Survey

Traffic survey locations were selected after detailed reconnaissance survey and in line with the TOR. All the traffic surveys were carried out as per the IRC guidelines given in IRC: SP 19-2001, IRC 37:2012, IRC: 108-2015, IRC SP: 41-1994, IRC: 102-1988, IRC 103- 2012 and IRC: 09-1972 etc.

All the above surveys were carried out manually by employing sufficient number of trained enumerators recording information in the pre-designed formats. The enumerators were selected from locally available educated people familiar with traffic characteristics and condition of the project road. They were properly briefed and trained about the survey work before putting them on actual survey work in field. An experienced supervisor was kept in-charge for all the locations.

The locations for the various surveys were so selected that all vehicles can be viewed and interpreted easily without endangering the safety of enumerators and drivers. The most important part of all traffic survey was to exercise adequate quality control. The quality assurance was achieved through:

- Proper briefing and demonstration to enumerators before the start of work;
- Continuous independent checking by Traffic engineers / supervisor in the field during the survey work;
- Checking of filled in survey formats by Traffic engineer; and
- Validation of computer data entry with raw surveyed data

The survey data were recorded in the pre-designated approved formats for each type

of survey. All the above traffic surveys were carried out as per the schedule finalised after considering requirements of TOR and project requirements as presented below.

4.6 Classified Traffic Counts at Mid Block and Intersection Location

Classified traffic counts were carried out for a period of 7 consecutive days at 3 mid-block locations and for a period of 12 hours at 6 intersection locations along the project road. The surveys were carried out manually by trained enumerators. The data served as population base for the base year and will be used to project traffic. The Survey locations are presented in Figure 2.1. The survey data are presented in Annexure – 1.

4.7 Road Side OD Surveys

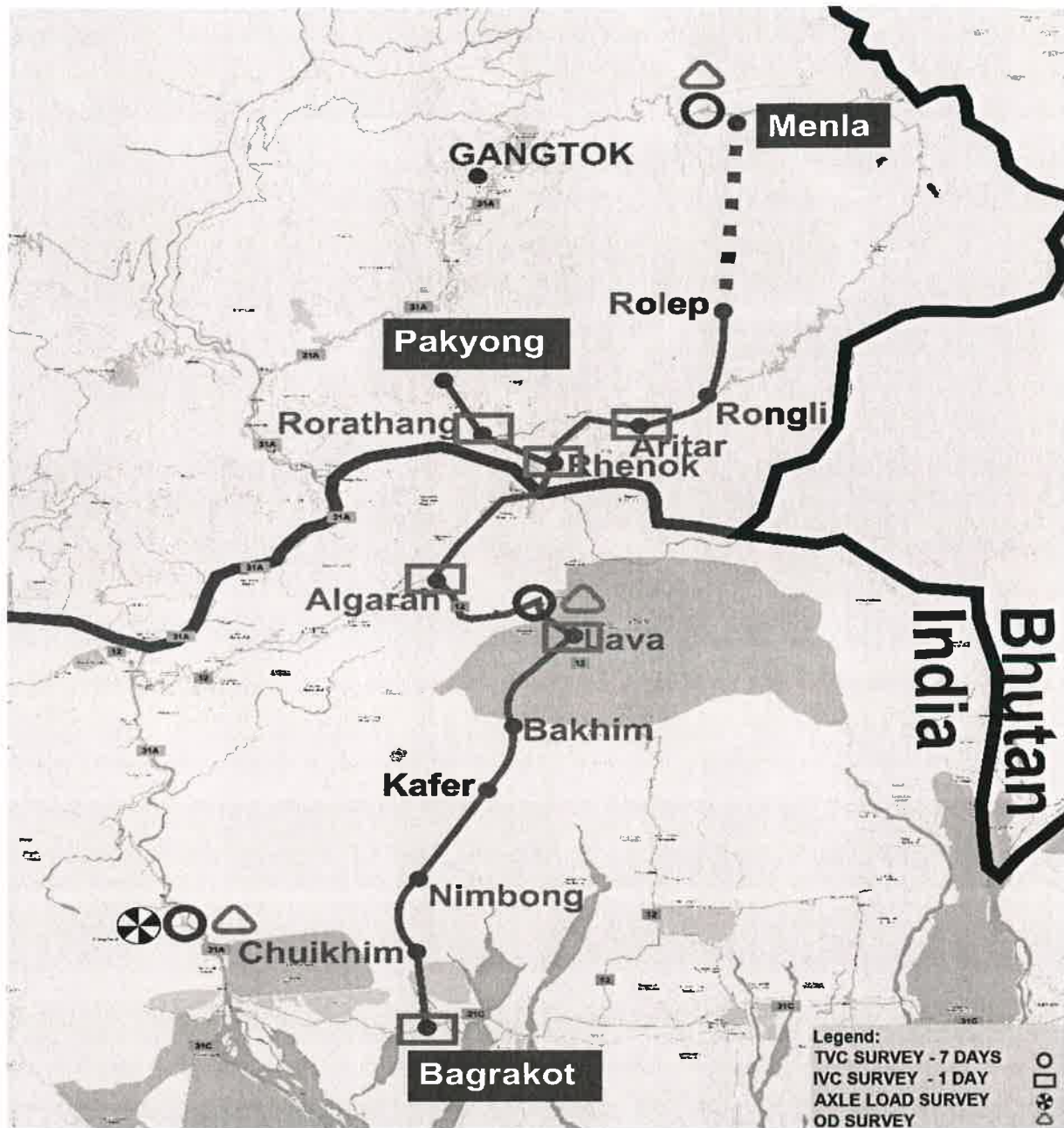
These surveys were carried out on sample basis by trained enumerators for a period of 24 hours at same locations as the classified traffic counts. The vehicles were stopped on random sample basis with police help and the drivers were asked about their trip and travel characteristic on a prepared survey format. The vehicles selected were Light Commercial Vehicles (LCV) Medium Commercial Vehicles (MCV) or trucks and Heavy Commercial Vehicles (HCV) having more than 2 Axle among the goods vehicles, while the passenger vehicles included Cars, Buses, 2 wheelers and 3 Wheelers. The buses were not stopped but their origin and destination was noted from the board on front or side and their occupancy was estimated on visual basis. Care was taken not to obstruct the flow during survey by randomly selecting the vehicles and releasing them before taking on the next vehicle.

4.8 Axle Load Surveys

The Axle Load Surveys were carried out at one location for a period of 12 hours. The Vehicles selected were light Commercial vehicles, Trucks and MAV's. A few samples of empty vehicles were also included besides the loaded trucks. The left side wheels of stopped vehicles (front and rear) were mounted on a weigh pad to note the wheel/dual assembly Load. This was multiplied by 2 to calculate the Axle Load. Each Axle of the selected vehicle was considered and the Axle Load spectrum was prepared at office.

TABLE 4.1 SURVEY LOCATIONS ALONG PROJECT ROAD

S. No.	Type of Survey	Location Code	Location Name	Survey Date	Remark
1	Traffic Volume Count	TVC - 01	1. Near Kalijhora on NH-31A	4th January 2015 to 10th January 2015	7 Days
		TVC-02	2. Near Algarah (Baluwakhani Checkpost) - SH-12	8th January 2015 to 14th January 2015	
		TVC-03	3. Near 3rd Mile Checkpost on NH-31A (JLN Marg)	10th January 2015 to 16th January 2015	
2	Origin - Destination Survey	OD-01	1. Near Kalijhora on NH-31A	14th January 2015	1 Day
		OD-02	2. Near Algarah (Baluwakhani Checkpost) - SH-12	8th January 2015	
		OD-03	3. Near 3rd Mile Checkpost on NH-31A (JLN Marg)	10th January 2015	
3	Axle Load Survey	Axl - 01	1. Near Kalijhora on NH-31A	14th January 2015	1 Day
4	Turning Movement Survey	INT-01	1. Start point of the project/ Jn. With NH-31	8th January 2015	1 Day
		INT-02	2. Lava Junction near kms 56 of SH-12	6th January 2015	
		INT-03	3. Algarah Junction	6th January 2015	
		INT-04	4. Rehnok Junction	5th January 2015	
		INT-05	5. Rorathang Junction	7th January 2015	
		INT-06	6. Dalepchen near Rongli	5th January 2015	



Traffic Survey Location

4.9 TRAFFIC VOLUME COUNT AT MID BLOCK LOCATION

The classified traffic volume counts at 3 mid-block location were carried out by trained enumerators for 7 days continuously to note the weekly and daily traffic trends on a pre-designed format at 15 minutes interval. The data is recorded by direction.

4.9.1 PCU (Passenger Car Unit) Conversion Factor

For the analysis of traffic counts carried out at selected Intersection along the project corridor for study, the PCU Factor adopted is presented in **Table 4.1**.

TABLE 4.1 PASSENGER CAR UNITS FOR THE CONVERSION AS PER IRC 64-1990

Vehicular Modes	PCU VALUE
Car/ Van/ Jeep/ Taxi	1.0
2-Wheeler	0.5
3-Wheeler	1.0
Bus	3.0
Mini Bus	1.5
LCV	1.5
2-Axle Truck	3.0
3-Axle Truck	3.0
Multi Axle Vehicles (MAV)	4.5
Agricultural Tractor - Without Trailer	1.5
Agricultural Tractor- With Trailer	4.5
Cycle	0.5
Cycle-Rickshaw	2.0
Hand Cart	3.0
Bullock Cart	6.0

Source: IRC: 64-1990

4.9.2 Average Daily Traffic

The analysis shows that the Average Daily Traffic (ADT) varies from 362 PCU at TVC-02 to 8571 PCU at TVC-01. The details are presented in **Table 4.2**.

TABLE 4.2 TRAFFIC CHARACTERISTICS (ADT) AT MID BLOCK LOCATIONS

Mode		TVC-01 (Nr. Sevok, Kalijhora, NH-31)	TVC-02 (Baluakhani Checkpoint, Near Algarah, SH- 12)	TVC-03 (3rd Mile Check Post, JLN Marg)
Heavy Fast Passenger Vehicles	Standard Bus	12	0	0
	Mini Bus	130	1	0
Light Fast Passenger Vehicles	Car/ Van/ Jeep/ Taxi	3643	257	676
	3-Wheeler	0	0	0
	2-Wheeler	282	51	18
Goods Commercial Vehicles	LCV	712	49	11
	2-Axle Truck	1036	1	16
	3-Axle Truck	30	0	0
	MAV	2	0	0
Toll Exempted Vehicles	Govt. Car/ Van/ Jeep	26	1	43
	Govt. Bus/ Truck	66	0	62
	Govt. LCV/ Mini Bus	0	0	0
Agricultural Vehicles	Tractor	0	0	0
	Tractor Trailer	0	0	0
Slow Vehicles	Cycle	0	2	0
	Cycle Rickshaw	0	0	0
	Animal/ Hand Drawn	0	0	0
Total Vehicles		5941	361	827
Total PCU		8517	362	981

Source: Traffic Survey, January 2015

4.9.3 Directional Distribution of Traffic

At TVC-01, the directional distribution of traffic shows that the traffic moving between Silliguri and Sikkim is slightly high as 51% while 49% traffic move in opposite direction. At TVC-02, the directional distribution of traffic shows that the traffic moving between Algarah and Lava is 2% lower than the traffic moving in opposite direction. At TVC-03, the directional distribution of traffic shows that the traffic moving between Nathula and Gangtok is 4% higher than the traffic flow in opposite direction. The details are presented in **Table 4.3**.

TABLE 4.3 DIRECTIONAL DISTRIBUTION OF AVERAGE DAY TRAFFIC

Mode		TVC-01 (Nr. Sevok, Kalijhora, NH-31)			TVC-02 (Baluakhani Checkpost, Near Algarah, SH-12)			TVC-03 (3rd Mile Check Post, JLN Marg)		
		Silliguri- Sikkim	Sikkim- Siliguri	Both Direction	Algarah- Lava	Lava- Algarah	Both Direction	Gangtok- Nathula	Nathula- Gangtok	Both Direction
Heavy Fast Passenger Vehicles	Standard Bus	8	4	12	0	0	0	0	0	0
	Mini Bus	69	61	130	0	0	1	0	0	0
Light Fast Passenger Vehicles	Car/ Van/ Jeep/ Taxi	1951	1693	3643	123	134	257	336	339	676
	3-Wheeler	0	0	0	0	0	0	0	0	0
	2-Wheeler	133	149	282	27	24	51	8	10	18
Goods Commercial Vehicles	LCV	305	407	712	25	24	49	5	6	11
	2-Axle Truck	537	500	1036	1	0	1	4	12	16
	3-Axle Truck	13	18	30	0	0	0	0	0	0
	MAV	1	1	2	0	0	0	0	0	0
	Govt. Car/ Van/ Jeep	15	11	26	1	1	1	20	23	43
Toll Exempted Vehicles	Govt. Bus/ Truck	35	31	66	0	0	0	28	34	62
	Govt. LCV/ Mini Bus	0	0	0	0	0	0	0	0	0
Agricultural Vehicles	Tractor	0	0	0	0	0	0	0	0	0
	Tractor Trailer	0	0	0	0	0	0	0	0	0
Slow Vehicles	Cycle	0	0	0	2	0	2	0	0	0
	Cycle Rickshaw	0	0	0	0	0	0	0	0	0
	Animal/ Hand Drawn	0	0	0	0	0	0	0	0	0
Total Vehicles		3066	2875	5941	178	183	361	403	424	827
Total PCU		4373	4144	8517	178	184	362	467	514	981

[SA Infrastructure Consultants]

[NHIDCL]

Mode	TVC-01 (Nr. Sevok, Kalijhora, NH-31)			TVC-02 (Baluakhani Checkpost, Near Algarah, SH-12)			TVC-03 (3rd Mile Check Post, JLN Marg)		
	Silliguri-Sikkim	Sikkim-Siliguri	Both Direction	Algarah-Lava	Lava-Algarah	Both Direction	Gangtok-Nathula	Nathula-Gangtok	Both Direction
% age distribution (PCU)	51%	49%	100%	49%	51%	100%	48%	52%	100%

Source: Traffic Survey, January 2015

4.9.4 Traffic Composition

The traffic composition chart shows that the share of cars varies from 61% (at TVC-01) to 82% (at TVC-03) among the TVC locations. The share of 2-wheelers is varying from 2% to 14% while the share of buses and slow vehicles are negligible at all location. The share of LCV's varies from 1% (at TVC-03) to 14% (at TVC-02), the share of Trucks are varies from 2% (at TVC-03) to 18% (at TVC-01). The details are graphically presented in **Figure 4.1**.

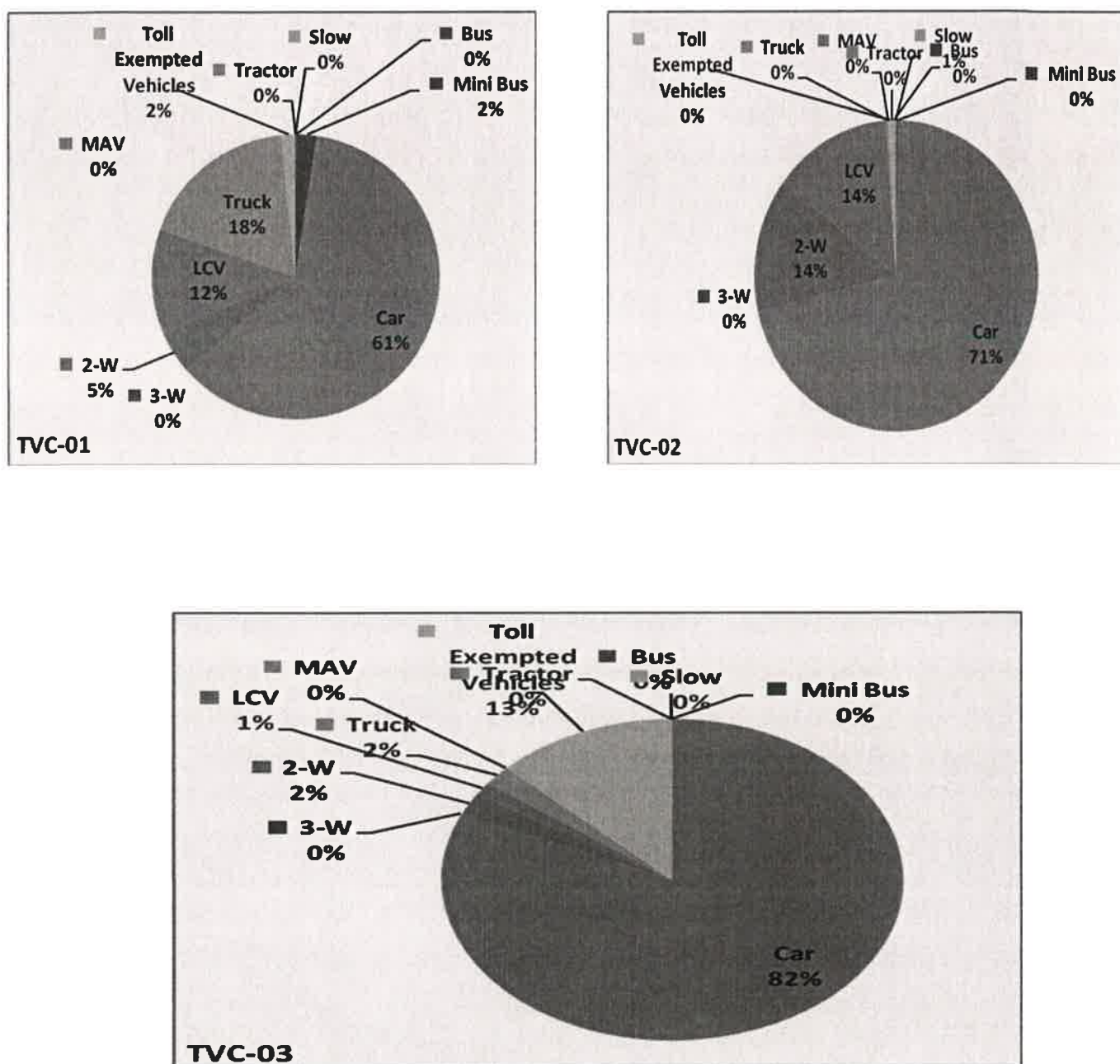


FIGURE 4.1 TRAFFIC COMPOSITION AT MID BLOCK LOCATIONS

4.9.5 Day wise Variation of Traffic

The traffic along the regional routes varies by day on account of the local factors like weekly markets, land use, traffic regulations etc. or due to regional factors. Traffic demand on a peak day may lead to excessive congestion and delays as the road infrastructure is unable to cope with the demand. This trend too was witnessed at the locations along which traffic counts were carried for this project.

The analysis shows that at TVC-01, the observed ADT was 8517 PCU while the day wise traffic varies from 7580 PCU (Sunday) to 10701 PCU (Monday). At TVC-02, the observed ADT was 365 PCU and the day wise traffic varies from 301 PCU (Saturday) to 392 PCU (Monday). At TVC-03, the average daily traffic was 981 PCU while the day wise traffic varies from 894 PCU (Sunday) to 1044 PCU (Wednesday). The details are presented in **Table 4.4** and graphically presented in **Figure 4.2 to 4.3**.

TABLE 4.4 DAYWISE VARIATION OF TRAFFIC AT MID BLOCK LOCATIONS

Days	Date	Day	TVC-01		Date	Day	TVC-02	
			(Nr. Sevok, Kalijhora, NH-31)				(Baluakhani Checkpost, Near Algarah, SH-12)	
			Vehicles	PCU			Vehicles	PCU
1	4-Jan-15	Sunday	5735	7580	8-Jan-15	Thursday	359	364
2	5-Jan-15	Monday	7596	10701	9-Jan-15	Friday	380	375
3	6-Jan-15	Tuesday	5567	8044	10-Jan-15	Saturday	297	301
4	7-Jan-15	Wednesday	5519	8337	11-Jan-15	Sunday	342	343
5	8-Jan-15	Thursday	5529	8086	12-Jan-15	Monday	391	392
6	9-Jan-15	Friday	5996	8624	13-Jan-15	Tuesday	375	372
7	10-Jan-15	Saturday	5643	8246	14-Jan-15	Wednesday	385	388
Mean			5941	8517			361	362
Standard Deviation			748	1014			33	31

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Days	Date	Day	TVC-03 (3rd Mile Check Post, JLN Marg)	
			Vehicles	PCU
1	10-Jan-15	Saturday	756	953
2	11-Jan-15	Sunday	729	894
3	12-Jan-15	Monday	859	1013
4	13-Jan-15	Tuesday	855	997
5	14-Jan-15	Wednesday	891	1044
6	15-Jan-15	Thursday	867	1020
7	16-Jan-15	Friday	833	945
Average			827	981
Standard Deviation			61	52

Source: Traffic Survey, January 2015

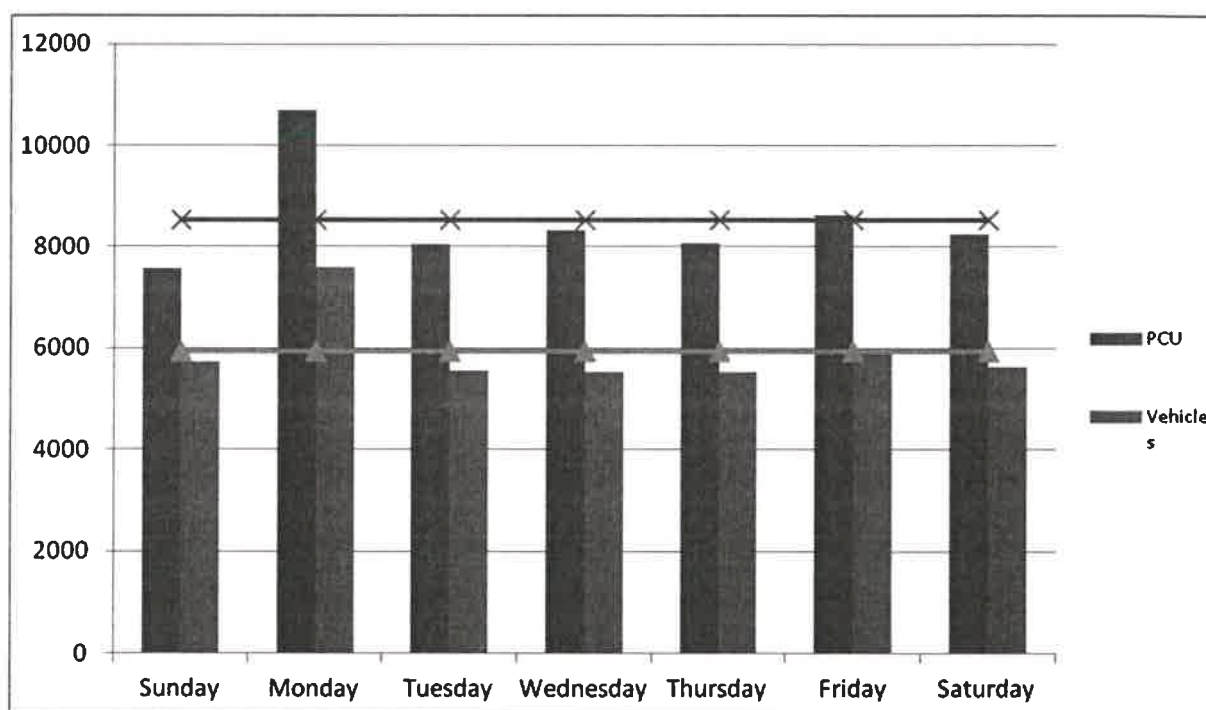


FIGURE 4.2 DAY WISE VARIATION OF TRAFFIC AT TVC-01

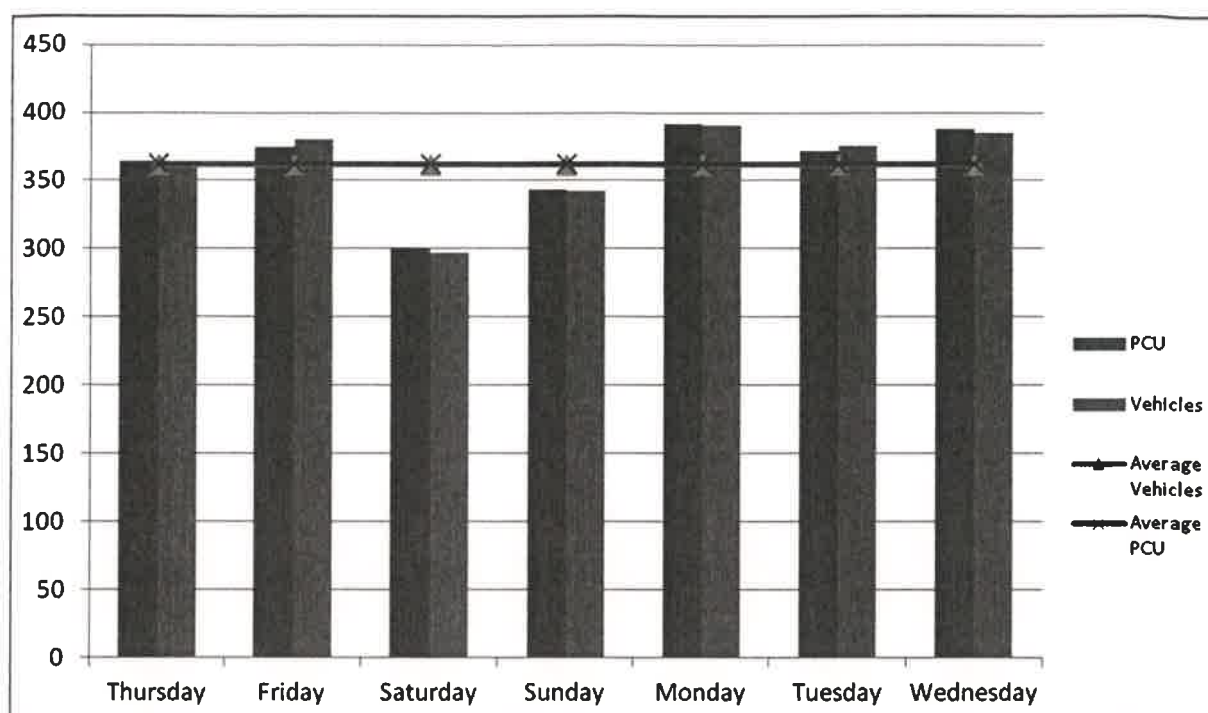


Figure 4.3 day wise variation of traffic at tv-02

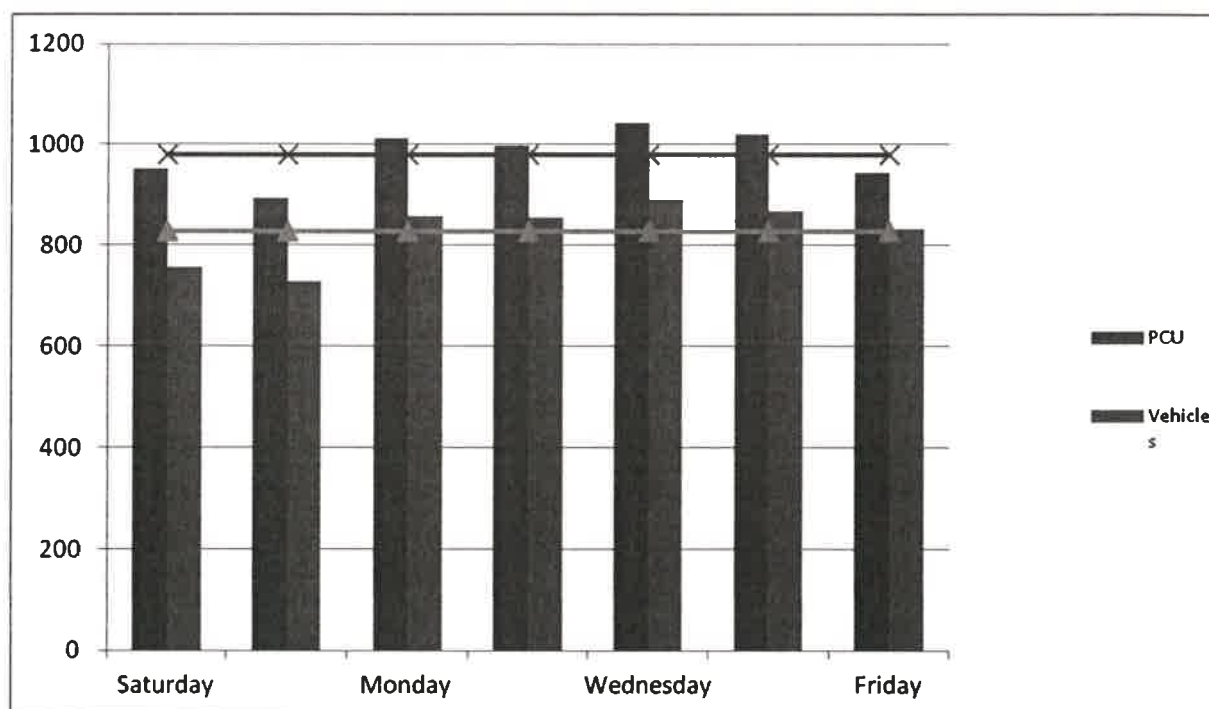


Figure 4.4 day wise variation of traffic at tv-03

4.9.6 Peak Hour Share of Traffic

The analysis shows that the share of peak hour traffic is varying from 7% to 18% during morning peak and 7% to 9% during evening peak hour. The details are presented in **Table 4.5**.

TABLE 4.5 SHARE OF PEAK HOUR TRAFFIC

S.No.	Location	Total Volume (PCU)	Morning Peak Hour			Evening Peak Hour		
			PCU	% share	Peak Hour Time	PCU	% share	Peak Hour Time
1	TVC-01 (Nr. Sevok, Kalijhora, NH-31)	8517	623	7%	0900-1000	612	7%	1900-2000
2	TVC-02 (Baluakhani Checkpost, Near Algarah, SH-12)	362	34	9%	0900-1000	32	9%	1700-1800
3	TVC-03 (3rd Mile Check Post, JLN Marg)	981	178	18%	0900-1000	67	7%	1700-1800

Source: Traffic Survey, January 2015

4.9.7 Hourly Variation of Traffic

The hourly variation of traffic count shows the pattern of traffic flow during the survey period. The hourly variation chart shows that the peak period during morning peak hours between 0900 AM and 1200 AM and during evening peak hour between 1600 PM and 2000 PM. The traffic during night hours is negligible. The hourly variation of traffic is graphically presented in **Figure 4.5 to 4.7**.

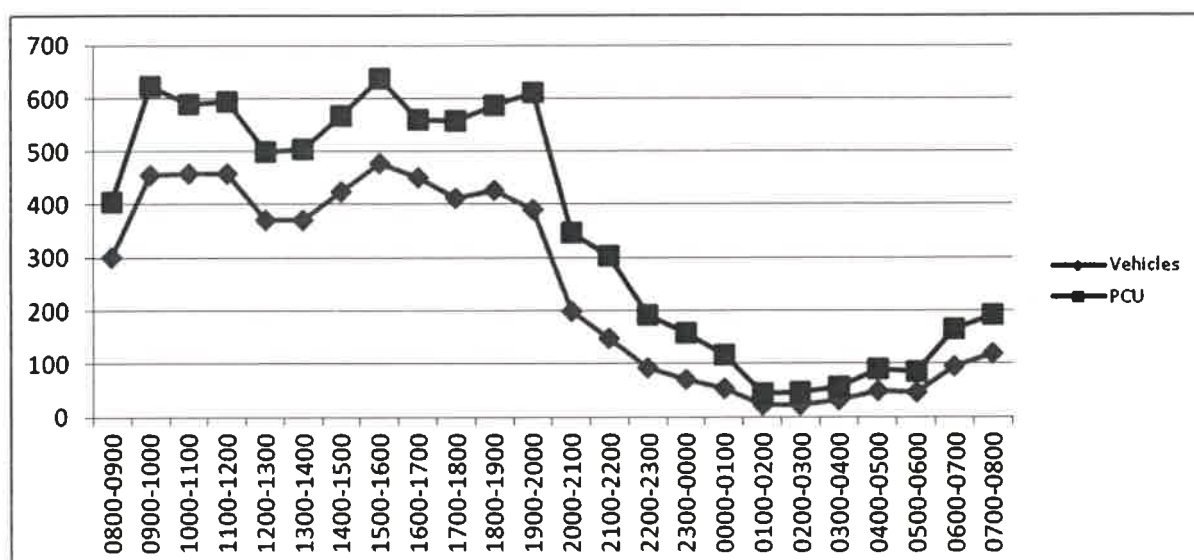


Figure 4.5 Hourly Variation of Traffic at TVC-01

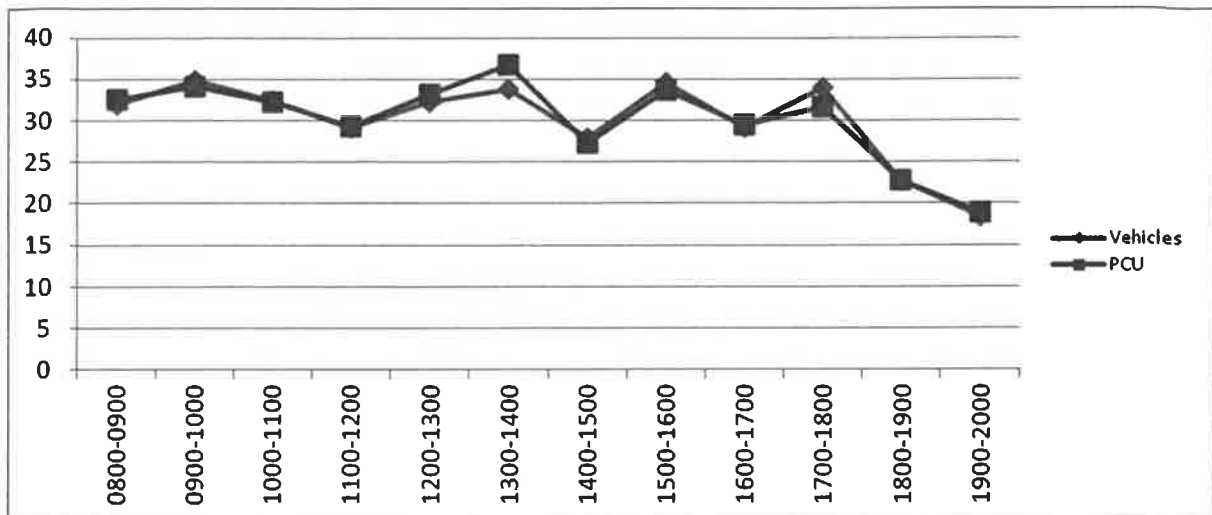


FIGURE 4.6 HOURLY VARIATION OF TRAFFIC AT TVC-02

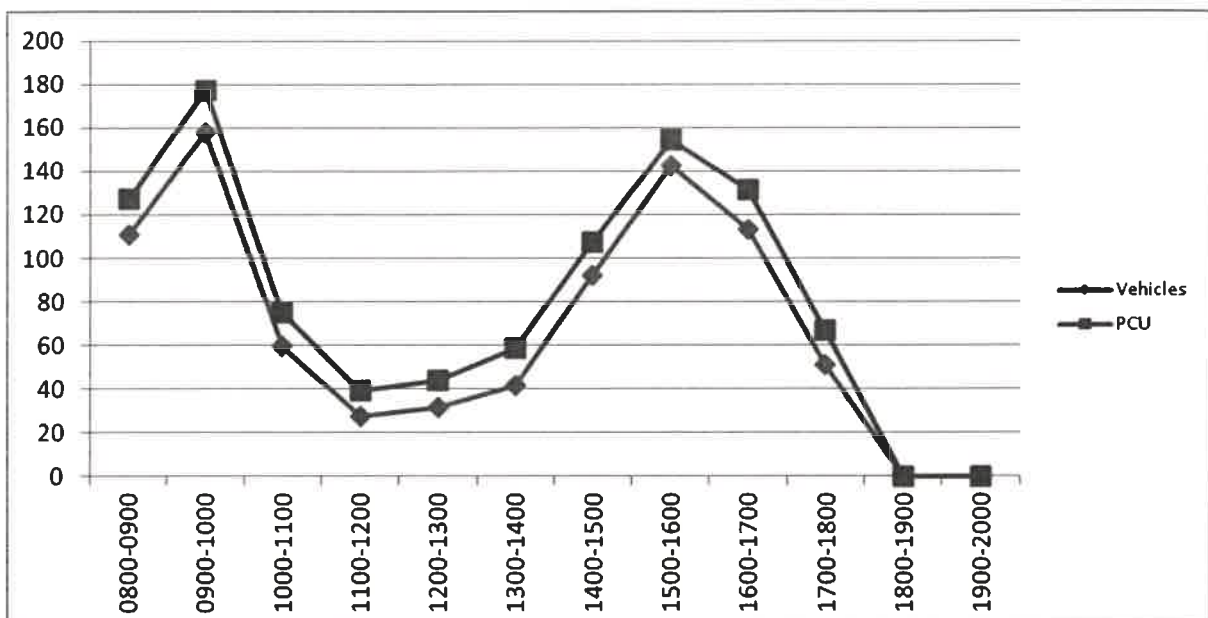


FIGURE 4.7 HOURLY VARIATION OF TRAFFIC AT TVC-03

4.9.8 Annual Average Daily Traffic

Traffic during different months of the year is not likely to be the same. During the harvest season, there is a significant goods vehicle movement, during school holidays there is lots of personal vehicle movement, during festival season there is lots of personal vehicle movement. In order to obtain an accurate estimate of the

variations it is essential that this phenomenon is captured in the traffic study. This manifest is estimation of a metric called Annual Average Daily Traffic (AADT)

Traffic engineers estimate the seasonal impacts by using a factor called as the “Seasonal Correction Factor (SCF)”. The seasonal correction factor is generally derived from secondary data sources such as historical month-wise traffic data on the project road, monthly toll revenues from existing tolled highways in the immediate influence area, for this study this is done by the estimation of Seasonal Correction Factor using month wise with Fuel Sale data variations. The seasonal correction factor (SCF) is presented in **Table 4.6(a) & (b)**.

TABLE 4.6(A) SEASONAL CORRECTION FACTOR (SCF) ALONG NH-31A

Month/ Year	Hill View Fill Station Sevoke Bazar Siliguri, West Bengal			Seasonal Correction Factor (SCF)		
	Diesel in Litres	Petrol in Litres	Total	Diesel	Petrol	Total
Mar-13	40500	17900	58400	0.99	1.00	0.99
Apr-13	40000	16900	56900	1.00	1.06	1.02
May-13	39000	15900	54900	1.03	1.13	1.06
Jun-13	34500	15400	49900	1.16	1.17	1.16
Jul-13	34300	14700	49000	1.17	1.22	1.18
Aug-13	36300	16700	53000	1.10	1.08	1.09
Sep-13	38500	16900	55400	1.04	1.06	1.05
Oct-13	40000	19900	59900	1.00	0.90	0.97
Nov-13	43500	21900	65400	0.92	0.82	0.89
Dec-13	47800	20900	68700	0.84	0.86	0.84
Jan-14	44000	19900	63900	0.91	0.90	0.91
Feb-14	42000	18700	60700	0.95	0.96	0.96
Total	40033	17975	58008			

Source: Fuel Sale Data

TABLE 4.6(B) SEASONAL CORRECTION FACTOR (SCF) ALONG JLN MARG

Month/ Year	Sri R.A.L Mangal KSK, Rhenock East Sikkim, Sikkim			Seasonal Correction Factor (SCF)		
	Diesel in Litres	Petrol in Litres	Total	Diesel	Petrol	Total
Jun-14	9000	9000	18000	2.69	2.28	2.49
Jul-14	27000	18000	45000	0.90	1.14	0.99
Aug-14	27000	27000	54000	0.90	0.76	0.83
Sep-14	27000	27000	54000	0.90	0.76	0.83
Oct-14	27000	27000	54000	0.90	0.76	0.83
Nov-14	22000	18000	40000	1.10	1.14	1.12

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Month/ Year	Sri R.A.L Mangal KSK, Rhenock East Sikkim, Sikkim			Seasonal Correction Factor (SCF)		
	Diesel in Litres	Petrol in Litres	Total	Diesel	Petrol	Total
Dec-14	29000	18000	47000	0.84	1.14	0.95
Jan-15	26000	19000	45000	0.93	1.08	0.99
Feb-15	28000	22000	50000	0.87	0.93	0.90
Mar-15	26000	23000	49000	0.93	0.89	0.91
Apr-15	23000	20000	43000	1.05	1.03	1.04
May-15	20000	18000	38000	1.21	1.14	1.18
Total	24250	20500	44750			

Source: Fuel Sale Data

The consultant has estimate the SCF for project road is based on the average SCF of locations for diesel and petrol propelled vehicles. The average SCF is 0.92 and 0.99 for diesel and petrol propelled vehicles respectively.

For the estimation of Annual Average Daily Traffic (AADT), the Seasonal Correction Factor (SCF) is used for the month of January. The seasonal correction factor for Diesel vehicles is 0.92 and petrol vehicles is 0.99. This means that the diesel sale in the month of January was 8% above the average monthly sale while petrol sale during month of January (coinciding with the survey month) was 1% above the normal sale. Accordingly the number of diesel propelled vehicles has to be decreased by 8% and number of petrol propelled vehicles have to decrease by 1%.

The annual average daily traffic will be estimated by multiplying the Average Day Traffic of petrol propelled vehicles by 0.99 and for diesel propelled vehicle by 0.92. The Average Daily Traffic (ADT) has been presented in Table 4.2 while the Estimated Annual Average Daily Traffic (AADT) is presented in **Table.4.7**.

TABLE 4.7 ANNUAL AVERAGE DAILY TRAFFIC (AADT)

Mode		TVC-01 (Nr. Sevok, Kalijhora, NH-31)	TVC-02 (Baluakhani Check post, Near Algarah, SH-12)	TVC-03 (3rd Mile Check Post, JLN Marg)
Heavy Fast Passenger Vehicles	Standard Bus	11	0	0
	Mini Bus	119	1	0
	School Bus	0	0	0
	School Mini Bus	0	0	0
Light Fast Passenger	Car/ Van/ Jeep/ Taxi	3607	254	669

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Mode		TVC-01 (Nr. Sevok, Kalijhora, NH-31)	TVC-02 (Baluakhani Check post, Near Algarah, SH-12)	TVC-03 (3rd Mile Check Post, JLN Marg)
Vehicles	3-Wheeler	0	0	0
	2-Wheeler	279	50	18
Goods Commercial Vehicles	LCV	655	45	10
	2-Axle Truck	954	1	15
	3-Axle Truck	28	0	0
	MAV	2	0	0
Toll Exempted Vehicles	Govt. Car/ Van/ Jeep	24	1	39
	Govt. Bus/ Truck	61	0	57
	Govt. LCV/ Mini Bus	0	0	0
Agricultural Vehicles	Tractor	0	0	0
	Tractor Tractor	0	0	0
Slow Vehicles	Cycle	0	2	0
	Cycle Rickshaw	0	0	0
	Animal/ Hand Drawn	0	0	0
Total Vehicles		5740	354	810
Total PCU		8100	353	950

Source: Consultant Estimates

4.10 TURNING MOVEMENT VOLUME COUNT

The classified turning traffic volume count were carried out at 6 location along project road for the period of 12 Hrs. at each location (0800 AM – 0800 PM). The analysis results are presented below.

4.10.1 Approach Traffic

The table shows that the approach traffic during survey period along project road varies from 540 PCU (at INT-06, Rongli) to 5597 PCU (at INT-01, Bagrakot). The share of morning peak hour traffic at the intersection varies from 10% to 13% while the share of evening peak hour is varies from 8% to 11%. The approach traffic for each intersection is presented in **Table 4.8**.

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TABLE 4.8 APPROACH TRAFFIC (PCU) AT STUDY INTERSECTIONS

Sr. No.	Intersections	Locations Name	Approach Arm	Inflow/Outflow	Entire Day	Morning Peak	Evening Peak
1	INT -01	Bagrakot (Start Point of Project Road), NH-31	Sevoke	Inflow	2462	237	217
				Outflow	2306	248	178
				Both	4767	485	395
			Bagrakot	Inflow	727	68	41
				Outflow	555	90	35
				Both	1281	158	76
			Damdim	Inflow	2409	290	192
				Outflow	2641	267	221
				Both	5050	557	413
			Oodalabari	Inflow	284	47	19
				Outflow	380	37	36
				Both	664	84	55
Total Inflow at Intersection					5597	594	450
2	INT -02	Lava Intersection (SH-12)	Algara	Inflow	167	18	13
				Outflow	174	18	18
				Both	340	36	31
			Rishop	Inflow	35	4	4
				Outflow	21	3	1
				Both	56	6	5
			Lava	Inflow	176	20	18
				Outflow	191	23	15
				Both	367	43	33
			Chumung Forest	Inflow	41	6	1
				Outflow	33	4	2
				Both	73	9	3
Total Inflow at Intersection					377	41	35
3	INT -03	Algarah	Algarah	Inflow	286	18	40
				Outflow	292	57	17
				Both	578	75	57
			Pedong	Inflow	310	60	19
				Outflow	307	19	45
				Both	617	79	64
			Baluwakh	Inflow	41	2	5

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Sr. No.	Intersection s	Locations Name	Approach Arm	Inflow/ Outflo w	Entire Day	Morning Peak	Evenin g Peak
			ani	Outflo w	38	4	2
				Both	78	6	7
Total Inflow at Intersection					596	78	59
4	INT -04	Rhenock	Algara	Inflow	218	24	18
				Outflo w	239	21	31
				Both	456	45	49
			Roarhang	Inflow	505	54	52
				Outflo w	486	68	57
				Both	991	122	109
			Rongali	Inflow	192	34	22
				Outflo w	221	30	18
				Both	413	63	40
			Rhenock Bazaar	Inflow	536	65	67
				Outflo w	505	58	53
				Both	1041	123	119
Total Inflow at Intersection					914	111	92
5	INT -05	Roarhang Bridge	Rangpu	Inflow	447	36	56
				Outflo w	367	51	35
				Both	814	87	90
			Roarhang	Inflow	222	33	15
				Outflo w	210	16	12
				Both	431	48	27
			Rhenock	Inflow	372	38	33
				Outflo w	465	40	57
				Both	837	77	89
Total Inflow at Intersection					669	69	71
6	INT -06	Rongali	Algarah	Inflow	192	20	17
				Outflo w	156	15	20
				Both	348	35	37
			Roarhang	Inflow	111	11	12
				Outflo w	138	15	10
				Both	248	26	22
			Rongali	Inflow	237	25	23
				Outflo	246	27	23

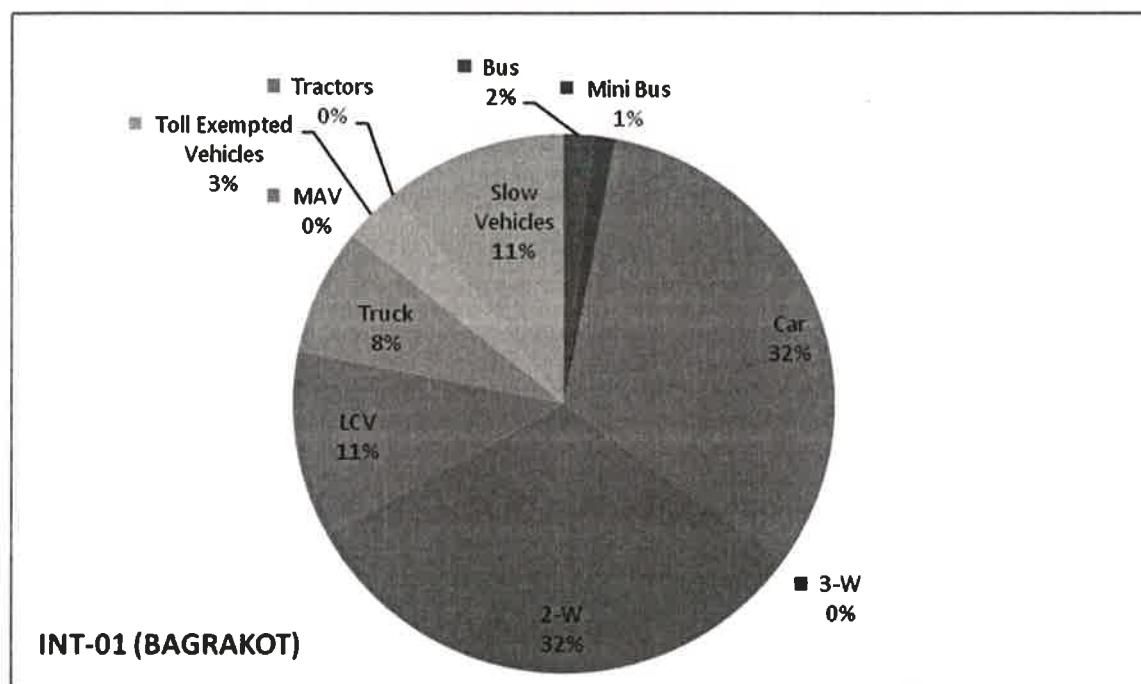
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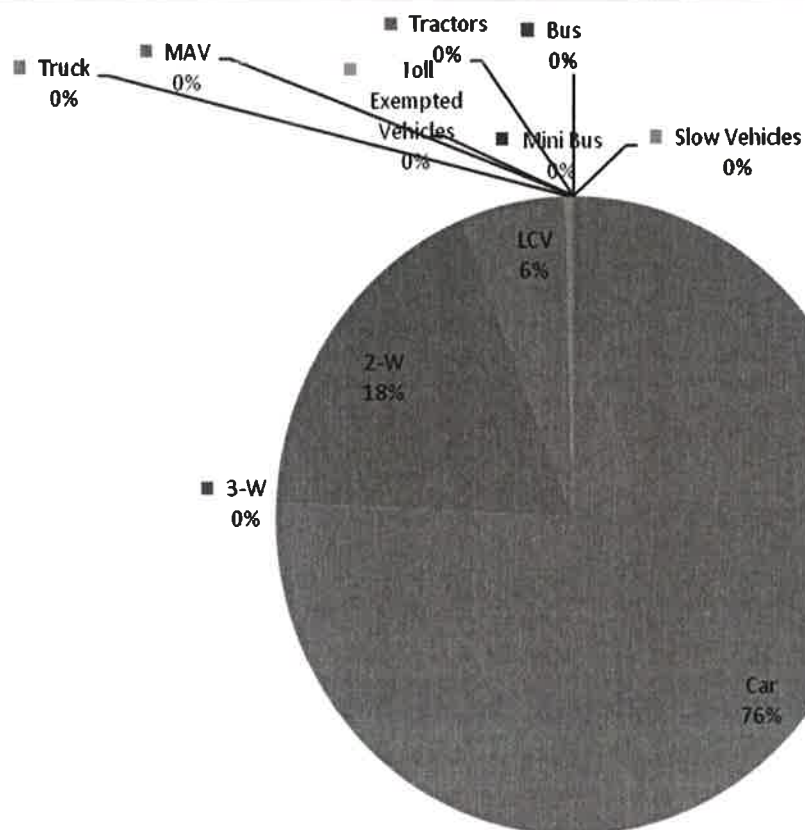
Sr. No.	Intersection s	Locations Name	Approach Arm	Inflow/ Outflow w w	Entire Day	Morning Peak	Evenin g Peak
				Both	483	51	46
Total Inflow at Intersection					540	56	52

Source: Traffic Survey, January 2015

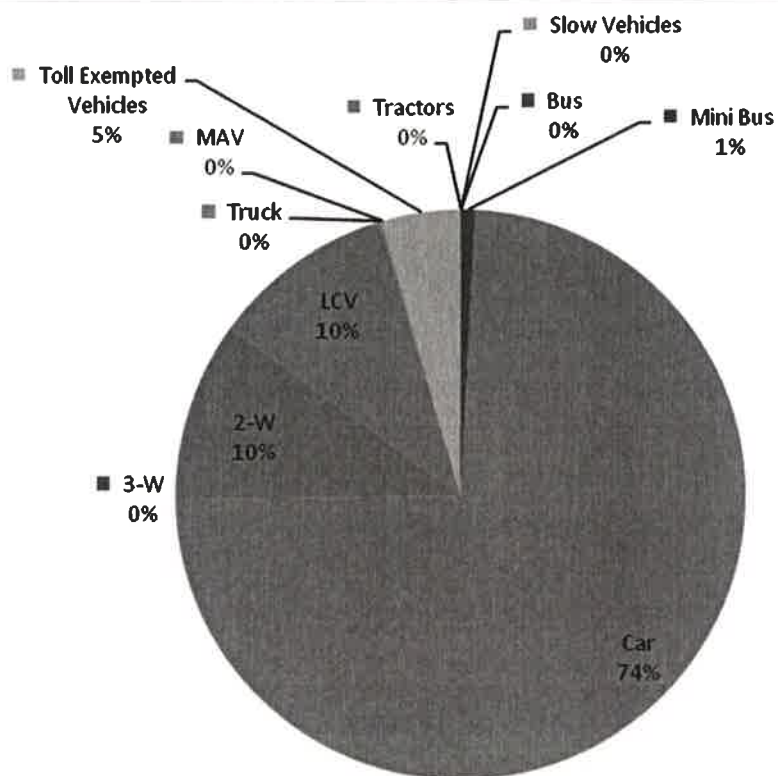
4.10.2 Traffic Composition at Study Intersection

The traffic composition chart shows that the share of cars are varies from 32% to 75%, share of 2-wheelers are varies from 10% to 32% among the six intersection location. The share of LCV's are varies from 6% 11% while the share of trucks are varies from 1% to 11% among the location. The share of buses and slow vehicles are negligible. The traffic composition at each intersection is presented in **Figure 4.8**.

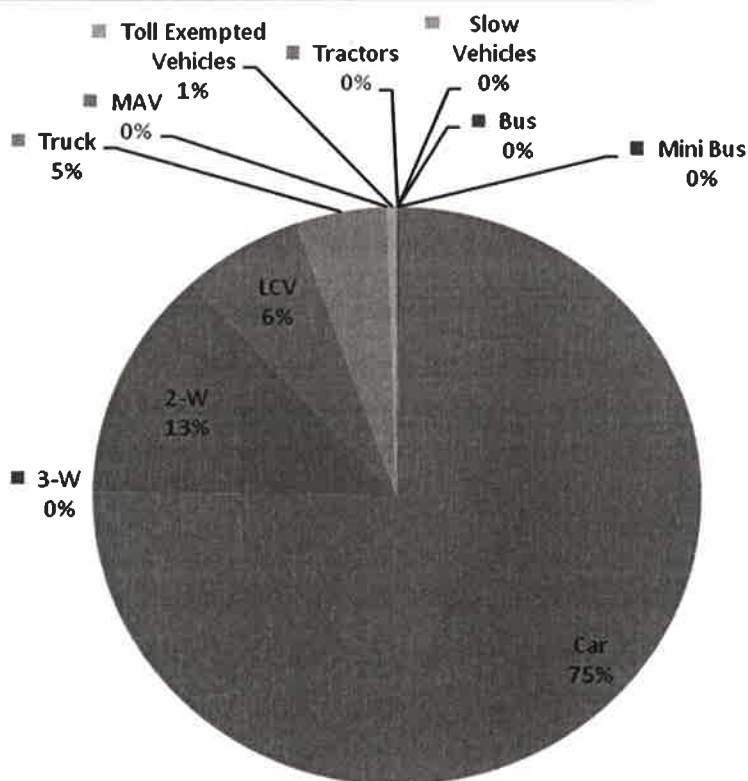




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INT-03 (ALGARAH)



INT-04 (RHENOK)

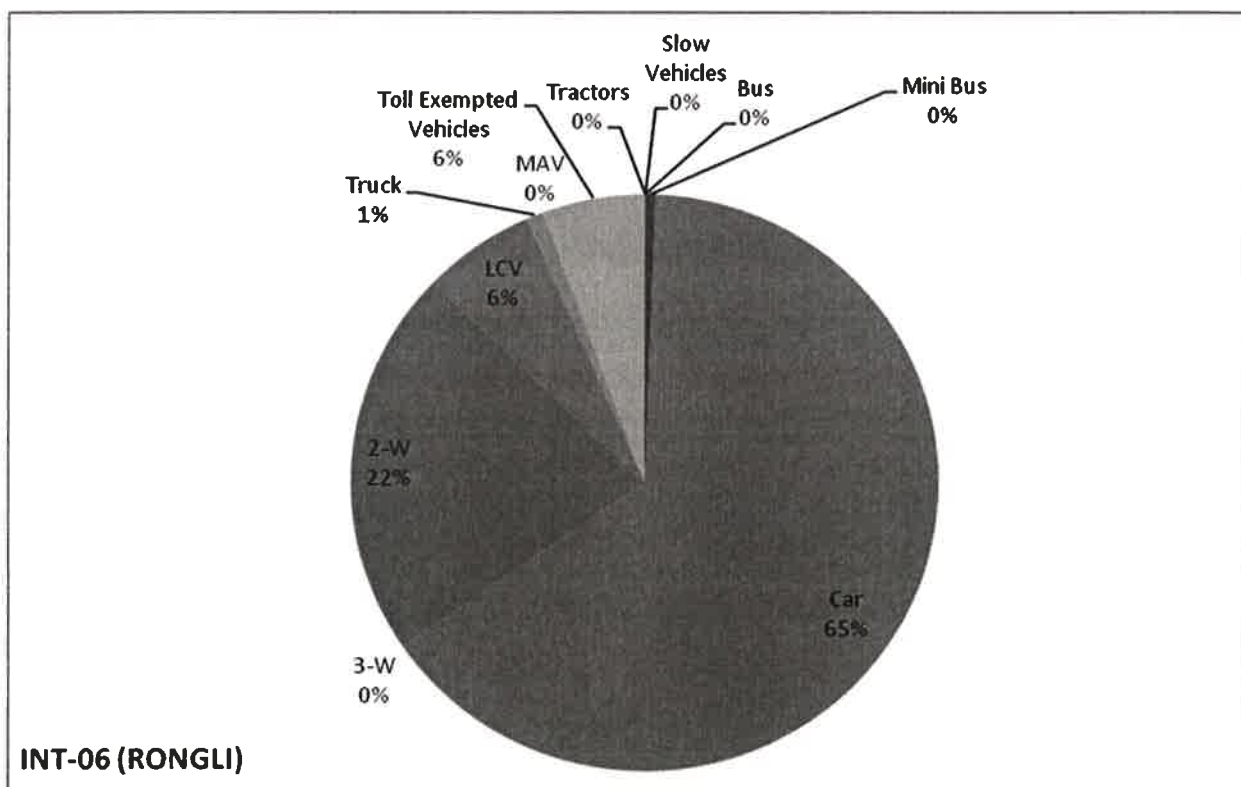
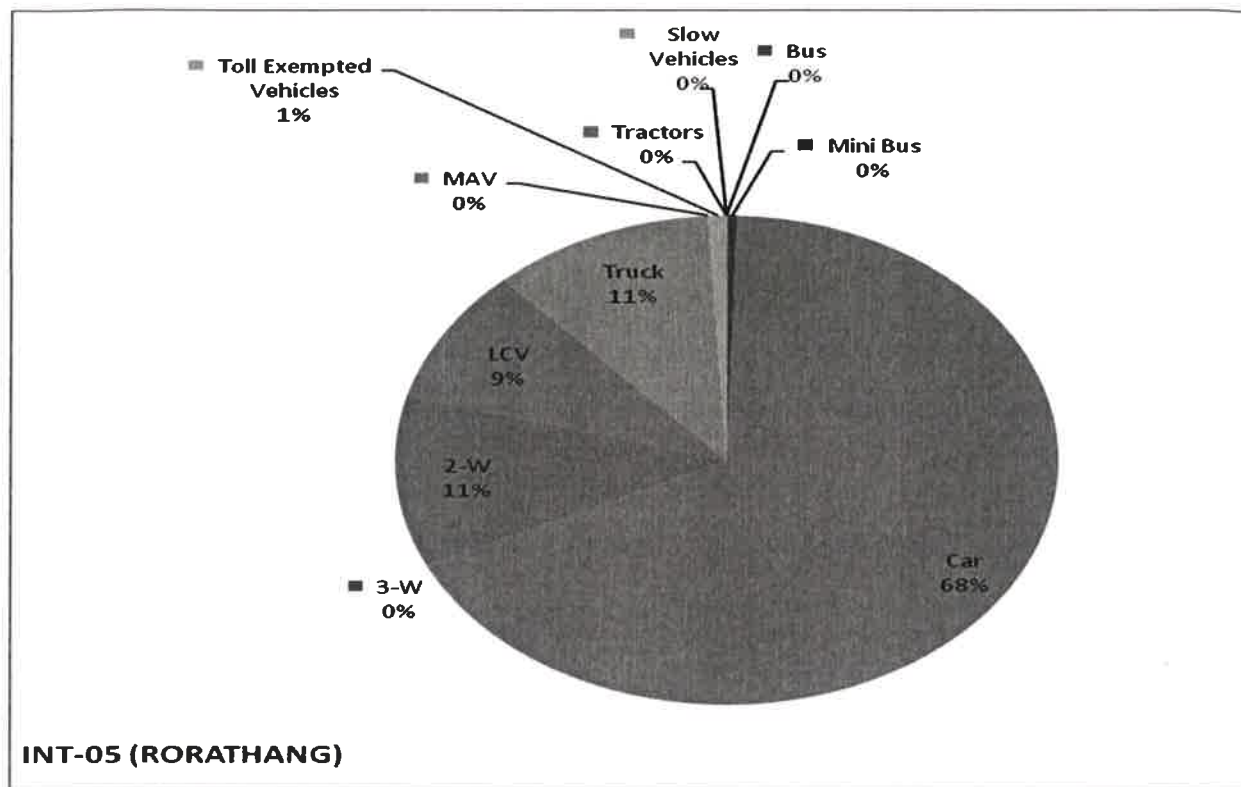


FIGURE 4.8 TRAFFIC COMPOSITION AT STUDY INTERSECTION