PREPARATORY STUDY FOR ROAD NETWORK IMPROVEMENT IN NORTH-EAST STATES OF INDIA

<u>DRAFT FINAL REPORT</u>

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Abbreviations

AADT	- Average Annual Daily Traffic
AC	- Asphalt Concrete
ADB	- Asian Development Bank
ADT	- Average Daily Traffic
AH	- Asian Highway
BOT	- Built Operation Transfer
BRDB	- Border Roads Development Board
BRO	- Border Roads Organization
CAGR	- The Compound Annual Growth Rate
CC	- Cement Concrete
CTCS	- Classified Traffic Count Survey
DB	- Double Bituminous Surface Dressing
DPR	- Detailed Project Report
EIA	- Environmental Impact Assessment
EIRR	- Economic Internal Rates of Return
EMMP	- Environmental Mitigation and Monitoring Plan
F/S	- Feasibility Study
GDP	- Gross Domestic Product
GOI	- Government of India
GOJ	- Government of Japan
GS	- General Staff roads
GQ	- Golden Quadrilateral
HDM4	- Highway Development & Management 4
IEE	- Initial Environmental Examination
INR	- Indian Rupee
IRC	- Indian Road Congress
IRI	- International Roughness Index
IWAI	- Inland Waterway Authority of India
IWT	- Inland Water transport
JICA	- Japan International Cooperation Agency
LCV	- Light Commercial Vehicle
MDONER	- Ministry of Development of North Eastern Region
MEA	- Ministry of External Affairs of India
MOEF	- Ministry of Environment and Forests
MORTH	- Ministry of Road Transport and Highways
NE	- North East
NEC	- North Eastern Council
NER	- North Eastern Region
NH	- National Highway
NHAI	- National Highway Authority of India
NHDP	- National Highway Development Plan (NHDP)
NHIDCL	- National Highways and Infrastructure Development Corporation
NPV	- Net Present Values
NSDP	- Net State Domestic Product
O-D	- Origin Destination
PCI	- Per Capita Income
PCU	- Passenger Car Units
PHF	- Peak Hour Factor
PM	- Penetration Macadam
PWD	- Public Works Department
RO	- Regional Offices
ROW	- Right of Way

RSI	- Roadside Origin-Destination Survey
SARDP-NE	- Special Accelerated Road Development Programme for North-East
SB	- Single Bituminous Surface Dressing
SEZ	- Special Economic Zone
SH	- State Highway
SR	- State Road
Strtg	- Strategic roads
SVF	- Seasonality Variation Factors
UN ESCAP	- United Nation Economic and Social Commission for Asia and the Pacific
TOR	- Terms of Reference
V/C	- Vehicle Capacity Ratio
VOC	- Vehicle Operating Cost
VOT	- Value of Time
WB	- World Bank

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

The remarkable economic growth of India located in South Asia is known to the world widely today. Well progress of development of infrastructures in transport sector with strengthening the connection between major cities makes this economic growth. Especially, road is one of most important mode to deal with most of the domestic transportation activities along with mode of railway, because road transportation constitute 85% of passenger and 60% of freight each. However, in mountainous areas, strengthening of traffic infrastructures has not processed smoothly due to financial and technical issues, while the reinforcement of the main highways in the plain area has been processed with acceleration of economic growth of India.

Particularly, only 28.5% (63.4% is average in whole country) of the road in North-East state is paved road and only 53% of national highway has more than 2-lane road. This is because the North-East state is located far from mainland of India as well as access road to reach the border of neighbor countries is undeveloped, Government of India (hereinafter referred to as "GOI") does not approve the agreement to make transportation with neighboring countries available except particular countries to avoid security risk. Furthermore, the area of North-East state has severe natural conditions such as steep mountainous geography (most of the state is located in hilly area) and high rainfall area (more than 10,000mm rainfall per year was recorded in Mizoram especially). Therefore, it is key issue how we prevent or reduce the road closer caused by natural disaster to achieve the economic growth in this state.

GOI raises "Special Accelerated Road Development Programme for North-East" committed in "Twelfth Five Years Plan (from April, 2012 to March, 2017)" to cope with above mentioned problems by improvement of national highways connected between major cities within the North-East state.

Based on such a background, GOI requested Government of Japan (hereinafter referred to as "GOJ") to provide loan assistance in carrying out the improvement of existing roads in eight sections, repairing of two existing bridges and construction of one new bridge within six states of North-East state in India.

1.2 Objectives of the Study

The major objectives of this Study are:

- To analyze present conditions and prioritization of target road under the study;
- To analyze the existing data/reports and review of existing Detailed Project Report (hereinafter referred to as "DPR"); and
- To examine procurement and construction method, implementation schedule, project organization, capability of operation and maintenance, social and environmental conditions and evaluate project cost and feasibility of target sections;

1.3 Study Roads and Contents of Request

Study area of this project is following eleven (11) roads located in six (6) states of North-East state (including state of Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura)

Table 1.1.1 Study Roads & Contents of Request

No.	Target Roads	Target Length	Request Type
①	Mizoram State, Aizawl－Tuipang Section, NH54	381km (Approx.)	Improvement
②	Meghalaya State, Dudhanal－Dalu Section, NH62	183km (Approx.)	Improvement
③	Meghalaya State, Tura－Dalu Section, NH51	54km (Approx.)	Improvement
④	Meghalaya State, Shillong－Dawki Section, NH40	84km (Approx.)	Improvement
⑤	Manipur State, Imphal－Jiribam Section, NH53	221km (Approx.)	Improvement
⑥	Manipur State, Imphal - Nagaland State, Kohima Section, NH39	138km (Approx.)	Improvement
⑦	Manipur State, Ukhrul－Tadubi Section, NH102A	115km (Approx.)	Improvement
⑧	Tripura State, Manu - Simlung Section NH44	110km (Approx.)	New / Improvement
⑨	Assam State, Badarpurghat Bridge near Silchar	360m	Improvement
⑩	Assam State, Koliabhomora Bridge near Tezpur	2.5km	Improvement
⑪	Assam State, Dhubri－Phulbari Section	Bridge: 18km (Approx.) Access Road: 21km (Approx.)	New Bridge

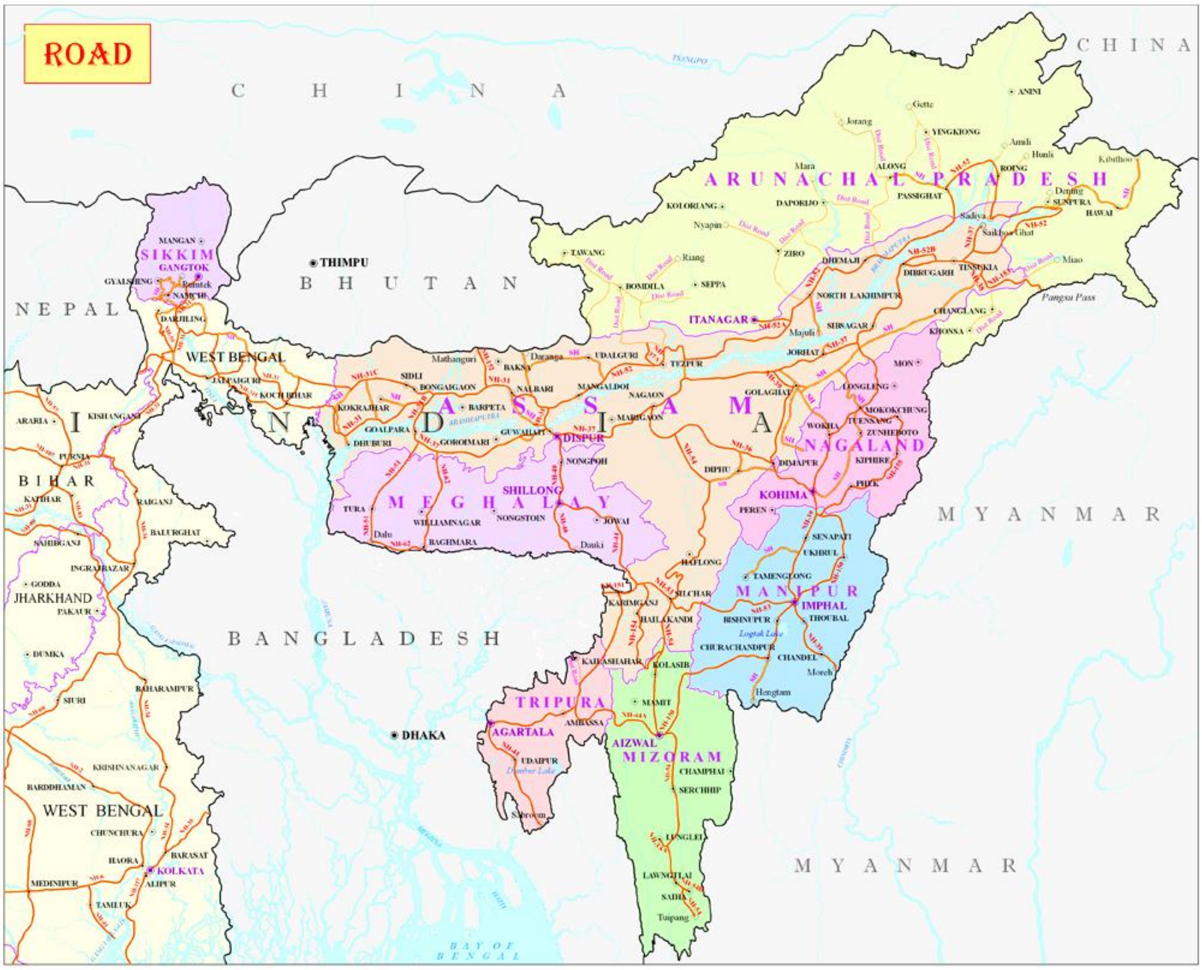
Source: JICA Study Team

CHAPTER 2 PRESENT CONDITION OF THE STUDY AREA

2.1 Present Status of Highway Network in the Study Area and Neighboring Countries

2.1.1 Highway Network in North-Eastern States

Highway network in subjected six states to the study consists of approximately 391,000km highways and the highways are classified into national highway, state highway, and other highway administrated by state Public Works Department (hereinafter referred to as “PWD”). Total length of national highway network in the study area is 9,770km as shown in Table 2.1.1 and the network mainly connects between state capitals and major districts, as well as international cross border network as shown in Figure 2.1.1.



Source: Ministry of Development of North Eastern Region

Figure 2.1.1 National Highway Network in North Eastern Region

Table 2.1.1 Numbers and Lengths of National Highways in North Eastern States

States	National Highway Nos	Total Length (Km)
Assam	31, 31B, 31C, 36, 37, 37A, 37E, 38, 39, 44, 51, 52, 52A, 52B, 53, 54, 61, 62, 117A, 127B, 127C, 127D, 127E, 151,152, 153, 154, 315A, 329, 427, 627, 702, 702C, 715A	3,783
Manipur	39, 53, 102A, 102B, 102C, 129A, 137, 137A, 150, 155, 702A	1,745
Meghalaya	40, 44, 51, 62, 127B	1,204
Mizoram	6, 44A, 54, 54A, 54B, 102B, 150, 154, 302, 306A, 502A	1,381
Nagaland	36, 39, 61, 129A, 150, 155, 702, 702A, 702B	1,080
Tripura	44, 44A, 108A, 208	577
Total		9,770

Source: Ministry of Road Transport and Highway

Table 2.1.2 Routes and Lengths of National Highways in North Eastern States

NH No.	Route	Length (Km)
	Assam	
31	W.B. Border - Gouripur - North Salmara - Bijni - Nalbari - Rangia - Charali Amingaon (NH-37)	307.75
31B	North Salmara - Abhayapuri - Jogighopa (NH-37)	19.66
31C	W.B. Border - Kochugaon - Sidli - Bijni (NH-31)	93.00
36	Nagaon - Dabaka - Amlakhi - Nagaland Border	154.20
37	Goalpara (NH-31B) - Paikan - Boko - Guwahati - Dispur - Sonapur - Raha - Nagaon - Bokaghat - Numaligarh - Jorhat - Jhanzi - Sibdagar - Morahat - Dibrugarh - Tinsukia - Makum - Saikhoghat -Arunachal Pradesh Border	685.33
37A	Kuwari Tal (NH-37) – Tezpur (NH.-52)	23.10
38	Makum - Ledo - Likhapani	56.35
39	Numaligarh - Garampani - Naojan - Bokajan - Nagaland Border	106.78
44	Meghalaya Border - Badarpur - Karimganj - Patharkandi - Tripura Border	110.77
51	Paikan - Meghalaya Border	21.87
52	Baihata Charali - Mangaldai - Dhekiajuli - Tezpur - Gohpur-Bander Dewa - North Lakhimpur - Dhemaji - Kulajan - Arunachal Pradesh Border	540.76
	Arunachal Pradesh border - near Saikhoaghat (NH-31)	
52A	Gohpur - Arunachal Pradesh Border	9.23
	Arunachal Pradesh border - Bander Dewa	
52B	Kulajan - Dibrugarh - Arunachal Pradesh border	79.32
53	Badarpur (NH-44) - Silchar - Lakhipur - Manipur Border.	73.55
54	Dabaka - Lumding - Langting - Haflong - Silchar - Dwarband - Mizoram Border	321.37
61	Jhanzi - Amguri - Nagaland border	17.51
62	Damara - Meghalaya Border	8.60
151	Karimganj - Bangaladesh Border	14.06
152	Patacharkuchi - Hajua - Bhutan Border	38.00
153	Ledo - Likhapani - Arunachal Pradesh Border	23.70
154	Dhaleshwar (Badarpur) - Bhairabhi - Mizoram Border	88.23
315A (New)	Arunachal Pradesh Border - Nahorkatia - Tinsukia (NH-37)	64.22
127B (New)	Srimrampur – Dhuburi - Meghalaya border	74.00
127C New	Shyamthai - Hithijhar State PWD road statarting from NH- 27 in Chirang District, Assam and meeting at Galegphu in Bhutan.	40.00
127D New	Rangiya - Darrangamela State PWD road starting from NH- 27 in the district of Kamrup, Assam and meeting at Samdrupjunjkhar in Bhutan.	48.60
627 New	Nelle (Amsoi Gate)-NH-27 connecting Rajagaon, Doyangmukh, Umrangso, Khobak and terminating at NH-27 near Harangajao in the State of Assam	244.00
427 New	Howli on NH-27- Barpeta- Hajo- Jalukbari on NH 27	108.00
329 New	NH-29 near Manja connecting Diphu and terminating at its junction with new NH No. 27 near Lumding	54.60
117A	NH-17 near Bilasipara connecting Kokrajhar and terminating at its junction with New NH-27 near Garubhasa in the State of Assam	47.00
715A	NH-27 near Nakhola connecting Jagiroad, Marigaon, Kaupati, Rowta, Udalguri, Khoirabari and terminating at Indo/Bhutan border in the State of Assam	125.00
127E	NH-27 near Barama connecting Baska, Subankhata and terminating at Indo/Bhutan border in the State of Assam	65.00
702 New	Sonari -new NH No. 215 near Sapekhati in the State of Assam.	32.00
702C New	Sibasagar on NH-2 connecting Simalguri and terminating at its junction with new NH No. 702 at Sonari.	48.00
	Sub Total	3743.55
52B	Under Railway Dept.	13.65
37E	NH length taken up by MORTH on BOT	25.81
	Total Km in ASSAM	3783.01
	Manipur	

39	Nagaland Border - Maosongsang - Maram - Karong - Kangpokpi - Imphal - Thoubal - Wangling - Palel - Sibong - Moreh - Indo/Myanmar Border.	242.595
53	Assam Border - Oinamlong - Nungba - Imphal	221.14
150	Mizoram border - Parbung - Thanlon - Phaiphengmum - Churachandpur - Moirang - Bishnupur - Imphal - Humpum - Ukhrul - Kuiri - Nagaland Border	532
155	Jassami - Nagaland border	5
102A (New)	From Tadubi on N.H 2 connecting Paomata, Ukhrul, Finchcorner, Phungyar Kasom Khullen, Kampang and terminating at its junction with NH-102 near Thengnoupal	321
102B (New)	The highway starting from Churachandpur on N.H-2 connecting Singhat, Sinzawl, Tuivai Road and terminating at Mayanmar Road in the state of Manipur.	183
137	The highway starting from Rengpang on N.H-37, Khongsang and terminating at Tamenglong (Tenglong) in the state of Manipur.	65
129A New	Maram (NH-2) - Nagaland Border	108
702A New	Nagaland Border- Jessam (new NH No. 29)	2
102C New	Palel (new NH No. 102)- Chandel	20
137A New	From Khumbong (near new NH No. 37) connecting Nambol, Mayang, Imphal and terminating at its junction with new NH No. 102 near Kakching Lamkhai in the State of Manipur.	46
	Sub Total	1745.735
Meghalaya		
40	Assam border - Barni Hat - Nongpoh - Umsning - Barapani - Shillong - Indo/Bangladesh border - Dawki - Jowai	217.061
40 & 44	Bypass	48.76
44	Nongstoin - Shillong - Mawlyngkneng - Assam Border	255.725
51	Assam border - Bajengdoda - Rongram - Tura - Kherapara - Dalu	126.412
62	Damra - Dambu - Baghmara - Dalu	195.4
127B (New)	Assam border – Phulbari - Tura - Rongram - Ronjeng - Nongston.	361
	Sub Total	1204.358
Mizoram		
44A	Tripura Border - Tukkalh - Mamit - Sairang - Aizawl	130
54	Assam Border - Chhimlung - Kolasib - Bualpui - Mualvum - Alzawl - Zobawk - Serchhip - Pangzawl- Leite - Zobawk - Sairep - Saiha - Kaladan - Tuipang	522
54A	Lunglei - Theriat	9
54B	Venus Saddle - Saiha	27
150	Manipur Border - Thingsa - Ratn - Darlawn - Phaileng - Seling - Aizawl	140
154	Assam Border - Kanpui (NH 54)	58
502A (New)	Lawngtlai - Mayanmar Border (Kaladan road)	100
302 New	Theriat- Lunglei- Lungseni- Tuiehong - Demagiri	100
6 New	Kanpui- Aizawal- Selling- Lumtui- Khawthlir- Tuisen- Neihdawn - Champai	95
102B (New)	Nagopa, Hliappui, Saichal and terminating at new NH No- 6 near Keifang	140
306A New	Vairengte connecting Saiphai, Zonmun and terminating at its junction with NH-2 near New Vertek	60
	Sub Total	1381
Nagaland		
36	Assam Border - Dimapur	7.29
39	Dimapur - Cichuguard - Kohima - Viswema - Manipur border	107.3
61	Kohima - Tseminyu - Wokha - Mokokchung - Chantongia - MerangKong - Assam Border	240
150	Kohima - Chizami - Manipur Border	116
155	Mokokchung - Tuensang - Sampurre - Meluri - Manipur Border	326.5
129A New	Peren- Jaluki- Pimla Junction- Razaphe Junction- Dimapur	63

702 New	Chantongia - Longling- Lonhching- Mon- Lapa- Tizit - Assam Border	98
702A New	Mokokchung - Zunheboto- Phek - Manipur Border	88
702B New	Longling on new NH No.702 in Assam and terminating at its junction with new NH No. 202 at Tuensang in Nagaland.	34.00
	Sub Total	1080.09
	Tripura	
44	Assam Border - Churai Bari - Manu - Ambasa - Agaratala - Visalgarh - Barjala - Udaipur - Sabrum.	335
44A	Mizoram Border - Sakhan - Manu	133
108A New	Jolaibari (new NH No. 8) - Belonia- Indo/Bangladesh border	15
208 New	Kumarghat - Kailashahar- Khowai -Teliamura	94
	Sub Total	577

Source: Ministry of Road Transport and Highway

Indicator of national highways in the study area shows higher rate comparing with the rate of all India in terms of “Length of NH in km/1000km2” and “Length of NH in km/lakh population” as shown in Table 2.1.3. However, lane-wise length of national highways in the study area clearly shows disparity between the study area and all India as shown in Table 2.1.4 and Figure 2.1.2.

Table 2.1.3 National Highways Indicator in North Eastern States

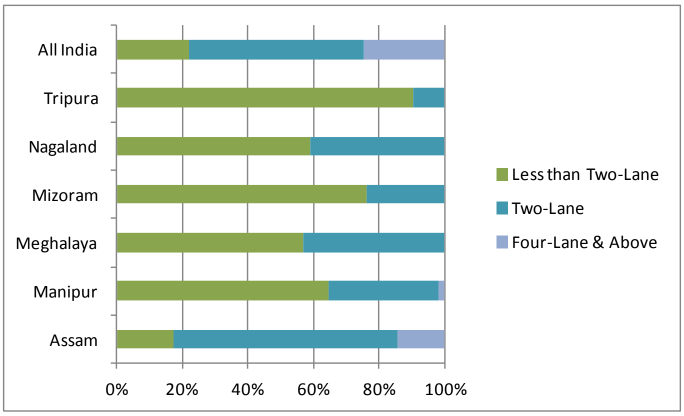
State	Total NH length (Km)	Area (1000 km2)	Length of NH in km/1000 km2	Population in Lakhs as per 2011 census	Length of NH in km/ lakh population
Assam	3,783.23	78.438	48.2	311.69	12.1
Manipur	1,745.74	22.327	78.2	27.22	64.1
Meghalaya	1,204.36	22.429	53.7	29.64	40.6
Mizoram	1,381	21.081	65.5	10.91	126.6
Nagaland	1,080.09	16.579	65.1	19.81	54.5
Tripura	577	10.486	55	36.71	15.7
All India	96,260.72	3,292.564	29.2	12,086.69	8

Source: Ministry of Road Transport and Highway

Table 2.1.4 Lane-wise Length of National Highways in North Eastern States as on 31st March 2012

States	Total Length (km)	Less than Two-Lane		Two-Lane		Four-Lane & Above	
		(km)	%	(km)	%	(km)	%
Assam	2,940	505	17	2,007	68	428	15
Manipur	1,317	850	65	444	34	23	2
Meghalaya	1,171	665	57	506	43	0	0
Mizoram	1,027	784	76	243	24	0	0
Nagaland	494	291	59	203	41	0	0
Tripura	400	362	91	38	10	0	0
All India	76,818	16,998	22	40,720	53	19,100	25

Source: Ministry of Road Transport and Highway



Source: Ministry of Development of North Eastern Region

Figure 2.1.2 Share of Lane-wise Length of National Highways in North Eastern States as on 31st March 2012

Table 2.1.5 shows road network indicator of whole road network in the study area. Surfaced road ratios of Assam, Manipur, Nagaland, and Tripura are lower than all India.

Table 2.1.5 Road Network Indicator in North Eastern States as on 31st March 2012

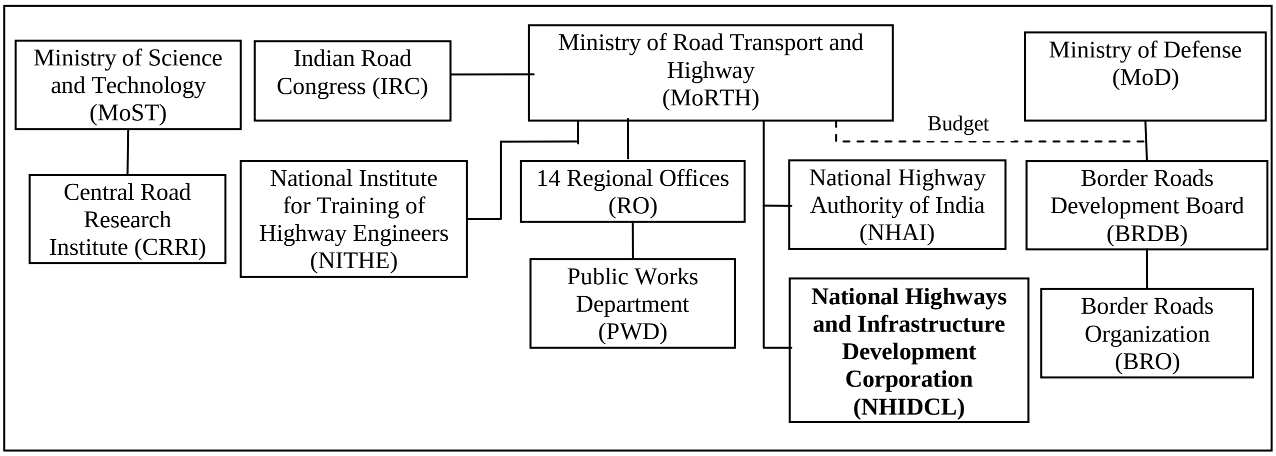
States	Total Road Length (km)	Surfaced Road (%)	Road Density (per 1000 sq. km)	Road Density (per 1000 population)
Assam	284,232	18.83	3,623.65	9.19
Manipur	19,252	54.32	862.27	7.77
Meghalaya	12,103	65.45	539.61	4.57
Mizoram	11,293	71.72	535.70	11.12
Nagaland	35,189	47.84	2,122.50	15.47
Tripura	29,248	49.74	2,789.24	8
All India	3,965,394	63.43	1,206.29	3.28

Source: Ministry of Road Transport and Highway

2.2 National and Regional Highway Development Plans

2.2.1 Organizations related to National Highway Development

National Highways development has been promoted by National Highway Authority of India (hereinafter referred to as "NHAI") and Regional Offices (hereinafter referred to as "RO") under Ministry of Road Transport and Highway (hereinafter referred to as "MORTH"), and Border Roads Organization (hereinafter referred to as "BRO") under Border Roads Development Board (hereinafter referred to as "BRDB"). National Highways and Infrastructure Development Corporation (hereinafter referred to as "NHIDCL") was established for promoting development of National Highways in North East and border area of India, and started operation from 1st January 2015. Figure 2.2.1 shows overall structure of organizations related to national highways development.



Source: Ministry of Road Transport and Highway (JICA Study Team modified)

Figure 2.2.1 Overall Structure of Organizations related to National Highway Development

NHAI was set up by the National Highways Authority of India Act of 1988. It is the main nodal agency for developing, managing and maintaining India's network of National Highways. It became an autonomous body in 1995. The NHAI maintains 70,934 Km of National Highways and Expressways across India.

NHIDCL started operation from 1st January 2015 and development of the target roads of this study is being promoted under NHIDCL. Vision, Mission, Description of NHIDCL, and organization structure of NHIDCL are shown below and Figure 2.2.2:

Vision

To be an instrument for creation and management of infrastructure of the highest standard in the country with focus on the North East and Border areas and contribute significantly towards nation building.

Mission

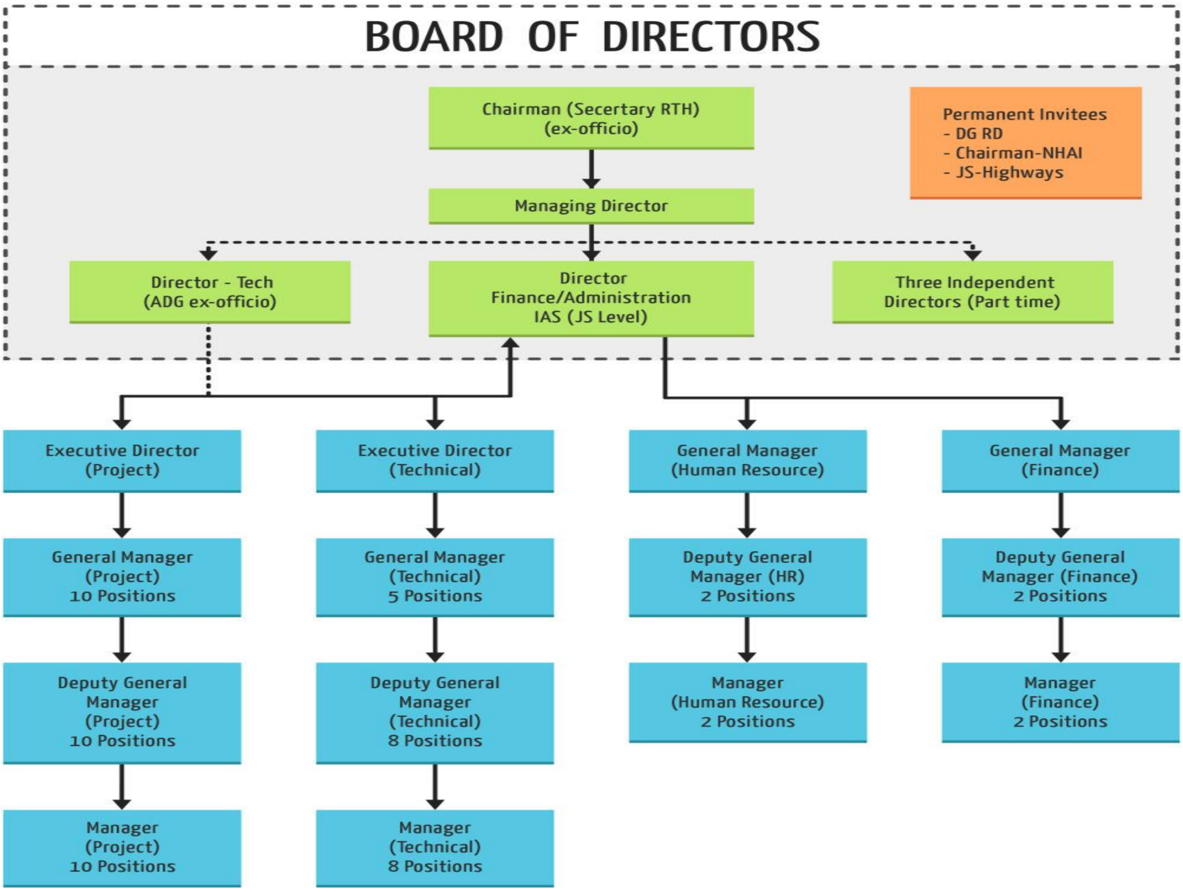
To be a professional company which works in most efficient and transparent manner and designs, develops & delivers infrastructure projects in a time bound basis for maximizing benefits to all stakeholders.

Description of NHIDCL

National Highways and Infrastructure Development Corporation (hereinafter referred to as "NHIDCL") is a fully owned company of the Ministry of Road Transport & Highways, Government of India. The company promotes, surveys, establishes, designs, builds, operates, maintains and upgrades National Highways and Strategic Roads including interconnecting roads in parts of the country which share international boundaries with neighboring countries. The regional connectivity so enhanced would promote cross border trade and commerce and help safeguard India's international borders. This would lead to the formation of a more integrated and economically consolidated South and South East Asia. In addition, there would be overall economic benefits for the local population and help integrate the peripheral areas with the mainstream in a more robust manner. An approximate aggregate length of 10,000 kms has been identified to begin with for development through this company. The company envisages creating customized and specialized skills in terms of addressing issues like complexities of geographical terrains and addressing extensive coordination requirements with security agencies. The company would also endeavor to undertake infrastructure projects including but not restricted to urban infrastructure and urban or city transport and to act as an agency for development of all types of Infrastructure. The company envisages working towards cross sharing of technical know-how and enhancing opportunities for business development with other nations and their agencies including the multilateral organizations and institutions.

The company also proposes to improve road connectivity and efficiency of the international trade corridor, by expanding about 500 KMs of roads in the North Bengal and Northeastern region of India to enable efficient and safe transport regionally with other South Asia Sub-regional economic Cooperation (SASEC) member countries. These projects are being funded by ADB (Asian Development Bank).

Source: NHIDCL Home Page (http://www.nhidcl.com/)



Source: NHIDCL Home Page (http://www.nhidcl.com/)

Figure 2.2.2 Organization Structure of NHIDCL

2.2.2 National Highway Development Plan (NHDP)

The National Highways Development Project (hereinafter referred to as ‘NHDP) is a program to be executed in several phases to improve the road network in India. The program is overseen by NHAI. It has involved the widening of roads and building of new links between all of India’s major cities.

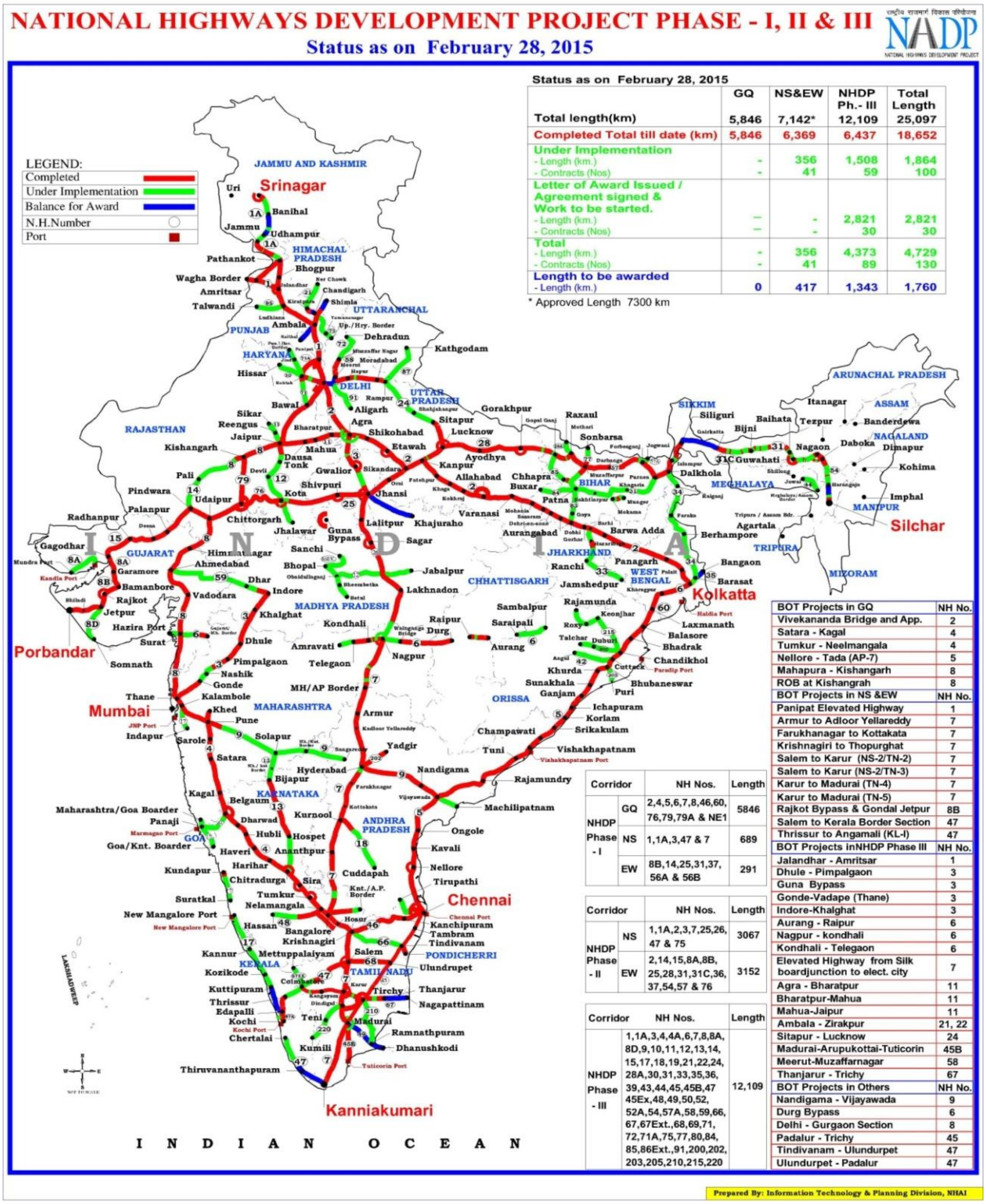
The first phase established the Golden Quadrilateral network, which linked India’s 4 major cities of Delhi, Mumbai, Kolkata and Chennai by 4-lane Highways. The second phase focused on the North-South and East-West corridors while subsequent phases have seen the widening of 4-lane roads to 6-lane.

In the study area, there is one section of East-West corridors from Srirampur in Assam to Silchar in Assam which is 670km stretch in total as part of Phase II (4 laning). Completed section of the section is approximately 71% as of 2012 and target date of completion is December 2014. There is one section of Phase III road in Meghalaya and the section is NH44 from Jowai in Meghalaya to Ratachhera in Meghalaya of 102km stretch in total (2 laining). Status of NHDP as on 31st January 2015 is shown in Table 2.2.1 and Figure 2.2.3 shows about implementation status as on 28 February 2015. There are incomplete sections on Phase II and Phase III sections in the study area according to Figure 2.2.3.

Table 2.2.1 Status of NHDP as on 31st January 2015

		Total Length (Km.)	Already 4/6Laned (Km.)	Under Implementation (Km.)	Contracts Under Implementation (No.)	Balance length for award (Km.)
NHDP	GQ	5,846	5,846 -100.00%	0	0	-
	NS - EW Ph. I & II	7,142	6,360	365	42	417
	Port Connectivity	380	379	1	1	0
	NHDP Phase III	12,109	6,393	4,373	89	1,343
	NHDP Phase IV	14,799	942	5,904	55	7,953
	NHDP Phase V	6,500	2,001	2,080	27	2,419
	NHDP Phase VI	1,000	-	-	-	1,000
	NHDP Phase VII	700	22	19	1	659
	NHDP Total	48,476	21,943	12,742	215	13,791
Others (Ph.-I, Ph.-II & Misc.)		1754	1428	326	10	-
SARDP -NE		388	99	12	1	277
Total by NHAI		50,618	23,470	13,080	226	14,068
*Total 20,000 Km. was approved under NHDP Phase IV.Out of which 14,799 Km. as assigned to NHAI remaining Km. with MORTH.						

Source: NHAI Web Site



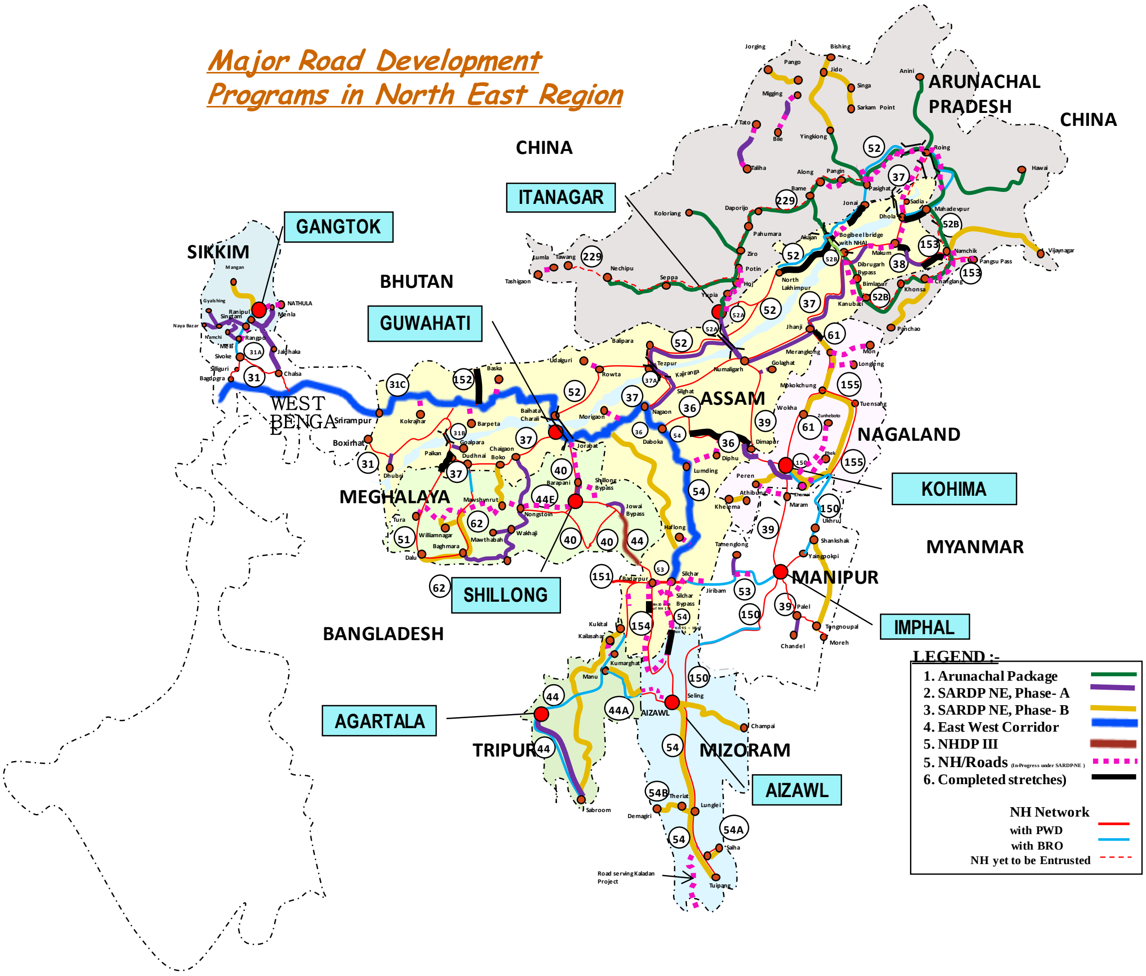
Source: National Highways Authority of India

Figure 2.2.3 Status of NHDP as on 28 February 2015

2.2.3 Special Accelerated Road Development Programme for North-East (SARDP-NE)

The Special Accelerated Road Development Programme for North-East (hereinafter referred to as SARDP-NE) was initiated by MORTH in 2005 with following objectives:

- Upgrade National Highways to 2/ 4 lane;
- To provide connectivity of all 88 District Headquarter by 2-lane road;
- connectivity to backward and remote areas of NE region;
- Improve roads of strategic importance;
- Improve connectivity to neighboring countries



Source: Ministry of Development of North Eastern Region

Figure 2.2.4 Major Road Development Programs in North East Region

Program of SARDP-NE is composed of Phase A, Phase B, and Arunnachal Pradesh Package. In Phase A, major objective is improvement of road network connecting between national arterial roads and districts in North Eastern state and priority of implementation is given to road project under Phase A. Road project under Phase B is intended to reinforce connectivity among districts in North Eastern states. Table 2.2.2 and Table 2.2.3 show detail of SARDP-NE, and related SARDP-NE projects with the study roads are shown in table 2.2.4.

Table 2.2.2 Length and Budget of SARDP-NE

Packages		Total Length (km)	Budget (INR Crore)	Budget per km (INR Crore)
Phase A	Approved for execution	3,213	12,821	4.0
	Approved In-Principle	886	8,948	10.0
	Total	4,099	21,767	5.3
Arunnachal Pradesh Package		2,319	11,919	5.14
Phase B		3,723	64 (for DPR only)	-
Total		10,141	33,752	-
*NH 4,798km (47%), SR 5,343km (53%)				

Source: Ministry of Development of North Eastern Region

Table 2.2.3 State-wise Status of SARDP-NE (2013)

STATE	SARDP-NE Phase 'A' (Km)			Arunachal Pradesh Package of Roads and Highways (Km)			SARDP-NE Phase 'B' (Km)			Grand Total (Km)		
	NHs	SR/GS	Total	NH	SR/GS/ Strtg	Total	NH	SR/GS/ Strtg	Total	NH	SR/GS/ Strtg	Total
Assam	1179	177	1356	126	12	138	0	285	285	1305	474	1779
Manipur	39	166	205	0	0	0	0	202	202	39	368	407
Meghalaya	259	526	785	0	0	0	161	201	362	420	727	1147
Mizoram	221	100	321	0	0	0	416	272	688	637	372	1009
Nagaland	81	350	431	0	0	0	622	169	791	703	519	1222
Tripura	130	22	152	0	0	0	86	310	396	216	332	548

Note: SR: State Road; GS: General Staff roads & Strtg: Strategic roads
Source: Ministry of Development of North Eastern Region

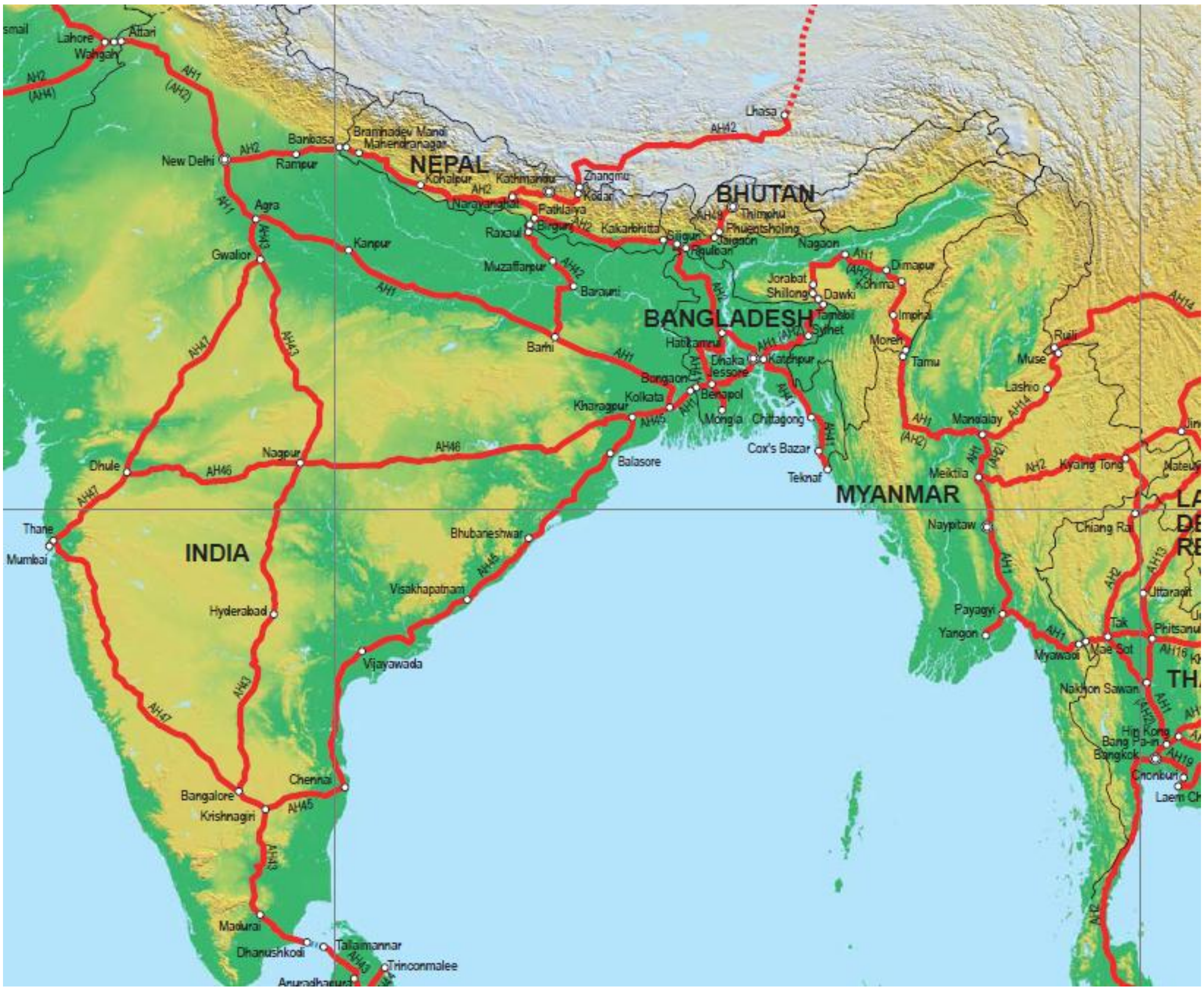
Table 2.2.4 Related SARDP-NE Project with the Study Roads

<table>
<tr><th>State & Package No.</th><th>Scope of work</th><th>Category of road & Implementing Agency</th><th>Length (Km)</th></tr>
<tr><td colspan="4">Phase A</td></tr>
<tr><td>Meghalaya</td><td>Construction of new Shillong By-pass connecting NH-40 & NH-44 (2-lane)</td><td>NH – 40 / BOT(Annuity)</td><td>50</td></tr>
<tr><td>Nagaland</td><td>Four laning of Dimapur to Kohima Road including Dimapur/Kohima Bypass on NH-39</td><td>NH - 39/ BOT(Annuity)</td><td>81</td></tr>
<tr><td rowspan="2">Manipur,</td><td>Widening to double lane and strengthening of NH-53 from km 147.000 to 166.000 (Jiribam-Barak Section) in Manipur, formation width of 12 m corresponding to 2-lane NH in hilly terrain under Phase ‘A’ of SARDP-NE</td><td>NH – 53 / BRO</td><td>19</td></tr>
<tr><td>Strengthening and widening of existing road from km.166.00 to 186.475 (Jiribam - Barak section)</td><td>NH – 53 / BRO</td><td>20.48</td></tr>
<tr><td>Meghalaya</td><td>Improvement of existing 2 lane Barapani - Shillong section of NH-40 and flyovers in Shillong city</td><td>NH – 40 / Meghalaya PWD</td><td>5
4</td></tr>
<tr><td colspan="4">Phase B</td></tr>
<tr><td>Meghalaya</td><td>2 laning from Assam/Meghalaya border to Dalu via Baghmara</td><td>NH- 62</td><td>161</td></tr>
<tr><td>Mizoram</td><td>2 laning from Aizawl to Tuipang section</td><td>NH- 54</td><td>380</td></tr>
<tr><td>Tripura</td><td>2 laning/ realignment from Manu to Tripura/Mizoram Border.</td><td>NH-44A</td><td>86</td></tr>
</table>

Source: Ministry of Development of North Eastern Region

2.2.4 Asian Highway

The Asian Highway network covers 32 countries in Asia and total length is approximately 142,000km. Main objectives of the Asian Highway network are contribution to interregional and international socio economic development and promotion of trade and tourism through networking between Asia and Europe. The Asian Highway network connects North Eastern states and neighboring country of Myanmar, Bangladesh, and Bhutan as shown in Figure 2.2.5.



Source: UN ESCAP

Figure 2.2.5 Asian Highway Network

The Asian Highway network is classified into four road categories and design standards is proposed as shown in Table 2.2.5.

Table 2.2.5 Classification and Design Standards of Asian Highway

Highway classification		Primary (4 or more lanes)				Class I (4 or more lanes)			
Terrain classification		L	R	M	S	L	R	M	S
Design speed (km/h)		120	100	80	60	100	80	50	
Width (m)	Right of way	(50)				(40)			
	Lane	3.50				3.50			
	Shoulder	3.00		2.50		3.00		2.50	
	Median strip	4.00		3.00		3.00		2.50	
Min. radii of horizontal curve (m)		520	350	210	115	350	210	80	
Pavement slope (%)		2				2			
Shoulder slope (%)		3 – 6				3 – 6			
Type of pavement		Asphalt/cement concrete				Asphalt/cement concrete			
Max. superelevation (%)		10				10			
Max. vertical grade (%)		4	5	6	7	4	5	6	7
Structure loading (minimum)		HS20-44				HS20-44			

Highway classification		Class II (2 lanes)				Class III (2 lanes)			
Terrain classification		L	R	M	S	L	R	M	S
Design speed (km/h)		80	60	50	40	60	50	40	30
Width (m)	Right of way	(40)				(30)			
	Lane	3.50				3.00 (3.25)			

Highway classification	Class II (2 lanes)				Class III (2 lanes)			
Shoulder	2.50		2.00		1.5 (2.0)		0.75 (1.5)	
Median strip	N/A		N/A		N/A		N/A	
Min. radii of horizontal curve(m)	210	115	80	50	115	80	50	30
Pavement slope (%)	2				2 - 5			
Shoulder slope (%)	3 – 6				3 - 6			
Type of pavement	Asphalt/cement concrete				Dbl. bituminous treatment			
Max. superelevation (%)	10				10			
Max. vertical grade (%)	4	5	6	7	4	5	6	7
Structure loading (minimum)	HS20-44				HS20-44			

Notes: Figures in parentheses are desirable values.
Minimum radii of horizontal curve should be determined in conjunction with superelevation.
The recommended width of the median can be reduced with the proper type of guard fence.
The Parties should apply their national standards when constructing structures such as bridges, culverts and tunnels along the Asian Highway.

Source: UN ESCAP

Table 2.2.6 to Table 2.2.9 are shown about status of Asian Highway network development in India and surrounding countries. HN40 in Meghalaya state and NH39 in Manipur state are part of Asian Highway route no. 1.

Table 2.2.6 Status of Asian Highway Development in India

AH Route No.	Own Route No./ Road Name	Road Category	AH Design Standard	City/Town Name at Start and end Point	Section Length (km)	Number of Lanes (km)				
					Existing Road	1	2	4	6	8
1	NH39, NH37, NH36, NH40, NH35, NH34, NH2, NH1	National	I, II, III, Below III	Moreh (Border of Myanmar)-Attari (Border of Pakistan)	2,870	80	1,809	936	37	8
2	SH, NH31, NH87, NH74, NH125, NH24	National, State	I, II, III, Below III	Border of Bangladesh (Phulbani)-New Delhi	377	27	290	56	0	4
42	NH28A, NH28, NH31	National	III	Raxaul (Border of Nepal)-Barhi	457	0	457	0	0	0
43	NH3, NH75, NH26, NH7, NH49	National	I, II, III, Below III	Agra-Dhanushkodi	2,433	10	2,115	300	8	0
45	NH5, NH4, NH46	National	I, II, III	Kolkata-Krishnagiri	1,945	0	165	1,780	0	0
46	NH6	National	I, III	Kharagpur-Dhule	1,508	0	1,470	38	0	0
47	NH3, SH, NH4, Expressway	National, State, State Expressway	I, II, III, Primary	Shajapur-Bangalore	2,060	0	1,068	878	114	0
48	NH31	National		Phulbari-Jaigaon (Border of Bhutan)	160	0	0	0	0	0

AH Route No.	Surface Type (km)				Surface Condition (km)			Carriageway Width (km)				
	AC	CC	PM/DB/SB	CG/Ma/Me	Good	Fair	Bad	<=4.5m	4.5-6m	6-7m	7-14m	>=14m
1	1,796	157	917	0	1,839	950	81	33	54	155	2,620	8
2	149	0	226	2	318	57	2	8	38	233	94	4
42	0	0	457	0	0	457	0	0	0	427	30	0
43	389	0	2,044	0	1,086	1,335	12	40	9	1,212	1,034	138
45	454	59	1,432	0	1,847	98	0	0	0	165	1,749	31
46	0	0	1,508	0	1,118	270	120	0	0	1,470	38	0
47	1,525	109	426	0	1,883	62	115	0	0	1,068	878	114
48	0	0	0	0	0	0	0	0	0	0	0	0

Source: UN ESCAP

AH 1 connects between Myanmar and North Eastern State at Moreh in Indian side and Tamu in Myanmar side.

Table 2.2.7 Status of Asian Highway Development in Myanmar

AH Route No.	Own Route No./ Road Name	Road Category	AH Design Standard	City/Town Name at Start and end Point	Section Length (km)	Number of Lanes (km)			
					Existing Road	1	2	4	6
1	Thaton-Paan-Kawkaerik-Myawadi Road, Yangon-Mawlamyne-Dawe-Myeik-Kawthaung Road, Yangon-Toungoo-Mandalay Road,Mandalay-Sagain-Ondaw-Moniwa Road, MoniwAH-Pale-Gangaw Road, Kalemyo-Kyigon-Tamu RoadGangaw-Kan-Kalemyo Road	Union	I, III, Below III	Myawadi (Border of Thailand)-Tamu (Border of India)	1,691	292	1,064	159	53
2	MTKT Road	Union	III, Below III	Tachilek (Border of Thailand)-Meiktila	804	356	351	0	96
3	Kyaing Tong-Mongla Road	Union	III	Mongla (Border of China)-Kyaing Tong	90	0	90	0	0
14	MBLM Road	Union	I, III	Muse (Border of China)-Mandalay	460	15	0	393	68
111	n.a.	Union	III	Thibaw-Loilem	240	240	0	0	0
112	n.a.	Union	Below III	Thaton-Kauthaung	1,059	15	823	224	4
123	n.a.	Union	I	Dawei (Deep Sea Port)	150	0	150	0	0

AH Route No.	Surface Type (km)		Surface Condition (km)			Carriageway Width (km)				
	AC	PM/DB/SD	Good	Fair	Bad	<=4.5m	4.5-6m	6-7m	7-14m	>=14m
1	131	1,435	1,221	292	31	359	151	32	939	80
2	2	802	681	91	30	367	0	325	115	0
3	0	90	90	0	0	0	93	0	0	0
14	0	460	0	460	0	0	0	386	67	0
111	0	240	0	240	0	n.a.	n.a.	n.a.	n.a.	n.a.
112	0	1,059	418	337	304	n.a.	n.a.	n.a.	n.a.	n.a.
123	0	150	0	150	0	n.a.	n.a.	n.a.	n.a.	n.a.

Source: UN ESCAP

AH 1 and AH 2 connect between Bangladesh and North Eastern State. AH1 connect Bangladesh and North Eastern State at Dawki in Indian side and Tamabil in Bangladesh side. AH2 connect Bangladesh and North Eastern State at Phulbari in Indian side and Banglabandha in Bangladesh side.

Table 2.2.8 Status of Asian Highway Development in Bangladesh

AH Route No.	Own Route No./ Road Name	Road Category	AH Design Standard	City/Town Name at Start and end Point	Section Length (km)		Number of Lanes (km)				
					Existing Road	River Ferry	1	2	4	6	8
AH1	N2, N1, N8, N805, N806, Z7503, R750, N706	National, Zila, Regional	II, Below III, III	Tamabil (Border of India)- Benapol (Border of India)	479	5.3	12	445	20	1	0
AH2	N3, N4, N405, N5	Urban Road, National	I, II, III, Below III	Dhaka (South)-Panchagarh	514	0	10	457	6	25	14

AH Route No.	Own Route No./ Road Name	Road Category	AH Design Standard	City/Town Name at Start and end Point	Section Length (km)		Number of Lanes (km)				
					Existing Road	River Ferry	1	2	4	6	8
AH41	N1, N507, N6, N704, N7	National	II	Teknaf- Khulna	744	0	6	705	31	1	0.5

AH Route No.	Surface Type (km)	Surface Condition (km)				Carriageway Width (km)					
	AC	Good	Fair	Bad	Unknown	Unknown	<=4.5m	4.5-6m	6-7m	7-14m	>=14m
AH1	479	262	125	63	28	0	6	21	32	479	0
AH2	514	271	206	38	0	0	11	14	135	514	33
AH41	744	160	341	244	0	0	0	90	249	630	0

Source: UN ESCAP

AH 48 connect between Bhutan and North Eastern State at Jaigaon in Indian side and Phuentsholing in Bhutan side.

Table 2.2.9 Status of Asian Highway Development in Bhutan

AH Route No.	Own Route No./ Road Name	Road Category	AH Design Standard	City/Town Name at Start and end Point	Section Length (km)	Number of Lanes (km)				
					Existing Road	1	2	4	6	8
AH48	2	National Highway	I, II, Below III	Phuentsholing (Border of India)-Thimphu	170	42	121	7	0	0

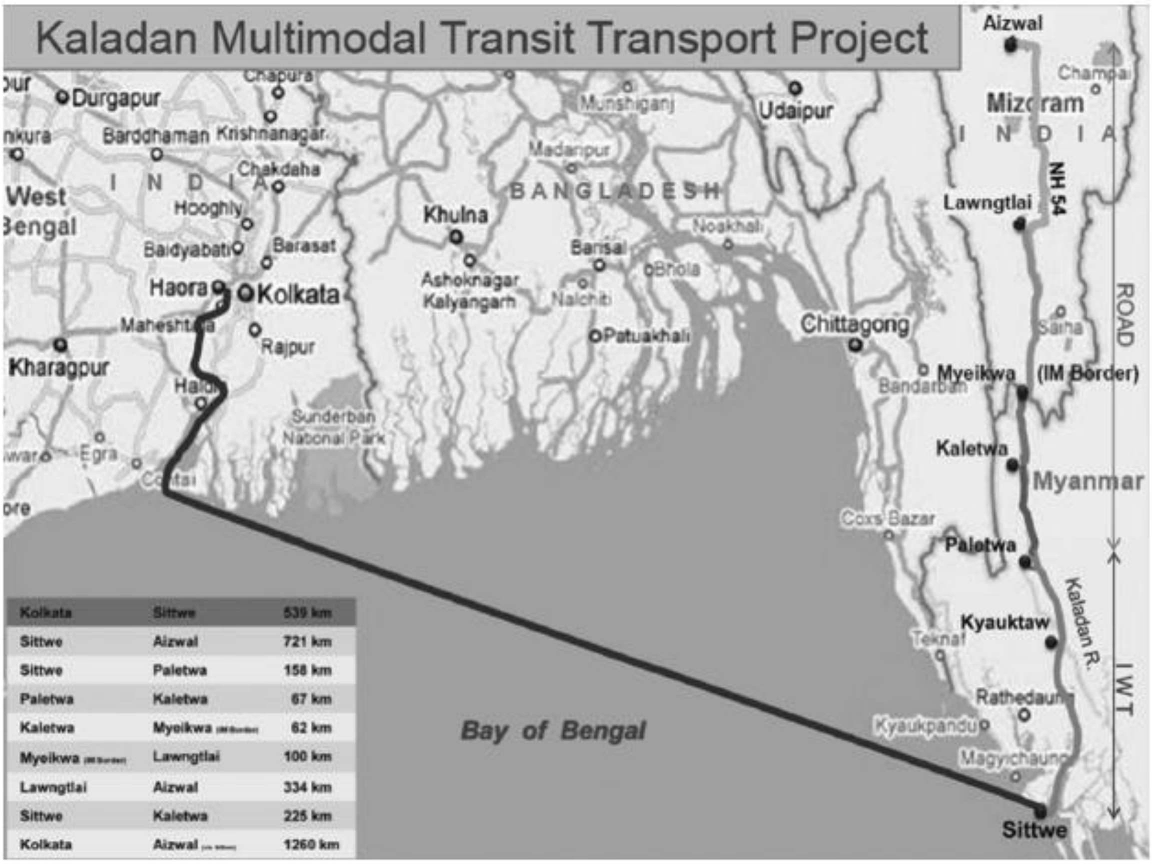
AH Route No.	Surface Type (km)		Surface Condition (km)			Carriageway Width (km)				
	AC	PM/DB/SD	Good	Fair	Bad	<=4.5m	4.5-6m	6-7m	7-14m	>=14m
AH48	128	42	170	0	0	42	0	0	128	0

Source: UN ESCAP

2.2.5 Other Related Projects

(1) Kaladan Multimodal Transport Project

Kaladan Multimodal Transport Project was proposed by the Ministry of External Affairs of India (hereinafter referred to as "MEA") to provide alternative connectivity from Mizoram to Haldia/Kolkata ports through NH54 and Kaladan River in Myanmar. MEA entered into a Framework Agreement with the Govt. of Myanmar in April 2008 to facilitate implementation of the project, and the work on the project has substantially been completed. The transit route envisaged between Kolkata (nearest Indian port / commercial hub) and comprises of segments as shown in Figure 2.2.6.



Source: Twenty Five Year Plan (2012-2017)

Figure 2.2.6 Kaladan Multimodal Transit Transport Project

(2) National Waterway-2: Brahmaputra-Barak Route

National Waterway-2 Brahmaputra was declared in 1988 to connect from Dhubri to Sadia with total distance of 891km as shown in Figure 2.2.7. This all weather water way helps to avoid the congested West Bengal – Sikkim narrow corridor and shorten distance from Tripura, Mizoram and Southern Assam to Bangladesh for cargo transport. *Inland Waterways Authority of India (hereinafter referred to as "IWAI") maintains navigational channel of minimum 45 m width and 2.5 m depth is in National Waterway-2 between Dhubri – Neamati, and terminal facilities for loading and unloading of cargo is being maintained by IWAI at strategic locations like Dhubri, Jogighopa, Pandu, Silghat, Neamati and Dibrugarh. Pandu (Guwahati) is being developed as a multi modal transport hub which can serve the entire N.E Region. A permanent terminal at Dhubri, Assam is under construction with all facilities at an approx cost of Rs. 46.68 Cr. Dhubri is the first important terminal on the Brahmaputra. The existing temporary IWT terminal at Jogighopa is proposed to be upgraded to a bulk cargo handling terminal for products like Meghalaya coal, with rail connectivity up to the terminal. (Source: Inland water Transport (IWT) Master Plan for NE/ Inland Waterways Authority of India (IWAI))*

Source: Inland water Transport (IWT) Master Plan for NE/ Inland Waterways Authority of India (IWAI)

Figure 2.2.7 National Waterway-2 Brahmaputra Project

2.3 On-going and Planned Road Projects related to the Study Roads by International Cooperation

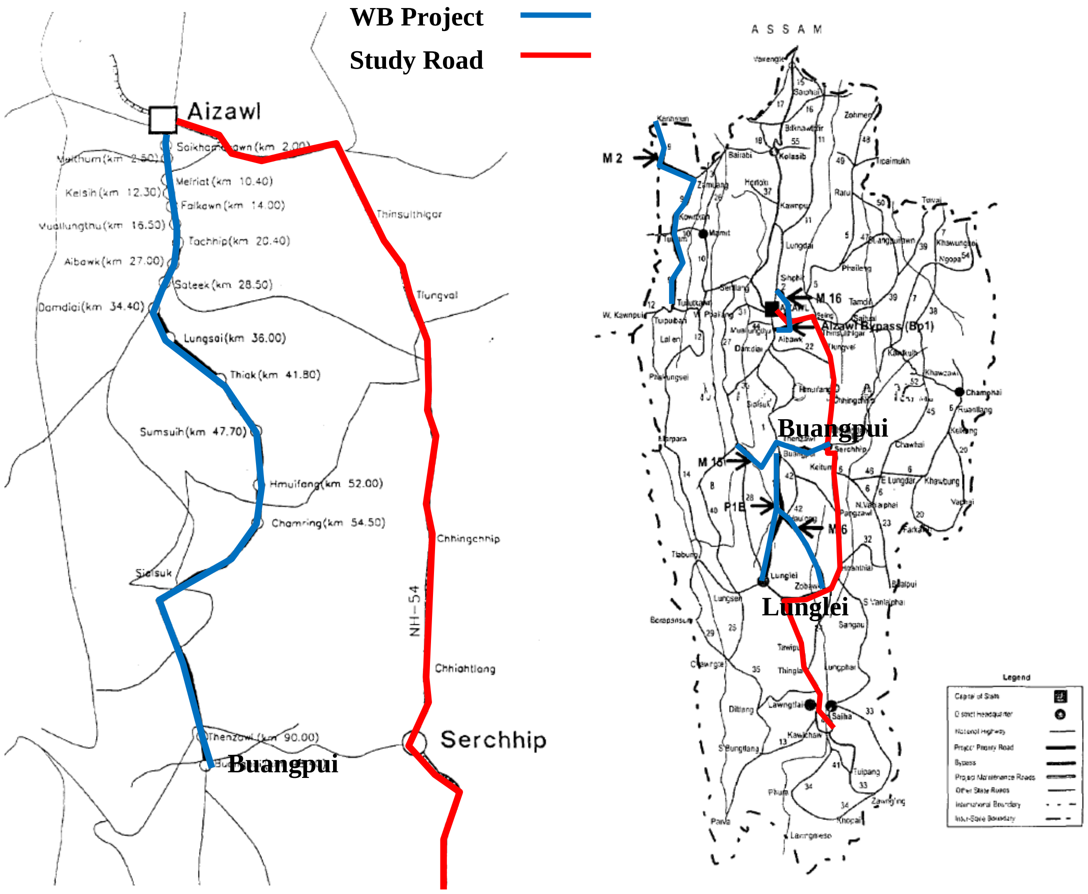
Several road projects related to the study roads has been implemented by finance of international cooperation agencies as shown in Table 2.3.1.

Table 2.3.1 On-going and Planned Road Projects

International Donor	Project Name
World Bank	Assam State Roads Project (SH46)
World Bank	Mizoram State Road Project
Asian Development Bank (LN-2770-IND)	North Eastern State Roads Investment Program- Project-1 (Assam, Meghalaya and Sikkim)
Asian Development Bank	North Eastern State Roads Investment Program- Project-2 (Assam, Manipur, Mizoram and Tripura)
Asian Development Bank (LN-2445-IND)	Rural Roads Sector II Investment Program- Project-3 (Assam and West Bengal)
Asian Development Bank (LN-2535-IND)	Rural Roads Sector II Investment Program- Project-4 (Assam, Orissa and West Bengal)

Source: JICA Study Team

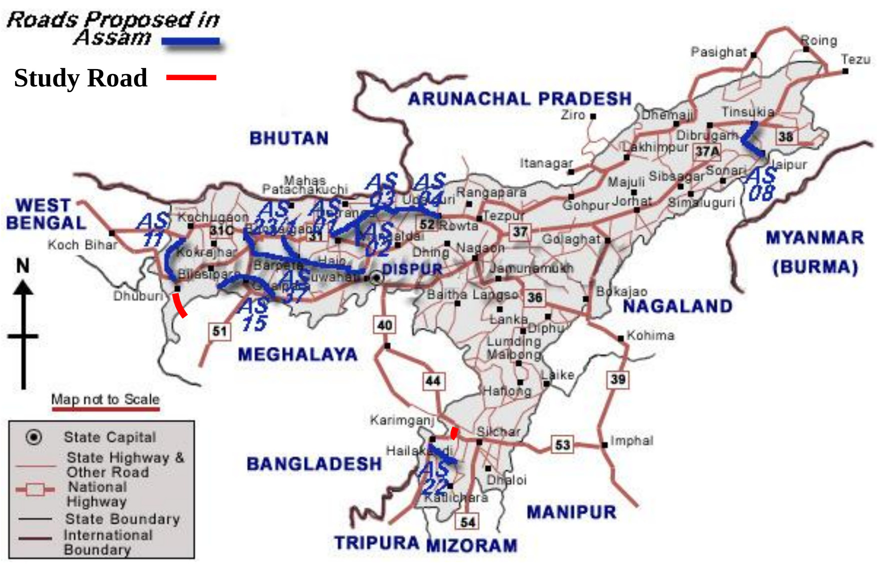
Mizoram State Road Project financed by World Bank (hereinafter referred to as "WB") has been carried out to connect districts along west side of NH54 corridor as shown in Figure 2.3.1. The project roads are connecting to NH54 at Lunglei and state highway design standard is applied to the project roads.



Source: Mizoram State Road Project Phase I & II, EIA Report

Figure 2.3.1 WB-Mizoram Road Infrastructure Development Project (Left: Phase I, Right: Phase II)

North Eastern State Roads Investment Program is a large-scale road development program for North Eastern State financed by Asian Development Bank (hereinafter referred to as "ADB"), and second phase of the program has been contracted with states in North Eastern Region. Figure 2.3.2 shows proposed roads by the program and AS 02, 03, 11, 37 roads are included in the second phase.



Source: North Eastern State Roads Investment Program, EIA Report

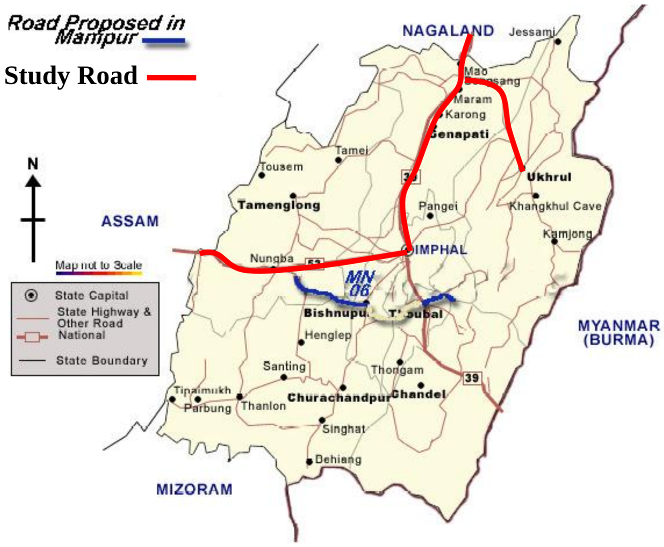
Figure 2.3.2 ADB-North Eastern State Roads Investment Program (Assam) No. 02, 03, 11, 37

In Meghalaya state, stretch from Dalu to Garobadhaba section connecting to NH51 from Tura to Dalu section has been implemented as second phase road as shown in Figure 2.3.3.

Source: Source: North Eastern State Roads Investment Program, EIA Report

Figure 2.3.3　　ADB-North Eastern State Roads Investment Program (Meghalaya)

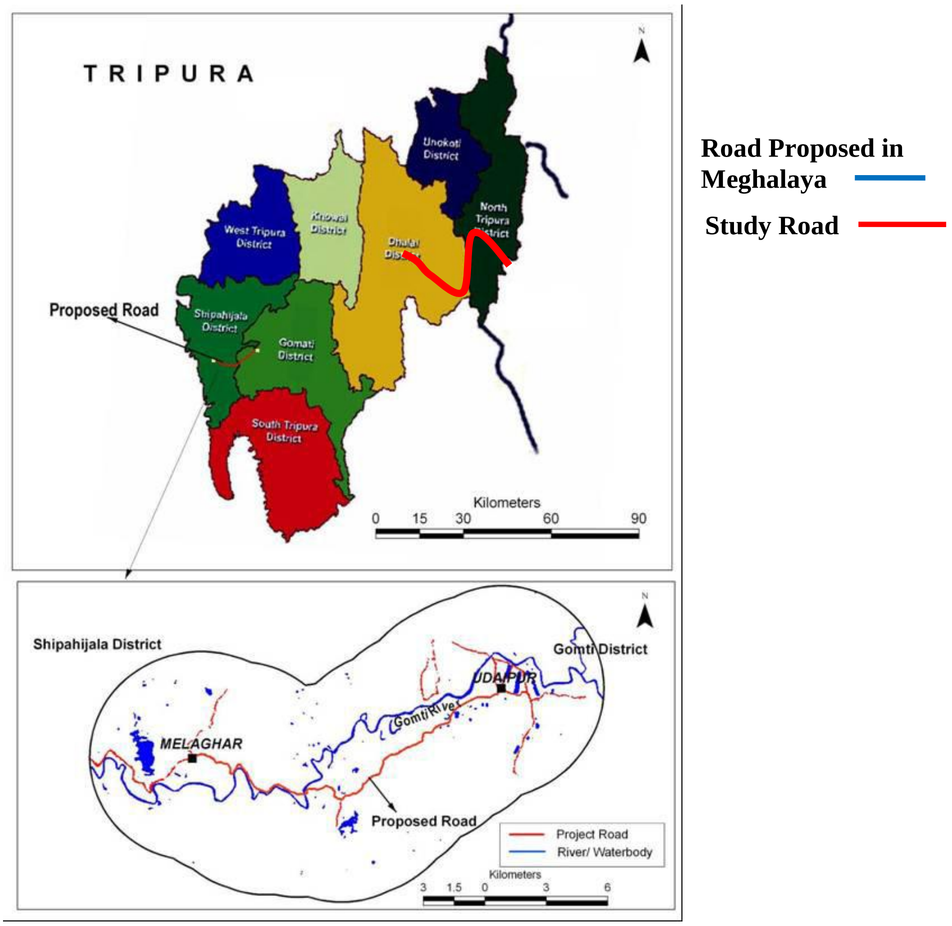
In Manipur state, stretch from Tupul to Kasom Khullen section connecting to NH53 has been implemented as second phase road as shown in Figure 2.3.4.



Source: Source: North Eastern State Roads Investment Program, EIA Report

Figure 2.3.4　　ADB-North Eastern State Roads Investment Program (Manipur)　No.06

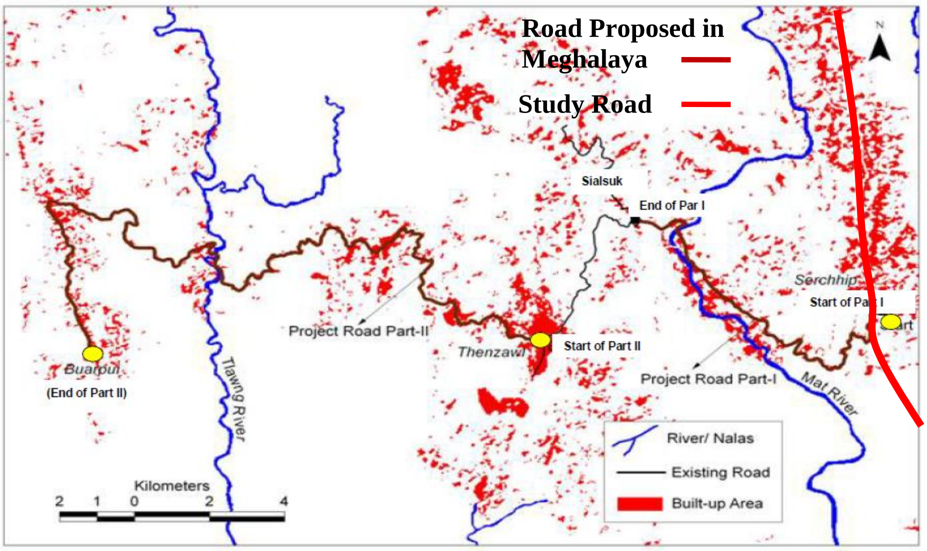
In Tripura state, stretch from Udaipur to Melaghar section has been implemented as second phase road as shown in Figure 2.3.5.



Source: Source: North Eastern State Roads Investment Program, EIA Report

Figure 2.3.5 ADB-North Eastern State Roads Investment Program (Tripura)

In Mizoram state, stretch from Serchip to Buarpui section near NH54 has been implemented as second phase road as shown in Figure 2.3.6.



Source: Source: North Eastern State Roads Investment Program, EIA Report

Figure 2.3.6 ADB-North Eastern State Roads Investment Program (Mizoram)

2.4 Socio Economic Conditions of North-Eastern States

The North-Eastern States of India constitute of 8 states, viz., Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. For the present study, the sates of Arunachal Pradesh and Sikkim are not included. The road network/ sections included in the present study are spread over 6 states.

2.4.1 Area & Social Framework

The area and population along with other social indicators are presented in Table2.4.1. The figures on population, sex ratio and literacy are based on actual census (2011 Census), which is conducted every 10 years. The study area, with a total area of 171340 sq. km (about 65% of the area of NER), contains about 44 million populations (about 96% of the total NER population). Almost half (about 46%) of the area of the "Study Area" is under Assam state, and the population of the state is about 71% of that of Study Area population, indicating higher concentration of population in Assam.

Within the states, the population density in Assam and Tripura states is more than three times of other 4 states (about 7.5 times that in Mizoram). It can be observed that despite the geographical area under Manipur, Meghalaya and Mizoram is almost equal; the population density in Mizoram is almost 40% less than that in the other two states.

The literacy rate in all the six states is above 70% (literacy at India level is 74.04%). Mizoram has the highest literacy rate at 91.33% and Assam the lowest at 72.19%. The sex ratio ranges between 931 (Nagaland, and is below the national figure of 940) to 992 (Manipur).

A comparison of the study area (constituting the six states), reveals that the total geographical area covered by the Study is about 5.2 % of the national area, whereas the population is about 3.6%, indicating lower population density of the study area vis-a-vis the national figure.

The study area falls in north-eastern part of India, and geographically the eastern part of India (consisting of 5 states – Bihar, West Bengal, Jharkhand, Odisha and Chhattisgarh) is adjacent to the north-eastern part, and therefore, a comparison of the social and other indicators of these two regions will be of interest for the present study.

The population of eastern region is 6.78 times that of Study Region and the area is 3.29 times, resulting in much higher population density (534 persons/ sq km) in eastern region as compared to Study Region. In terms of sex ratio and literacy rates, the two regions are almost comparable, with not much difference in the figures.

Table 2.4.1 Area, Population & Social Indicators of States

Items	Unit	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Tripura	Total	All India	Eastern Region
Area (2011)	Sq. Km	78,438	22,327	22,429	21,081	16,579	10,486	171,340	3,287,263	553,530
Districts (2011)	Nos.	27	9	7	8	11	4	66	640	129
Population (2011)	(000)	31,169	2,722	2,964	1,091	1,981	3,671	43,598	1,210,193	295,606
Sex Ratio (2011)	Females per 1000 Males	958	992	989	976	931	960		940	919 to 991
Population Density (2011)	Person/ Sq. Km	398	115	132	52	119	350	254	368	534
Literacy Rate (2011)	%	72.19	79.21	74.43	91.33	79.55	87.22		74.04	63.82% to 77.08%

Note: Eastern Region consists of Bihar, West Bengal, Jharkhand, Chhattisgarh, and Odisha
Source: North-East Council, Shillong

2.4.2 Regional Economy and Industrial Structure

(1) Net State Domestic Product (NSDP) and Per Capita Income (PCI)

The NSDP and PCI at constant (2004 prices) for all the six states, as well as for individual states, for the period 2004 -05 to 2013-14, are presented in Table 2.4.2 It can be observed that during the period 2004 -05 to 2013-14, the annual growth of the region (constituting the 6 states) was 6.41%. In the same period the Primary Sector (Agriculture & Allied Activities) grew at 4.11%, Secondary Sector (Industry – includes manufacturing, mining, quarrying, construction etc.) grew at 3.99%, and the Tertiary Sector (transport, communications, hotels, real estate, services, banking etc.) grew at 8.47%.

While the economy of the region grew at 6.41%, a change in the economic structure of the region is well evident, over the years. The contribution of Primary Sector to the regional economy (NSDP) was 27% in the year 2004-05, and it declined to 22% by 2013-14. Similarly, the share of Secondary Sector has declined from 24% to 20%. It may be emphasized that the decline in share of Primary Sector was higher at 18.52% than the share of Secondary Sector, which declined by 16.67%.

Contrary to the share of Primary & Secondary sectors, the regional share of Tertiary Sector during the period 2004-05 to 2013-24, increased from 49% to 58%, depicting an increase by 18.37%, over the period.

In term of PCI, the compound annual growth rate (CAGR) for the region as a whole, was observe at 4.93% during the period.

The NSDP at current price for the year 2013-14 for the Study Region stood at Rs 223219 crore (14.98% of that of Eastern Region), indicating a considerable difference in the economic out put of the two region. Also the growth rate of NSDP in the period 2004-05 to 2013 -14 for the Eastern Region was higher at 6.82% as compared to 6.13% observed during the same period for the Study Region.

In terms of the growth in PCI, the states in Eastern Region performed better than Study Region, as the growth rate of PCI during the period 2004-05 to 2013-14, for the states in Eastern Region varied between 4.03% to 8.15%, the same for states in Study Region was 2.44 % to 7.06%.

Table 2.4.2 State-wise NSDP & PCI Series

(Million INR)

Sector	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	CAGR (%)
Assam											
Agriculture & Allied (P)	126280	128314	130213	134716	139425	148677	152262	159558	166068	173205	3.70
Share to NSDP (%)	27%	26%	26%	25%	25%	24%	23%	23%	23%	22%	
Industry (S)	119581	113511	113181	110972	119117	131640	131747	134948	137812	146397	2.83
Share to NSDP (%)	25%	23%	22%	21%	21%	21%	20%	20%	19%	19%	
Services (T)	225947	244192	264571	283991	302687	332622	373251	395842	426933	454158	7.95
Share to NSDP (%)	48%	50%	52%	54%	54%	54%	57%	57%	58%	59%	
NSDP	471807	486016	507965	529680	561230	612939	657260	690348	730813	773760	5.80
Population`(in 000)	28114	28506	28896	29282	29660	30037	30413	30791	31167	31540	1.27
PCI (INR)	16782	17050	17579	18089	18922	20406	21611	22420	23448	24533	4.53
Manipur											
Agriculture & Allied (P)	11548	11657	11549	12773	14123	16130	12931	13188	13288		2.32
Share to NSDP (%)	25%	24%	23%	24%	25%	27%	22%	21%	20%		
Industry (S)	16970	18300	18700	19073	19460	20825	17265	17722	17994		0.11
Share to NSDP (%)	37%	37%	37%	36%	34%	34%	29%	28%	27%		
Services (T)	17516	19112	19671	20815	22838	23440	28423	33291	34920		8.80
Share to NSDP (%)	38%	39%	39%	40%	40%	39%	48%	52%	53%		
NSDP	46033	49070	49920	52661	56421	60395	58619	64201	66202		4.53
Population`(in 000)	2470	2519	2569	2619	2670	2721	2772	2823	2956		2.09
PCI (INR)	18640	19478	19430	20104	21131	22197	21147	22739	22395		2.44
Meghalaya											
Agriculture & Allied (P)	14296	15000	15156	14946	15519	15814	15948	16696	16954	17739	2.12
Share to NSDP (%)	24%	24%	22%	21%	20%	19%	17%	16%	16%	15%	
Industry (S)	14465	15737	17949	18671	22071	23300	25667	31951	31438	34978	10.11
Share to NSDP (%)	25%	25%	26%	27%	28%	28%	28%	31%	30%	30%	
Services (T)	29696	32290	34672	36293	41303	44850	50646	54341	56510	65664	8.72
Share to NSDP (%)	51%	51%	51%	52%	52%	53%	55%	53%	54%	55%	
NSDP	58457	63028	67777	69909	78893	83964	92261	102988	104902	118381	7.82
Population`(in 000)	2427	2458	2488	2518	2548	2578	2609	3010	3085	3162	3.06
PCI (INR)	24086	25642	27242	27764	30963	32569	35363	34217	34004	37439	4.76
Mizoram											
Agriculture & Allied (P)	5891	5970	5957	6867	7809	8512	9914	9583	9541		7.64
Share to NSDP (%)	25%	23%	22%	23%	23%	22%	22%	22%	20%		
Industry (S)	3647	4825	4832	5430	6600	6732	7023	7081	6996		7.87

Sector	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	CAGR (%)
Share to NSDP (%)	15%	19%	18%	18%	19%	18%	15%	16%	15%		
Services (T)	14459	14977	16139	17587	19962	23076	28452	27388	30346		10.30
Share to NSDP (%)	60%	58%	60%	59%	58%	60%	63%	62%	65%		
NSDP	23996	25773	26927	29885	34370	38320	45389	44053	46883		9.30
Population`(in 000)	973	998	1024	1050	1077	1104	1133	1162	1192		2.53
PCI (INR)	24662	25826	26308	28467	31921	34699	40072	37921	39347		6.77
Nagaland											
Agriculture & Allied (P)	19425	19957	20176	20299	22066	22652	24545	25856	26872	27892	4.35
Share to NSDP (%)	36%	33%	31%	29%	30%	29%	29%	28%	27%	27%	
Industry (S)	6721	7921	9111	10069	11560	12145	10159	11586	12603	13709	6.63
Share to NSDP (%)	12%	13%	14%	14%	16%	15%	12%	12%	13%	13%	
Services (T)	28069	31983	35250	39416	40592	43623	51167	55471	59394	63622	8.98
Share to NSDP (%)	52%	53%	55%	56%	55%	56%	60%	60%	60%	60%	
NSDP	54215	59861	64537	69784	74217	78420	85872	92912	98869	105222	7.26
Population`(in 000)	1781	1810	1840	1870	1901	1932	1952	2005	2055	2106	1.80
PCI (INR)	30441	33072	35074	37317	39041	40590	43992	46340	48111	49963	5.46
Tripura											
Agriculture & Allied (P)	21304	21917	23629	27827	29796	31005	33874	35947	37092		7.55
Share to NSDP (%)	26%	25%	25%	28%	27%	25%	26%	25%	24%		
Industry (S)	18536	21097	23552	23512	25784	29006	29927	30424	31342		6.48
Share to NSDP (%)	23%	24%	25%	23%	23%	24%	23%	21%	20%		
Services (T)	41857	44068	47399	49483	55883	62862	68348	77018	87413		9.32
Share to NSDP (%)	51%	51%	50%	49%	50%	51%	52%	54%	56%		
NSDP	81697	87082	94580	100822	111463	122873	132149	143389	155847		8.24
Population`(in 000)	3349	3390	3432	3474	3515	3557	3599	3641	3683		1.19
PCI (INR)	24394	25688	27558	29022	31711	34544	36718	39382	42315		7.06
All 6 States											
Agriculture & Allied (P)	198743	202816	206679	217427	228738	242789	249474	260828	269813		4.11
Share to NSDP (%)	27%	26%	25%	25%	25%	24%	23%	23%	22%		
Industry (S)	179919	181392	187325	187728	204592	223649	221788	233712	238186		3.99
Share to NSDP (%)	24%	24%	23%	22%	22%	22%	21%	21%	20%		
Services (T)	357542	386621	417702	447585	483264	530472	600288	643351	695516		8.47
Share to NSDP (%)	49%	50%	51%	52%	53%	53%	56%	57%	58%		
NSDP	736205	770829	811706	852740	916594	996910	1071550	1137891	1203515		6.41
Population`(in 000)	39114	39681	40249	40813	41371	41929	42478	43432	44138		1.48
PCI (INR)	18822	19426	20167	20894	22156	23776	25226	26199	27267		4.93

Note: P = Primary Sector; S = Secondary Sector, T = Tertiary Sector   CAGR = Compound Annual Growth Rate

Source: Ministry of Statistics & Programme Implementation, Government of India

(2) Industries

As per the Annual Report 2011-12, Ministry of Micro, Small and Medium Enterprises, total number of working Enterprises in the year 2009-10 was 46,863, and the corresponding employment was 441,495 persons, depicting an employment intensity of 9.42 persons per unit (Table 2.4.3).

The annual growth of enterprises (small & medium) during 2006-07 to 2010-11 for the region (6 states) was observed at 11.79%. Assam with a share of around 53% (in number terms), indicated a growth of 7.48% during the same period. Nagaland, with a share of 11.95%, grew at an impressive rate of 48.66%. While Manipur, with a share of 10.16%, was able to grow annually at only 2.15%.

Table 2.4.3 Small & Medium Industries in the Study Region

Variables	States / Year	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Tripura	Total 6 States
Working Enterprises	2006-07	19864	4492	3010	3715	1332	1343	33756
	2007-08	21618	4530	3416	3941	2110	1499	37114
	2008-09	23249	4670	3826	4419	4631	1711	42506

Variables	States / Year	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Tripura	Total 6 States
	2009-10	24927	4759	4725	4919	5602	1931	46863
	2010-11*	26887	4881	5497	5403	9315	2180	54163
	CAGR (%)	**7.48%**	**2.15%**	**15.29%**	**9.71%**	**48.66%**	**12.22%**	**11.79%**
Employment (Persons)	2006-07	210507	19960	12700	26032	16281	23166	308646
	2007-08	229095	20129	14413	27616	25790	25857	342900
	2008-09	246379	20751	16143	30965	56605	29514	400357
	2009-10	264162	21146	19936	34469	68473	33309	441495
	2010-11*	284933	21689	23193	37860	113857	37604	519136
Production (Rs. in Crore)	2006-07	9389	200	447	310	1396	608	12351
	2007-08	10218	201	508	329	2211	679	14147
	2008-09	10989	208	569	369	4854	775	17763
	2009-10	11782	212	702	410	5871	875	19853
	2010-11*	12709	217	817	451	9763	987	24944

Note: 2010-11 figures are projections
Source: Annual Report 2011-12, Ministry of Micro, Small and Medium Enterprises

(3) Potential Industries of the region

The areas with good industrial potential are mainly, horticulture, tourism and the pharmaceutical. The main strength of the region lies in its ecology, which needs to be exploited. A summarized industrial potential of the region is presented in Table 2.4.4.

Table 2.4.4 Summary of Industrial Potential of the Study Region

Area/ Activity	Potential
Power	The Power industry is developing but still not has surplus for export. There is a potential of 60,000 MW of Hydro power in the region and some 4000MW is under construction. To solve the bottlenecks which mar the development of large Hydro power plants more people's participation coupled with taking up smaller run of the river projects be promoted. Development of Inland Water Transport will be an excellent mode of transport facilitating movement of construction material, machinery, equipments, raw material, and manpower for power projects (including hydro-power) located close to the river front.
Horticulture	The development of rubber plantation, fruit cultivation, spices, tea, cinchona, etc have shown an improvement but the enabling atmosphere for export in the form of cold storages, processing, packaging and marketing strategies are yet to develop. Moreover, the production levels and the quality standards need to match with the export requirements. There is a need to develop skills in this regard in the region. A cluster based approach to develop these products with the local level participation and providing the logistics support will instill a confidence in the local community and generate required growth in the region. The only SEZ in the region is Dimapur and the SEZs are planned at Moreh and Thoubal and are under development. A variety of horticulture products are produced that introduce scope for vertical integration and specialization of post harvest activities. Activities such as extraction of juice and slicing of fruits can be done close to fruit growing areas, and further processing, bottling and packaging can be carried out at industrial hub, this is expected to significantly reduce transportation cost, for which adequate road facilities shall be needed. Also, for transportation of agricultural products, quality of rural roads needs to be improved to avoid damages and pilferages.
Handlooms and Handicrafts	The development of Sericulture, handlooms and handicrafts are a major strength of the region and things are happening in the region. However, there is a need to increase awareness, advertisement and the cluster wise development that will give boost to the production, packaging, and marketing to the products.
Petroleum	The oil refining sector has a potential surplus with regards to its refining capabilities but the fuel produced is not export competitive owing to high grade of the output produced which is still not required in the adjoining Nations. Thus importing of crude and exporting the refined surplus by sea route via a pipeline to Sittwe port can be possible. Development of Inland Water Transport, wherever possible, for movement of petroleum products will be quite economical vis-à-vis other modes of transport. Strengthening and improving the improvement of petroleum product by rail transport.
Medical	There is a good potential for development of medical tourism on the lines of that being

Area/ Activity	Potential
Tourism	operated in other parts of the country. Development of air link will provide much needed impetus to promotion of medical tourism. It should be supported by rail link to facilitate movement of patients who otherwise would avoid travel by air.
Tourism	The tourism master Plan has been developed and the circuits have to be developed by the States with the support of the industry. The development of tourism in Sikkim is a case in point where the hospitality and the friendly atmosphere have given the required impetus to domestic and international tourism. Each tourism circuit needs to be equipped with good quality road network. Promotion of tourism shall also require providing adequate rail and air linkages suiting to different income groups, and these are to be adequately linked with road transport network to reach the tourist destinations.
Other Industries	There is a potential for the development of automobile spare parts industry and bi-cycle in the region as these have a great potential of not only for consumption in the region but for the export as well. Raw hides are being exported from the region; however efforts to promote the Tanning industry in the region will have to be considered. With the Gas potential, gas based industries can be developed, mainly in Tripura. The nature provides the best potential for developing the Pharmaceutical industry. The cluster –based approach for promotion of industry has been lacking due to the want of good intra and inter-state road connectivity. Similarly, promotion of vertical integration of industrial production between the hills and plains shall require improvement of road infrastructure. Roads are very much needed for backward integration of Land Custom Stations (LCSs) and Integrated Check Posts (ICPs), in particular for the following LCSs. a) Moreh (Manipur) b) Dawki (Mehglaya) c) Agartala (Tripura) d) Sutarkandi (Assam) **e)** Khwarpuchia (Mizoram)

Source: Taken from a various available documents on NER

(4) Export-Import

The exports & imports of the study region for period 2008-09 to 2012-13, are set out in Table 2.4.5. It can be observed that that exports & imports grew, during the period, at annual rate (CAGR) of 19.49%.

Table 2.4.5 Export and Imports in Rs. Mill. – Project Area

Area	2008-09	2009-10	2010-11	2011-12	2012-13	CAGR (%)
Shillong	3,094	3,511	2,906	4,767	6,389	17.56%
Dhubri	1,082	1,453	1,554	2,415	3,507	28.86%
Guwahati	3,323	4,669	3,951	5,046	6,145	13.07%
Karimganj	651	804	703	892	1,240	13.95%
Imphal	24	105	41	29	261	35.04%
Aizawl	0	0	0	1	0	-
Total	**8,173**	**10,542**	**9,154**	**13,151**	**17,542**	**19.49%**

Source: North-East Council, Shillong

CHAPTER 3 PRESENT CONDITION AND MAJOR ISSUES OF THE STUDY ROADS

3.1 General

3.1.1 Methodology of the Survey

(1) Present Road Conditions

Site investigations and secondary data collection to collect and analyze present road condition of the study road was carried out. Result of the investigations and secondary data collection is summarized in Table 3.1.1 and some data items are used for economic analysis.

The study road is basically divided into sections by number of lanes, and data are summarized by sections. Data of road dimensions and pavement condition are summarized based on results of sampling visual observation method. To be subjected to economic analysis, provisional improvement project cost of the study roads are estimated based on the unit prices which are set based on similar road projects in North Eastern States.

Table 3.1.1 Survey Items based on Road Investigation and Secondary Data Collection

No.	Data Items	Type / Unit	
1	Number of Lanes	Four (4): Carriageway Width (7m+7m), Double (2): Carriageway Width (7m/10m), Intermediate (1.5): Carriageway Width (5m/5.5m), Single (1): Carriageway Width (3.5m/3.75m), New (0)	
2	Carriageway Width	m	
3	Shoulder Width	Average in section / m	
4	Shoulder Type	Paved or Unpaved	
5	Average Altitude	m	
6	Average Roughness	IRI	
7	Total Area of Crack	%	
8	Ravelled Area	%	
9	No. of Pot Holes	per km	
10	Edge Break Area	m2/km	
11	Road Side Friction	%	
12	Average Travel Speed	km/h	
13	Road Capacity	PCU – IRC73-1980	
14	Improvement Project Cost (W=12m: Carriageway 3.5mx2+ Shoulder 2.5mx2)	Mountainous (INR crore/km)	
		Rolling (INR crore/km)	
		Level (INR crore/km)	
		Long Bridge (INR crore/km)	
		Total (INR crore)	

Source: JICA Study Team

(2) Identification of Limitation and Issue for Project Implementation

In parallel with the site investigations and secondary data collection, following surveys were carried out to identify limitation and issue for project implementation.

i) Conservation area (sanctuaries, reserved forest, etc)

ii) Situation of entrance restrictions of foreigner

Entrance restrictions for the foreigner including the Japanese are prescribed by "The Foreigners (Protected Areas) Order 1958 ". In the state in which the target section locates, application of the permission is necessary to enter to the area shown in the following list.

Table 3.1.2 Situation of Entrance Restriction in the Target Area

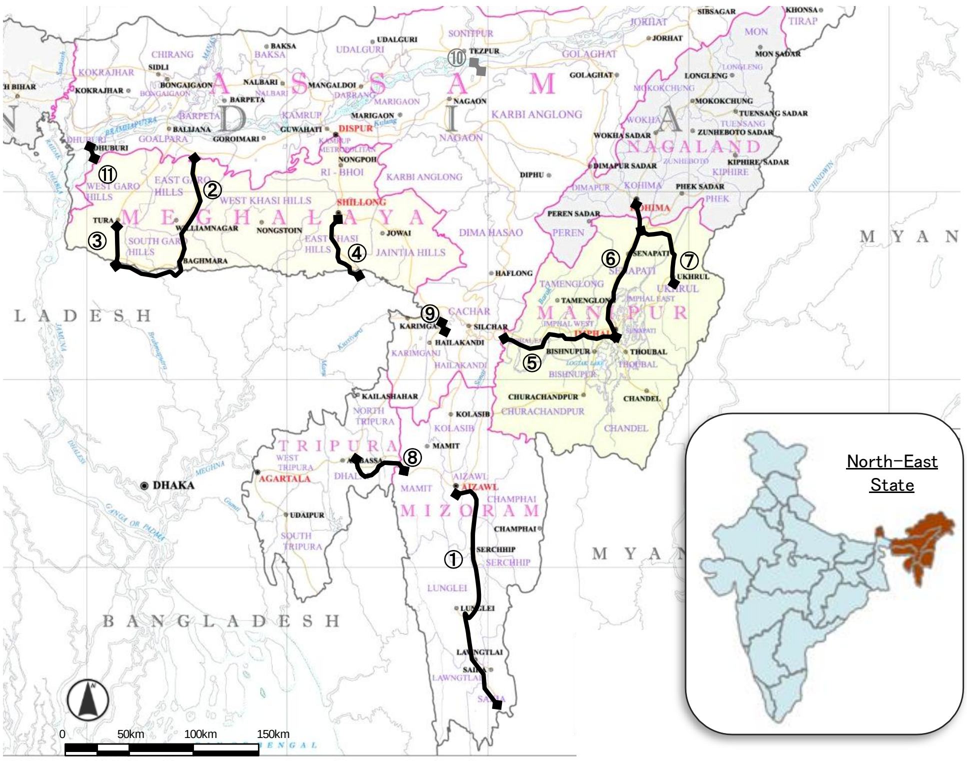
State	Prohibited/limited area	Organization in charge of the authorization
Manipur	Lohtak Lake, Imphal, Moirang INA Memorial, Keibul Deer Sanctuary and Waithe Lake Kongjam War Memorial	All Indian Missions abroad, All FRROs & MHA, State Government of Manipur
Mizoram	Vairangte, Thingdawl and Aizawl	All Indian Missions abroad, All FRROs, State Government of Mizoram
Nagaland	Dimapur District: Dimapur Town, Chumudima Sethikima and all places on the NH39 enroute to Kohima Town Kohima District: Kohima Town, Khonoma Dzulakie Kigwema, Jakhama Viswema, Khuzama, Japhfu, Dzuku Valley Mokochong District: Mokochong Town, Lungkhum, Ungma, Impur Mopungohukit, Chuchlyimlang, Tuli, Chani Wokha District: Wokha Town, Doyang, Vankhosand, Tsunki, Governor's Camp and Mount Tlyi	All Indian Missions abroad, All FRROs, State Government of Nagaland

Source: JICA Study Team

iii) Obtaining a topographical maps
iv) Administrative Jurisdiction
v) Related road plan
vi) Competing road development plan
vii) Others

3.1.2 The Study Roads

Total 11 study roads are initially requested to be subjected to the study as shown in Figure 3.1.1 and Table 3.1.3. Construction of No.10 Koliabhomora Bridge project has been started by GoI and JICA assistance for implementation of the project will not be required.



Source: JICA Study Team

Figure 3.1.1 Project Road for the Study

Table 3.1.3 The Study Roads for the Study

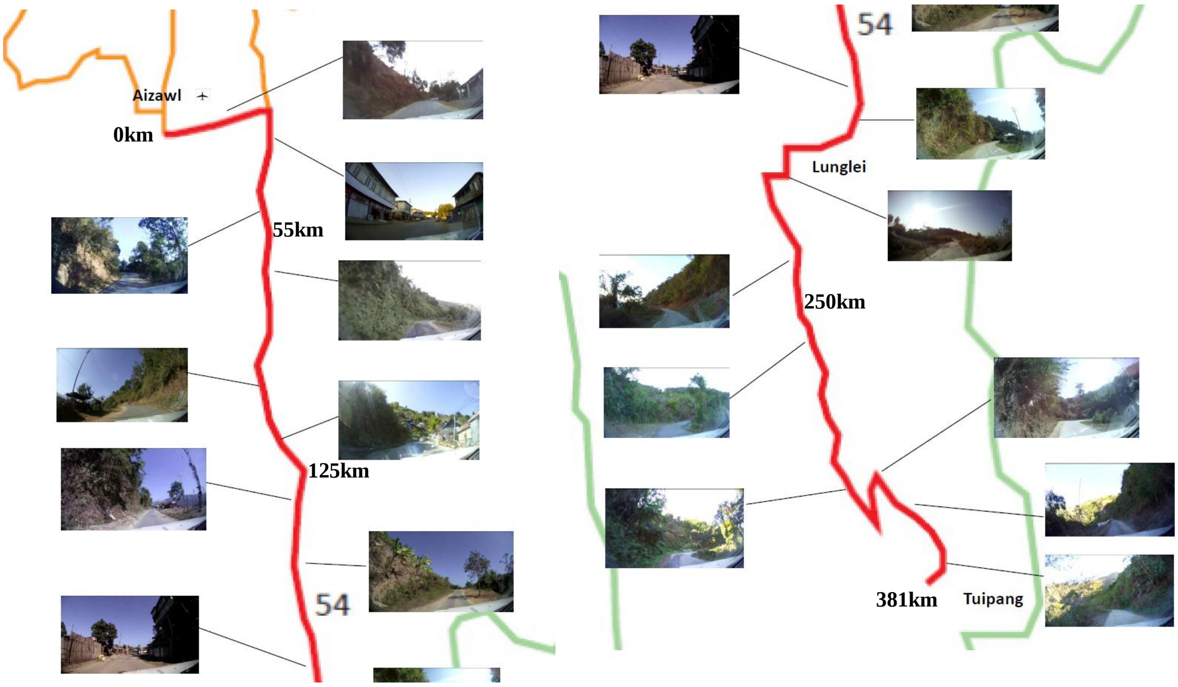
No.	Study Roads Section	Length	Request Type
①	Aizawl – Tuipang Section, NH54	381km	Improvement
②	Dudhanal – Dalu Section, NH62	196km	Improvement
③	Tura – Dalu Section, NH51	54km	Improvement
④	Shillong – Dawki Section, NH40	84km	Improvement
⑤	Imphal – Jiribam Section, NH53	221km	Improvement
⑥	Imphal - Kohima Section, NH39	138km	Improvement
⑦	Ukhrul – Tadubi Section, NH102A	115km	Improvement
⑧	Manu - Simlung Section NH44A	110km	Improvement/New
⑨	Badarpurghat Bridge near Silchar	360m	Improvement/New
⑩	Koliabhomora Bridge near Tezpur	2.5km	Improvement
⑪	Dhubri – Phulbari Section	Bridge: 18km Access Road: 21km	New Bridge

Source: JICA Study Team

3.2 Present Conditions and Major Issues of the Project Roads

3.2.1 NH54 (Aizawl-Tuipang)

The study road of NH54 starts from Aizawl in Mizoram state to Tuipang with total length of approximately 381km. The study road mainly pass on brow of variegated mountains and alignment of the study road consist of many small horizontal and vertical curves as shown in Figure 3.2.1 and Figure 3.2.2. Number of lanes is 1.5 lanes for the section near Aizawl and 1.0 lane for other sections. Pavement condition between Aizawl to Lunglei is fair, while section between Lunglei and Tuipang is deteriorated due to inadequate road maintenance.



Source: JICA Study Team

Figure 3.2.1 Road Alignment and Present Road Condition of NH54

Source: JICA Study Team

Figure 3.2.2 Existing Road Profile of NH54

Data collected by site investigation and secondary data collection and preliminary project cost are tabulated in Table 3.2.1. Average travel speeds are 30km/hour to 21km/hour and this low travel speed is evidence of steep mountainous terrain and low pavement surface condition.

Table 3.2.1 Present Conditions and Provisional Improvement Cost of NH54

No.	Data Items	Type / Unit	Road			
			NH54 (Upper: KM distance from Aizawl, Lower: KP)			
			0-55	55-125	125-250	250-381
			181-236	236-306	306-431	431-562
1	Number of Lanes	Four (4): Carriageway Width (7m+7m), Double (2): Carriageway Width (7m/10m), Intermediate (1.5): Carriageway Width (5m/5.5m), Single (1): Carriageway Width (3.5m/3.75m) New (0)	1.5	1	1	1
2	Carriageway Width	m	5.5	3.75	3.75	3.75
3	Shoulder Width	Average in section / m	0.4	0.5	0.4	0.45
4	Shoulder Type	Paved or Unpaved	Unpaved	Unpaved	Unpaved	Unpaved
5	Average Altitude	m	714	860	724	853
6	Average Roughness	IRI	4.5	5	6.2	9.1
7	Total Area of Crack	%	6.3	7.5	25	62
8	Ravelled Area	%	6.3	10	5	4
9	No. of Pot Holes	per km	5	5	21	7
10	Edge Break Area	m2/km	50	100	50	20
11	Road Side Friction	%	50	15	10	5
12	Average Travel Speed	km/h	30	26	23	21
13	Road Capacity	PCU – IRC73-1980	5,000	1,000	1,000	1,000

14	Improvement Project Cost (W=12m: Carriageway 3.5mx2+ Shoulder 2.5mx2)	Mountainous (INR crore/km)	9	55	495	70	630	125	1125	131	1179
		Rolling (INR crore/km)	5.5	0	0	0	0	0	0	0	0
		Level (INR crore/km)	4	0	0	0	0	0	0	0	0
		Long Bridge (INR crore/km)	120	0	0	0	0	0	0	0	0
		Total (INR crore)		495		630		1125		1179	

Source: JICA Study Team

There is no critical limitation and issue on improvement of NH54 based on interview survey to road administrators and secondary data collection.

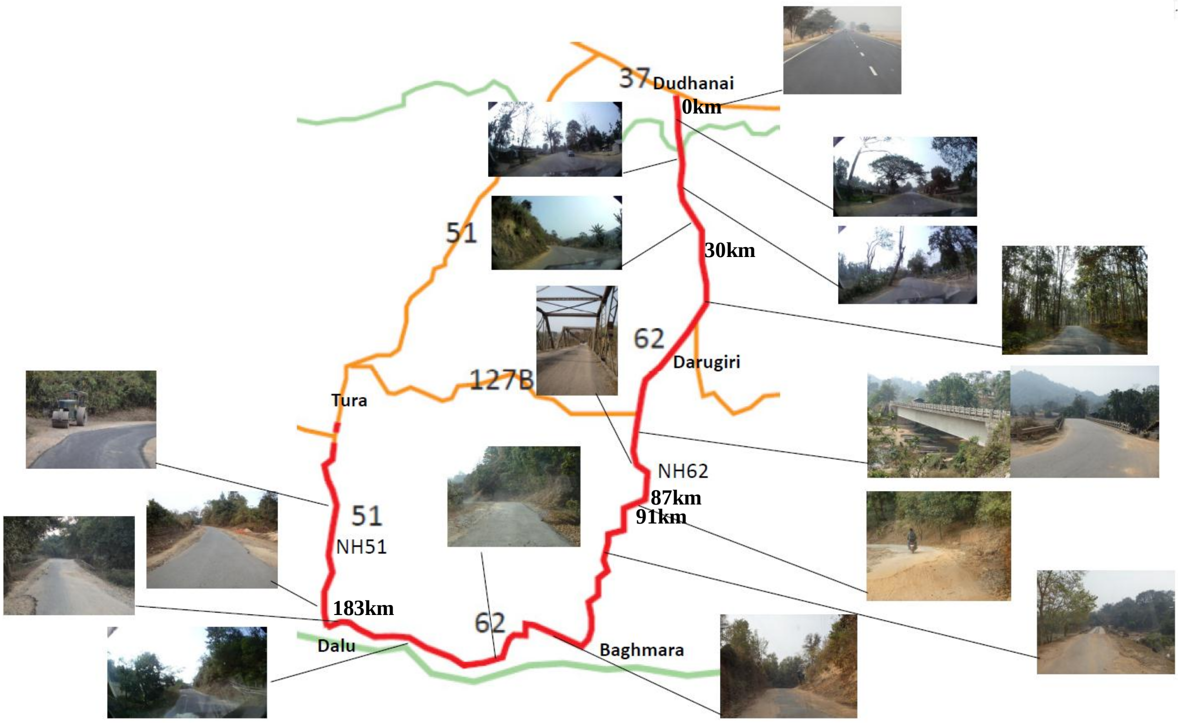
Table 3.2.2 Findings and Issues of NH54

Items	Findings	Issues
Conservation area	No	OK
Restrictions of foreigner	Need Registration	OK
Obtaining a topographical maps	Possible	OK
Administrative Jurisdiction	MORTH	OK
Bypass Plan	No large scale plan	OK
Competing plan	No	OK
Others	No	OK

Source: JICA Study Team

3.2.2 NH62 (Dudhanai-Dalu)

The study road of NH62 starts from Dudhanai in Assam state to Dalu in Meghalaya state with total length of approximately 183km. The study road passes on flat land section near Dudhanai, and rolling and mountainous sections in succeeding section. Alignment of the study road consist of combination of small and medium horizontal and vertical curves as shown in Figure 3.2.3 and Figure 3.2.4. Numbers of lanes are 2.0 lanes for the section near Dudhanai, 1.5 lanes for KM30-KM87, and 1.0 lane for succeeding section. Pavement condition is between Dudhanai to KM87 is fair, while section after KM87 is partially deteriorated due to inadequate road maintenance.



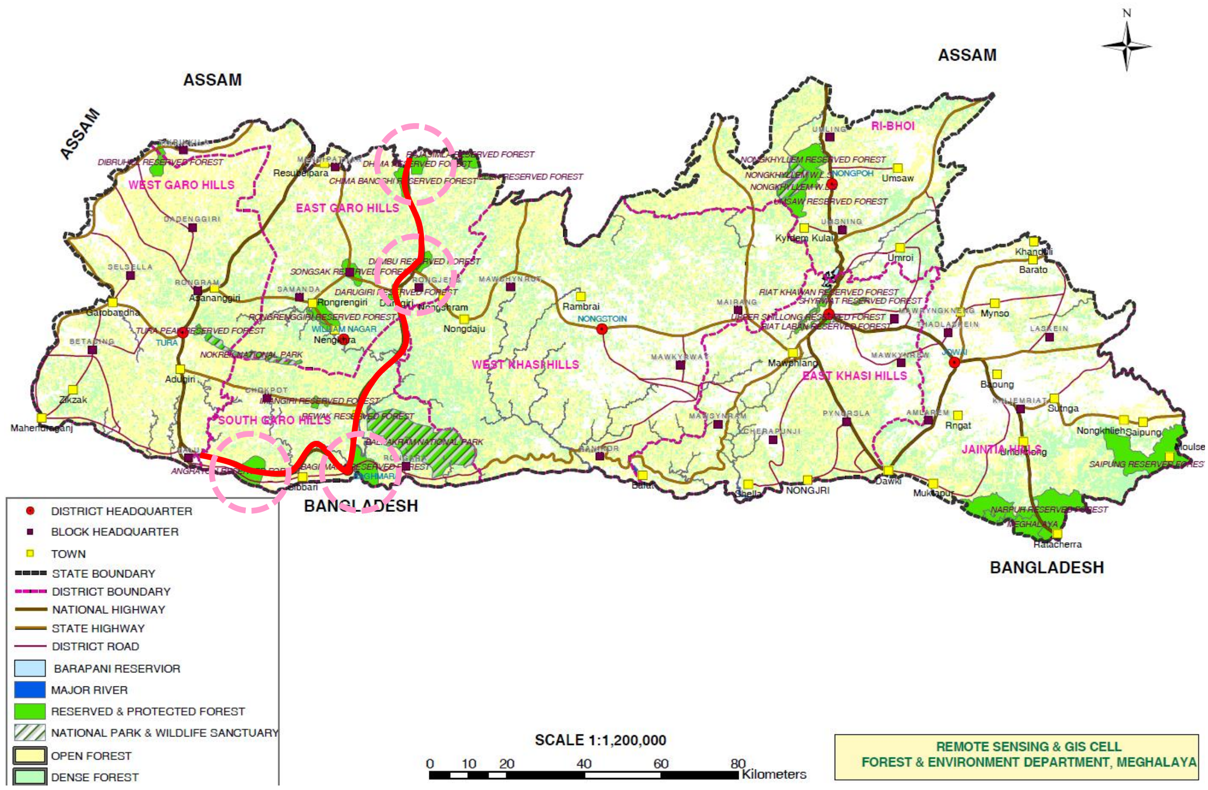
Source: JICA Study Team

Figure 3.2.3 Road Alignment and Present Road Condition of NH62

Source: JICA Study Team

Figure 3.2.4 Existing Road Profile of NH62

There are four reserved forest along NH62 according to forest map of Meghalaya state as shown in Figure 3.1.5. Necessary process for road improvement is needed to confirm.



Source: Forest & Environment Department, Meghalaya State

Figure 3.2.5 Reserved Forest along NH62

Data collected by site investigation and secondary data collection and preliminary project cost are tabulated in Table 3.2.3. Average travel speeds on section from Dudhanai to KM87 and section from KM91 to KM183 are high range from 52km/hour to 36km/hour. While, average travel speed on section from KM87 to KM91 is 28km/hour and this low travel speed is evidence of steep mountainous terrain and low pavement surface condition.

Table 3.2.3 Present Conditions and Provisional Improvement Cost of NH62

No.	Data Items	Type / Unit	Road			
			NH62 (Upper: KM distance from Dudhanai, Lower: KP)			
			0-30	30-87	87-91	91-183
			-	-	-	-
1	Number of Lanes	Four (4): Carriageway Width (7m+7m), Double (2): Carriageway Width (7m/10m), Intermediate (1.5): Carriageway Width (5m/5.5m), Single (1): Carriageway Width (3.5m/3.75m) New (0)	2	1.5	1	1
2	Carriageway Width	m	7	5.5	3.75	3.75
3	Shoulder Width	Average in section / m	0.3(20%)/1.0(80%)	1	1	1
4	Shoulder Type	Paved or Unpaved	Paved/Unpaved	Unpaved	Unpaved	Unpaved
5	Average Altitude	m	133	287	440	175
6	Average Roughness	IRI	4.1	4.5	8	7.2
7	Total Area of Crack	%	5	5	80	43
8	Ravelled Area	%	5	5	10	8
9	No. of Pot Holes	per km	5	5	50	42
10	Edge Break Area	m2/km	50	50	50	220
11	Road Side Friction	%	8	12	15	5
12	Average Travel Speed	km/h	52	39	28	36
13	Road Capacity	PCU – IRC73-1980	10,000	5,000	1,000	1,000

14	Improvement Project Cost (W=12m: Carriageway 3.5mx2+ Shoulder 2.5mx2)	Mountainous (INR crore/km)	9	10	90	52	468	4	36	62	558
		Rolling (INR crore/km)	5.5	0	0	5	27.5	0	0	30	165
		Level (INR crore/km)	4	20	80	0	0	0	0	0	0
		Long Bridge (INR crore/km)	120	0	0	0	0	0	0	0	0
		Total (INR crore)		170		495.5		36		723	

Source: JICA Study Team

Reserved forest is found as mentioned above along NH62 and there is some security risk surrounding of the project area according to security information.

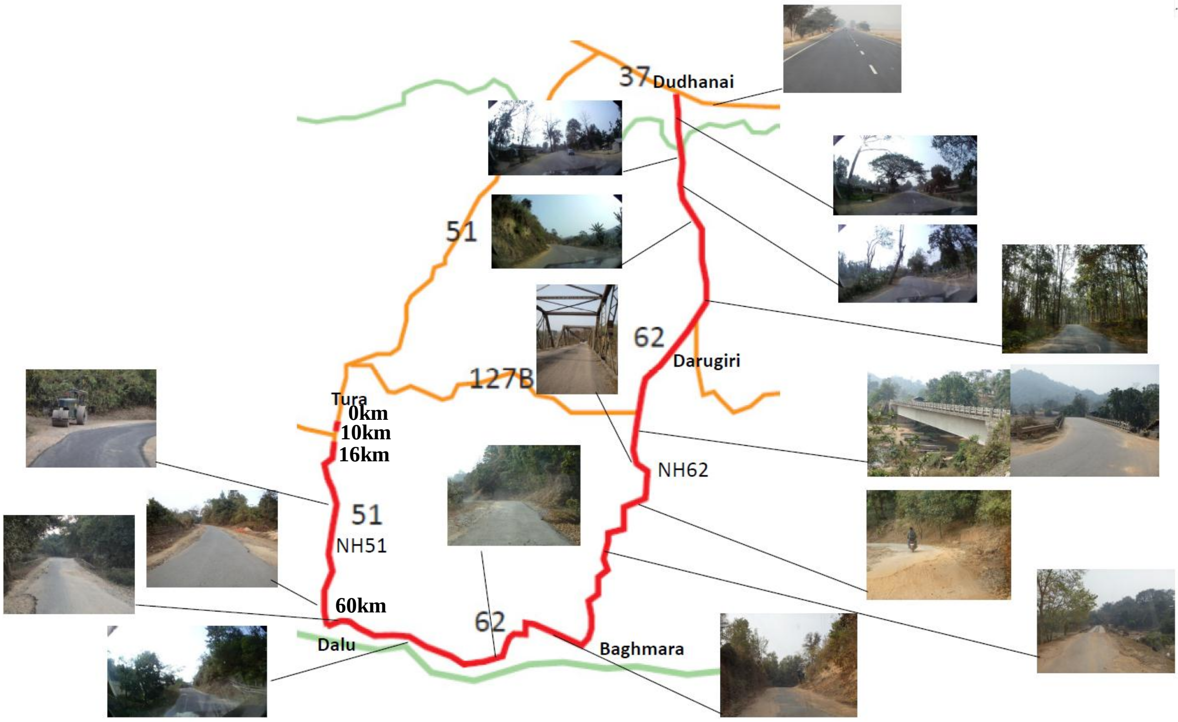
Table 3.2.4 Findings and Issues of NH62

Items	Findings	Issues
Conservation area	Reserved Forest	Need Confirmation
Restrictions of foreigner	No	OK
Obtaining a topographical maps	Possible	OK
Administrative Jurisdiction	MORTH	OK
Bypass Plan	No	OK
Competing plan	No	OK
Others	Security	Need Confirmation

Source: JICA Study Team

3.2.3 NH51 (Tura-Dalu)

The study road of NH51 starts from Tura to Dalu in Meghalaya state with total length of approximately 54km. The study road passes mostly on rolling terrain, and alignment of the study road consist of combination of medium horizontal and vertical curves as shown in Figure 3.2.6 and Figure 3.2.7. Number of lane is 1.0 lane for whole section. Pavement condition is rather deteriorated on whole section due to inadequate road maintenance.



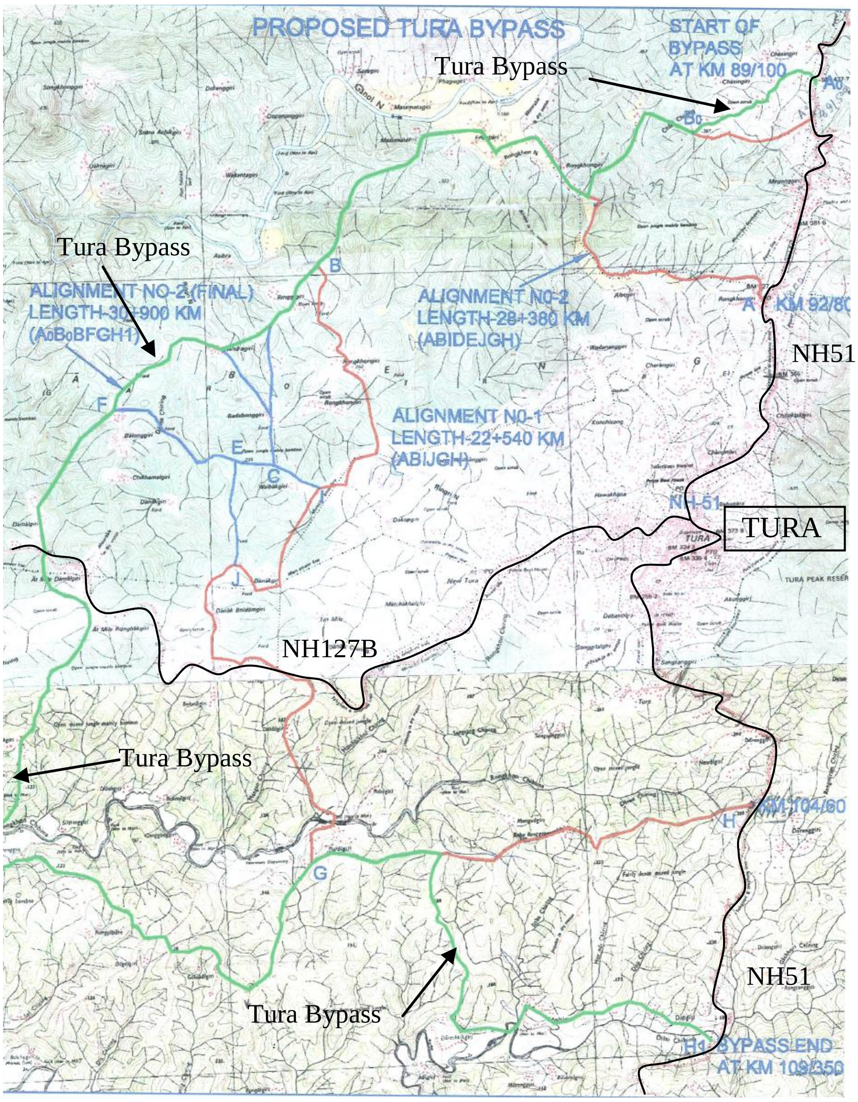
Source: JICA Study Team

Figure 3.2.6 Road Alignment and Present Road Condition of NH51

Source: JICA Study Team

Figure 3.2.7 Existing Road Profile of NH51

Bypass route at Tura city is proposed and draft DPR for the Bypass, named Tura Bypass, was prepared. Total length of Tura Bypass is 30.9km as shown in Figure 3.2.8 and 12m road width (7.0m carriage way + 1.5m hard shoulder x2 + 1.0m earthen shoulder x2) is given. There is only few existing earthen road under proposed alignment of Tura Bypass according to site investigation.



Source: PWD Meghalaya

Figure 3.2.8 Proposed Tura Bypass

Data collected by site investigation and secondary data collection and preliminary project cost are tabulated in Table 3.2.5. Average travel speed on section from Tura to KM10 is 21km/hour due to deteriorated pavement condition and steep road profile. While, average travel speed on succeeding section is 36km/hour.

Table 3.2.5 Present Conditions and Provisional Improvement Cost of NH51

No.	Data Items	Type / Unit	Road	
			NH51 (Upper: KM distance from Tura, Lower: KP)	
			0-10	16-60
			85-95	101-145
1	Number of Lanes	Four (4): Carriageway Width (7m+7m), Double (2): Carriageway Width (7m/10m), Intermediate (1.5): Carriageway Width (5m/5.5m), Single (1): Carriageway Width (3.5m/3.75m) New (0)	1	1
2	Carriageway Width	m	3.75	3.75
3	Shoulder Width	Average in section / m	1	1
4	Shoulder Type	Paved or Unpaved	Unpaved	Unpaved
5	Average Altitude	m	258	110

No.	Data Items	Type / Unit	Road	
			NH51 (Upper: KM distance from Tura, Lower: KP)	
			0-10	16-60
			85-95	101-145
6	Average Roughness	IRI	5.2	6.5
7	Total Area of Crack	%	25	32
8	Ravelled Area	%	1.5	2
9	No. of Pot Holes	per km	30	24
10	Edge Break Area	m2/km	162	162
11	Road Side Friction	%	40	27
12	Average Travel Speed	km/h	21	36
13	Road Capacity	PCU – IRC73-1980	1,000	1,000

14	Improvement Project Cost (W=12m: Carriageway 3.5mx2+ Shoulder 2.5mx2)	Mountainous (INR crore/km)	9	0	0	0	0
		Rolling (INR crore/km)	5.5	10	55	44	242
		Level (INR crore/km)	4	0	0	0	0
		Long Bridge (INR crore/km)	120	0	0	0	0
		Total (INR crore)		55		242	

Source: JICA Study Team

Since Tura bypass is almost green field project, implementation schedule need to be carefully considered in consideration of environmental related process, in case if Tura Bypass is incorporated into the study scope. There is some security risk surrounding of the project area according to security information.

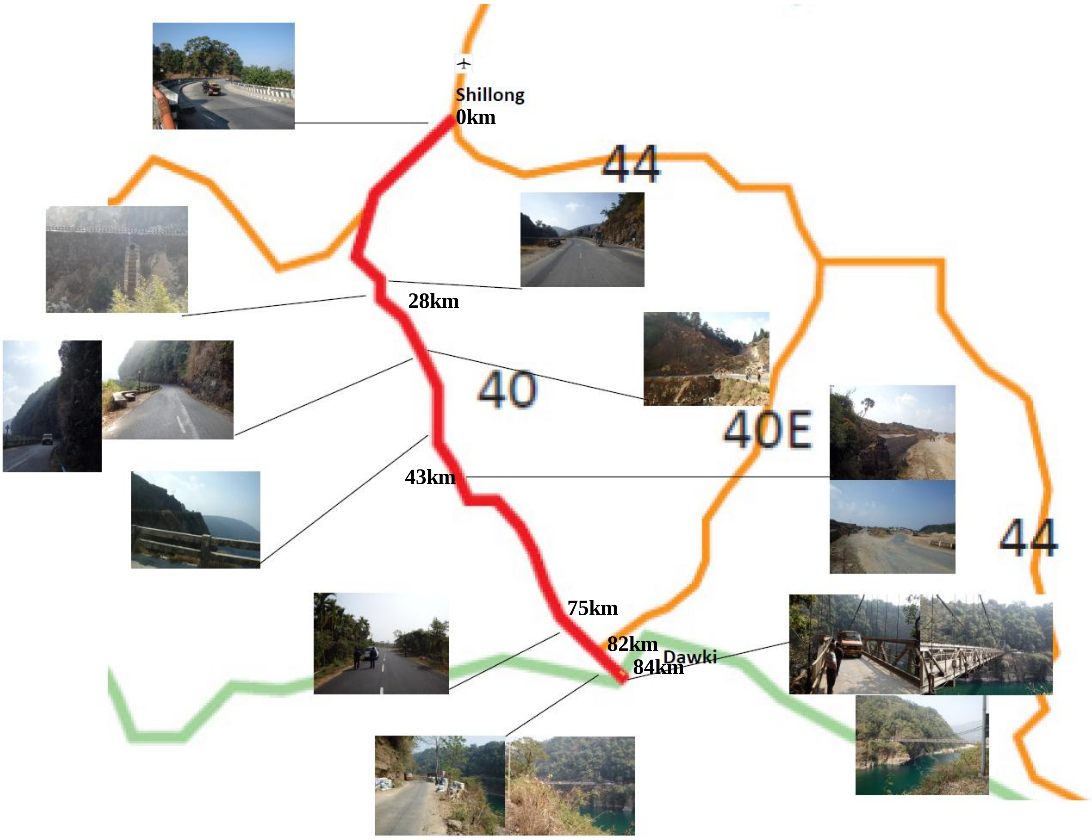
Table 3.2.6 Findings and Issues of NH51

Items	Findings	Issues
Conservation area	No	OK
Restrictions of foreigner	No	OK
Obtaining a topographical maps	Possible	OK
Administrative Jurisdiction	MORTH	OK
Bypass Plan	Tura Bypass	Need Confirmation
Competing plan	No	OK
Others	Security	Need Confirmation

Source: JICA Study Team

3.2.4 NH40 (Shillong-Dawki)

The study road of NH40 starts from Shillong to Dawki in Meghalaya state with total length of approximately 84km. Vertical interval of the study road is very high that starting from approximately 1,700m to approximately 50m at the ending point. Alignment of the study road consists of combination of medium horizontal and vertical curves as shown in Figure 3.2.9 and Figure 3.2.10. Numbers of lanes are variable from 2.0 lanes to 1.0 lane for whole section, and there are few narrow sections where locate between deep valley and overhanging rocky slope. There is an old steel suspension bridge (L=135m) near end of the study road and this bridge is a bottle neck of the study road due to 1 lane bridge width. Pavement condition is rather deteriorated on whole section except section from KM0 to KM28 due to inadequate road maintenance.



Source: JICA Study Team

Figure 3.2.9 Road Alignment and Present Road Condition of NH40

Source: JICA Study Team

Figure 3.2.10 Existing Road Profile of NH40

Data collected by site investigation and secondary data collection and preliminary project cost are tabulated in Table 3.2.7. Average travel speeds on section from Shillong to KM75 are high range from 40km/hour to 43km/hour. While, average travel speeds on succeeding section are from 15km/hour to 18km/hour and this low travel speed is evidence of steep mountainous terrain and low pavement surface condition.

Table 3.2.7 Present Conditions and Provisional Improvement Cost of NH40

No.	Data Items	Type / Unit	Road NH40 (Upper: KM distance from Sillong, Lower: KP)				
			0-28	28-43	43-75	75-82	82-84
			80-108	108-123	123-155	155-162	162-164
1	Number of Lanes	Four (4): Carriageway Width (7m+7m), Double (2): Carriageway Width (7m/10m), Intermediate (1.5): Carriageway Width (5m/5.5m), Single (1): Carriageway Width (3.5m/3.75m), New (0)	2	1.5	2	1	2
2	Carriageway Width	m	7	5	7	3.75	7
3	Shoulder Width	Average in section / m	0.5	0.5	0.4	0.5	0.5
4	Shoulder Type	Paved or Unpaved	Unpaved	Unpaved	unpaved	unpaved	unpaved
5	Average Altitude	m	1710	1552	813	47	30
6	Average Roughness	IRI	3.6	5.5	5	7	5.5
7	Total Area of Crack	%	3.5	20	16	40	30
8	Ravelled Area	%	2	30	10	10	30
9	No. of Pot Holes	per km	2	10	22	50	50
10	Edge Break Area	m2/km	45	50	80	150	150
11	Road Side Friction	%	65	5	12	5	30
12	Average Travel Speed	km/h	43	40	43	18	15
13	Road Capacity	PCU – IRC73-1980	10,000	5,000	10,000	1,000	10,000

No.	Data Items	Type / Unit		0-28		28-43		43-75		75-82		82-84	
14	Improvement Project Cost (W=12m: Carriageway 3.5mx2+ Shoulder 2.5mx2)	Mountainous (INR crore/km)	9	22	198	15	135	19	171	7	63	1.85	16.65
		Rolling (INR crore/km)	5.5	6	33	0	0	13	71.5	0	0	0	0
		Level (INR crore/km)	4	0	0	0	0	0	0	0	0	0	0
		Long Bridge (INR crore/km)	120	0	0	0	0	0	0	0	0	0.15	18
		Total (INR crore)		231		135		242.5		63		34.65	

Source: JICA Study Team

Two alternative routes to avoid present bottle neck of the existing steel suspension bridge are being studied by PWD Meghalaya. One is new bridge constriction at about 200m downstream of the existing steel suspension bridge and PWD Meghalaya carried out detailed design of the new bridge. Another is bypass route starting near from KM75 of NH40 to near ending point through NH40E with total length of approximately 13km. Since the bypass route includes green field section, implementation schedule need to be carefully considered in consideration of environmental related process, in case if the bypass will be adopted. As competing plan, intention of project implementation of widening of NH40E from Dawki-Jowai and NH44 from Jowai to Shillong are needed to confirm.

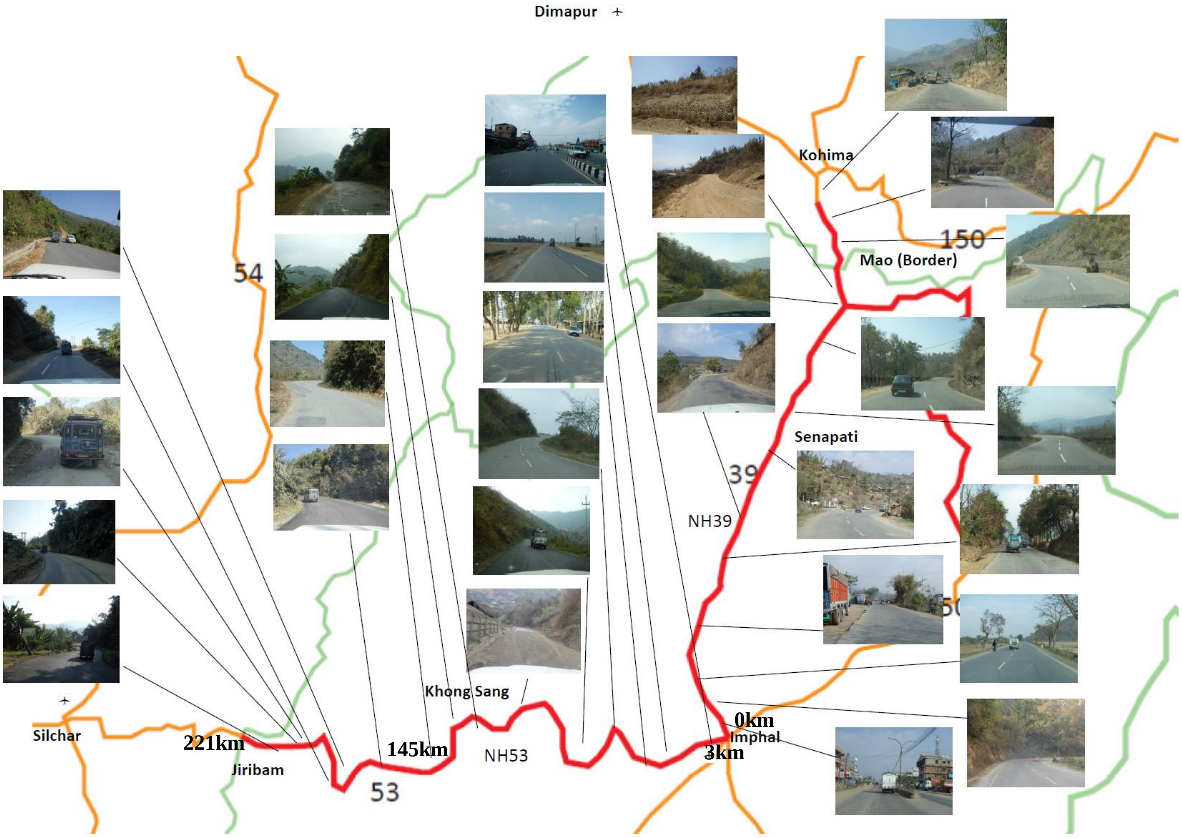
Table 3.2.8 Findings and Issues of NH40

Items	Findings	Issues
Conservation area	No	OK
Restrictions of foreigner	No	OK
Obtaining a topographical maps	Possible	OK
Administrative Jurisdiction	MORTH	OK
Bypass Plan	Dawki Bypass	Need Confirmation
Competing plan	Widening of NH40E (Dawki-Jowai) & NH44 (Shillong-Jowai) by ADB	Need Confirmation
Others	No	OK

Source: JICA Study Team

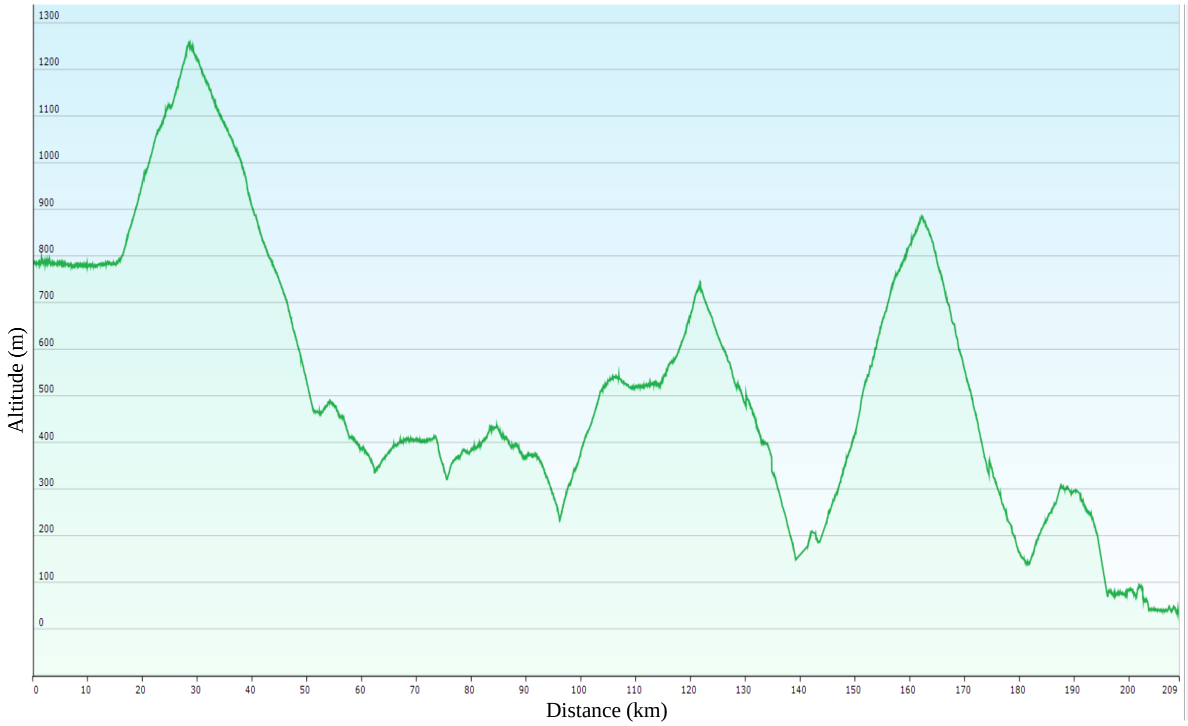
3.2.5 NH53 (Imphal-Jiribam)

The study road of NH53 starts from Imphal to Jiribam in Manipur state with total length of approximately 221km. The study road passes three mountains at KM30, KM120, and KM160 and existing profile shows steep grade around three mountains as shown in Figure 3.2.12. Alignment of the study road consists of combination of small and medium horizontal and vertical curves as shown in Figure 3.2.11 and Figure 3.2.12. Number of lane from near Imphal is 4.0 lanes and succeeding section is 2.0 lanes. Pavement condition between Imphal to Khong Sang is rather fair. While, pavement condition of succeeding sections are variable.



Source: JICA Study Team

Figure 3.2.11 Road Alignment and Present Road Condition of NH53



Source: JICA Study Team

Figure 3.2.12 Existing Road Profile of NH53

Data collected by site investigation and secondary data collection and preliminary project cost are tabulated in Table 3.2.9. Average travel speeds are stable range from 35km/hour to 40km/hour.

Table 3.2.9 Present Conditions and Provisional Improvement Cost of NH53

No.	Data Items	Type / Unit	Road		
			NH53 (Upper: KM distance from Imphal, Lower: KP)		
			0-3	3-145	145-221
			-	-	-
1	Number of Lanes	Four (4): Carriageway Width (7m+7m), Double (2): Carriageway Width (7m/10m), Intermediate (1.5): Carriageway Width (5m/5.5m), Single (1): Carriageway Width (3.5m/3.75m), New (0)	4	2	2
2	Carriageway Width	m	14	7	7
3	Shoulder Width	Average in section / m	0.3	0.4	0.5
4	Shoulder Type	Paved or Unpaved	Paved	unpaved	unpaved
5	Average Altitude	m	786	587	370
6	Average Roughness	IRI	4	5	5.5
7	Total Area of Crack	%	5	31.5	31
8	Ravelled Area	%	5	13.5	6
9	No. of Pot Holes	per km	5	65	78
10	Edge Break Area	m2/km	50	110	100
11	Road Side Friction	%	100	5	12
12	Average Travel Speed	km/h	39.6	35	37
13	Road Capacity	PCU – IRC73-1980	60,000	10,000	10,000

No.	Data Items	Type / Unit		0-3		3-145		145-221	
14	Improvement Project Cost (W=12m: Carriageway 3.5mx2+ Shoulder 2.5mx2)	Mountainous (INR crore/km)	9	0	0	130	1170	62	558
		Rolling (INR crore/km)	5.5	0	0	0	0	14	77
		Level (INR crore/km)	4	3	12	12	48	0	0
		Long Bridge (INR crore/km)	120	0	0	0	0	0	0
		Total (INR crore)		12		1218		635	

Source: JICA Study Team

Border Roads Organization (hereinafter referred to as "BRO") currently administrate maintenance and rehabilitation works. There is some security risk surrounding of the project area according to security information.

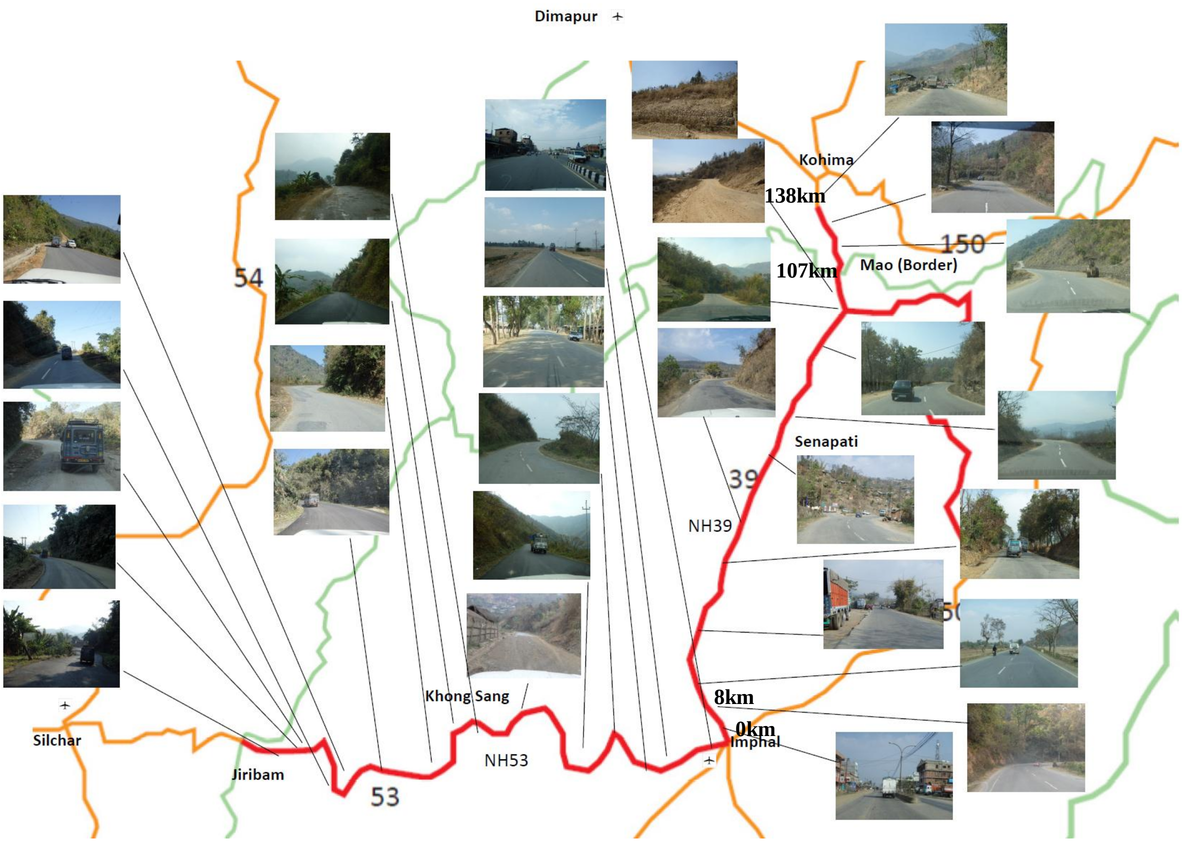
Table 3.2.10 Findings and Issues of NH53

Items	Findings	Issues
Conservation area	No	OK
Restrictions of foreigner	Need registration	OK
Obtaining a topographical maps	Army facilities	Need Confirmation
Administrative Jurisdiction	BRO	Need Confirmation
Bypass Plan	No	OK
Competing plan	No	OK
Others	Security	Need Confirmation

Source: JICA Study Team

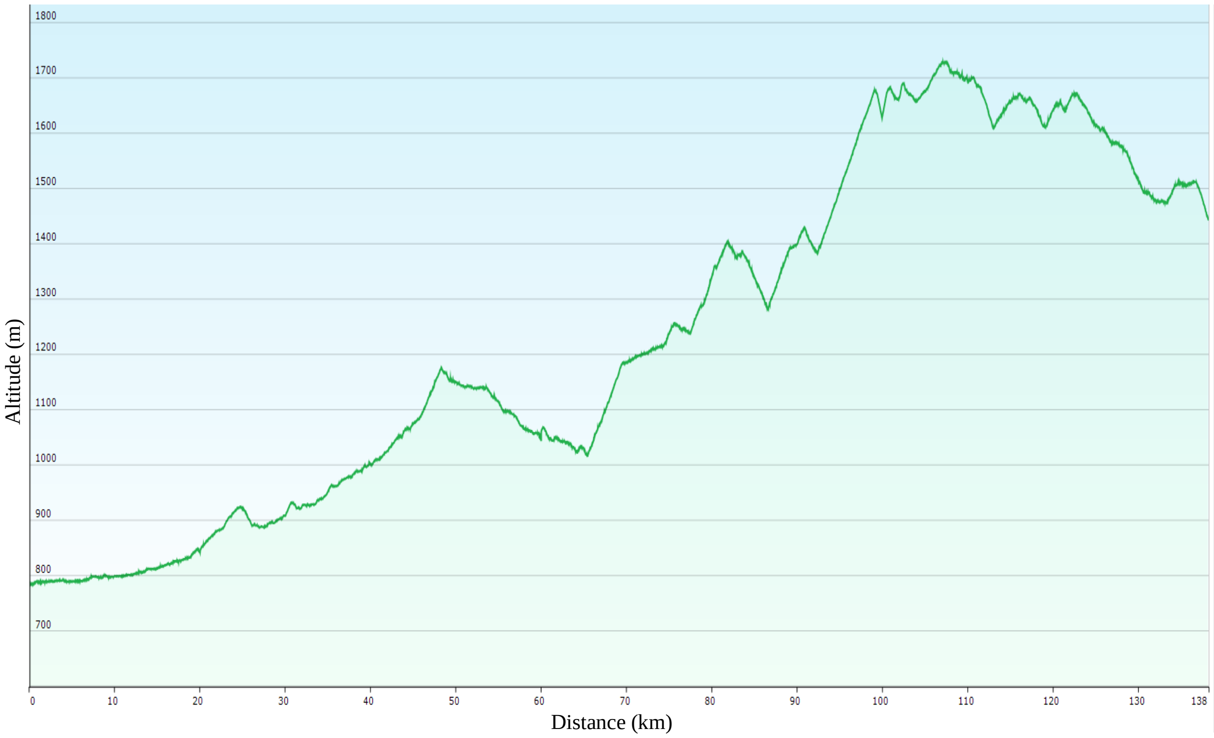
3.2.6 NH39 (Imphal – Kohima)

The study road of NH39 starts from Imphal in Manipur state to Kohima in Nagaland state with total length of approximately 138km. Vertical interval of the study road is high that starting from approximately 800m to approximately 1,700m at the ending point. Alignment of the study road consists of combination of medium horizontal and vertical curves as shown in Figure 3.2.13 and Figure 3.2.14. Number of lane from near Imphal is 4.0 lanes and succeeding section is 2.0 lanes. Pavement condition is rather fair for whole section.



Source: JICA Study Team

Figure 3.2.13 Road Alignment and Present Road Condition of NH39



Source: JICA Study Team

Figure 3.2.14 Existing Road Profile of NH39

Data collected by site investigation and secondary data collection and preliminary project cost are tabulated in Table 3.2.11. Average travel speeds are stable range from 37km/hour to 45km/hour.

Table 3.2.11 Present Conditions and Provisional Improvement Cost of NH39

No.	Data Items	Type / Unit	Road		
			NH39 (Upper: KM distance from Imphal, Lower: KP)		
			0-8	8-107	107-138
			181-212	212-311	311-319
1	Number of Lanes	Four (4): Carriageway Width (7m+7m), Double (2): Carriageway Width (7m/10m), Intermediate (1.5): Carriageway Width (5m/5.5m), Single (1): Carriageway Width (3.5m/3.75m), New (0)	4	2	2
2	Carriageway Width	m	14	7	7
3	Shoulder Width	Average in section / m	0.5	0.5	0.5
4	Shoulder Type	Paved or Unpaved	paved	unpaved	unpaved
5	Average Altitude	m	790	1148	1618
6	Average Roughness	IRI	4.5	5	5.5
7	Total Area of Crack	%	10	17.5	12.5
8	Ravelled Area	%	15	15	15
9	No. of Pot Holes	per km	50	40	27.5
10	Edge Break Area	m2/km	50	75	125
11	Road Side Friction	%	100	12	12
12	Average Travel Speed	km/h	45	45	36.6
13	Road Capacity	PCU – IRC73-1980	60,000	10,000	10,000

14	Improvement Project Cost (W=12m: Carriageway 3.5mx2+ Shoulder 2.5mx2)	Mountainous (INR crore/km)	9	0	0	74	666	31	279
		Rolling (INR crore/km)	5.5	0	0	25	137.5	0	0
		Level (INR crore/km)	4	8	32	0	0	0	0
		Long Bridge (INR crore/km)	120	0	0	0	0	0	0
		Total (INR crore)		32		803.5		279	

Source: JICA Study Team

BRO currently administrate maintenance and rehabilitation works for section in Nagaland state. Alternative routes of Kohima Bypass are being studied to divert through traffic in Kohima city. There is some security risk surrounding of the project area according to security information.

Table 3.2.12 Findings and Issues of NH39

Items	Findings	Issues
Conservation area	No	OK
Restrictions of foreigner	Need registration	OK
Obtaining a topographical maps	Army facilities	Need Confirmation
Administrative Jurisdiction	BRO (Nagaland section)	Need Confirmation
Bypass Plan	Kohima Bypass	Need Confirmation
Competing plan	No	OK
Others	Security	Need Confirmation

Source: JICA Study Team

3.2.7 NH102A (Ukhrul-Tadubi)

The study road of NH102A starts from Ukhrul to Tadubi in Manipur state with total length of approximately 110km. Site investigation was carried out only at ending point of Tadubi due to security reason.

Source: JICA Study Team

Figure 3.2.15 Road Alignment and Present Road Condition of NH102A

Data collected by site investigation and secondary data collection and preliminary project cost are tabulated in Table 3.2.13.

Table 3.2.13 Present Conditions and Provisional Improvement Cost of NH102A

No.	Data Items	Type / Unit		Road	
				NH102A (KM distance from Ukhrul)	
				0-115	
				-	
1	Number of Lanes	Four (4): Carriageway Width (7m+7m), Double (2): Carriageway Width (7m/10m), Intermediate (1.5): Carriageway Width (5m/5.5m), Single (1): Carriageway Width (3.5m/3.75m) New (0)		1	
2	Carriageway Width	m		3.5	
3	Shoulder Width	Average in section / m		0.5	
4	Shoulder Type	Paved or Unpaved		unpaved	
5	Average Altitude	m		-	
6	Average Roughness	IRI		-	
7	Total Area of Crack	%		-	
8	Ravelled Area	%		-	
9	No. of Pot Holes	per km		-	
10	Edge Break Area	m2/km		-	
11	Road Side Friction	%		-	
12	Average Travel Speed	km/h		-	
13	Road Capacity	PCU – IRC73-1980		1,000	
14	Improvement Project Cost (W=12m: Carriageway 3.5mx2+ Shoulder 2.5mx2)	Mountainous (INR crore/km)	9	115	1035
		Rolling (INR crore/km)	5.5	0	0
		Level (INR crore/km)	4	0	0
		Long Bridge (INR crore/km)	120	0	0
		Total (INR crore)		1035	

Source: JICA Study Team

BRO currently administrate maintenance and rehabilitation works. There is some security risk surrounding of the project area according to security information.

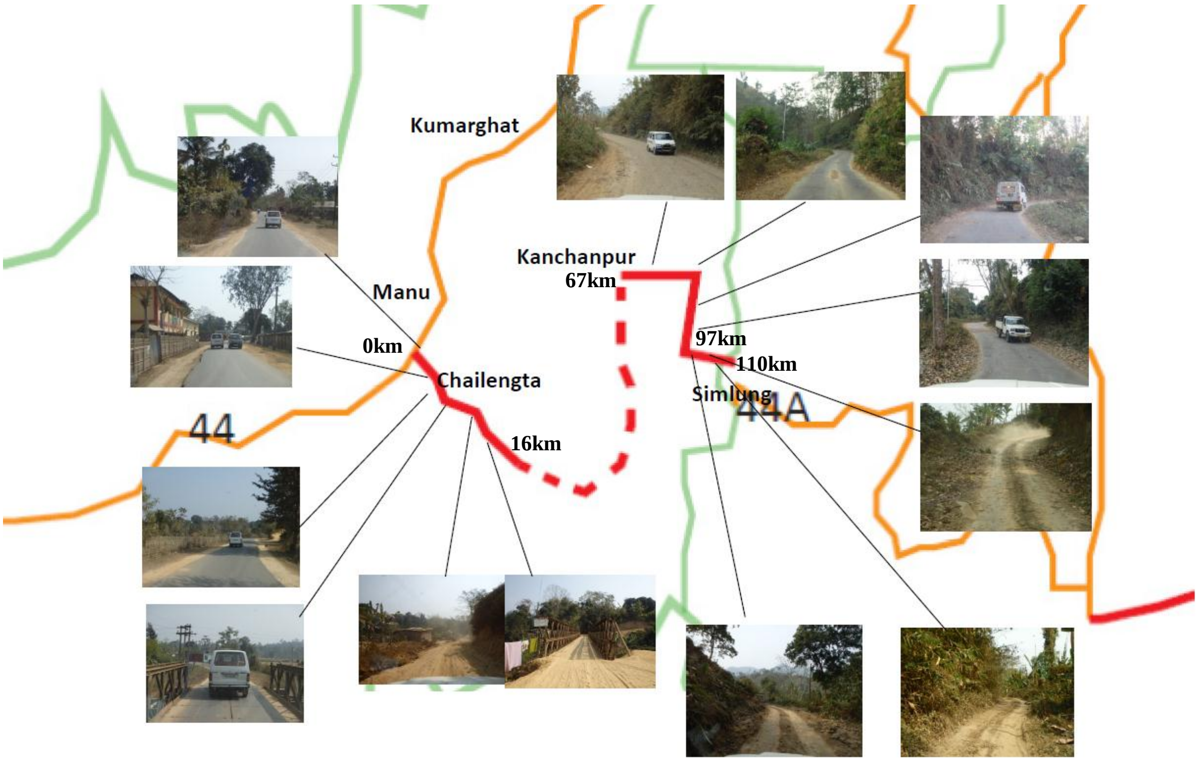
Table 3.2.14 Findings and Issues of NH102A

Items	Findings	Issues
Conservation area	No	OK
Restrictions of foreigner	Need registration	OK
Obtaining a topographical maps	Army facilities	Need Confirmation
Administrative Jurisdiction	BRO	Need Confirmation
Bypass Plan	No	OK
Competing plan	No	OK
Others	Security	Need Confirmation

Source: JICA Study Team

3.2.8 NH44A (Manu-Simlung)

The study road of NH44A starts from Manu to Simlung in Tripura state with total length of approximately 110km. The study road include approximately 50km new construction section, and cross over on about five mountain ranges as shown in Figure 3.2.17 and Figure 3.2.18. Alignment of the project road consists of combination of small and medium horizontal and vertical curves, and profile is steep around cross over section on mountain. Number of lane is 1.0 lane for whole section. Pavement condition of Manu side is fair. While, pavement condition of Simlung side is rather deteriorated.

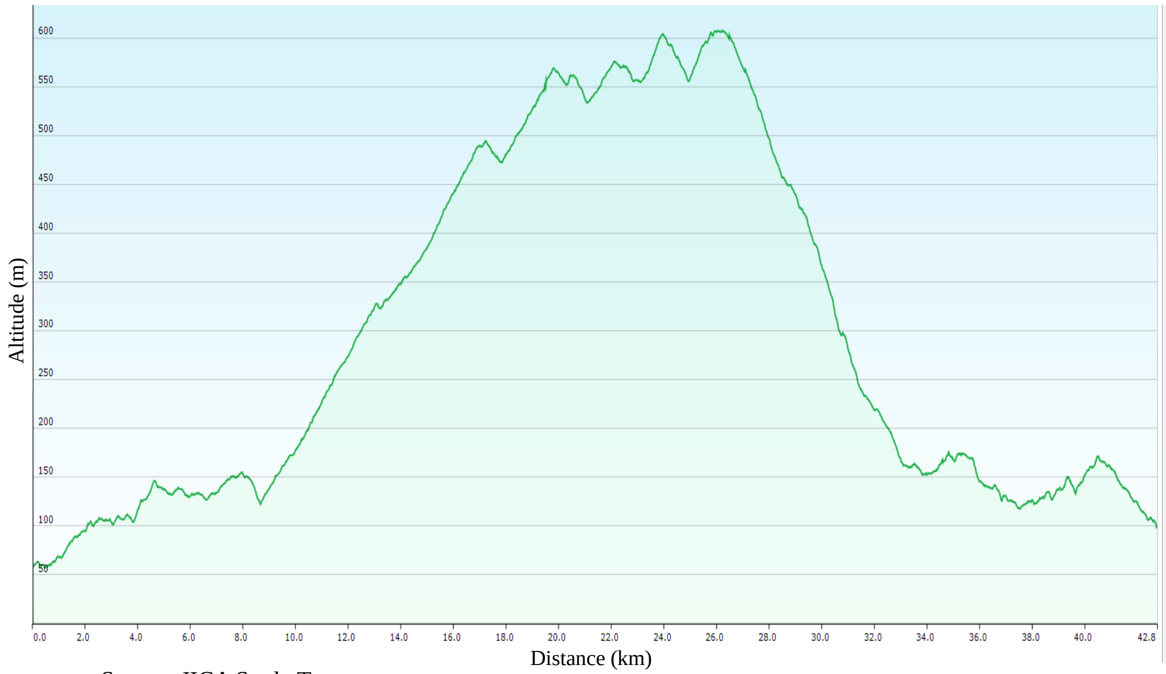


Source: JICA Study Team

Figure 3.2.16 Road Alignment and Present Road Condition of NH44A

Source: JICA Study Team

Figure 3.2.17 Existing Road Profile of NH44A (Manu Side)



Source: JICA Study Team

Figure 3.2.18 Existing Road Profile of NH44A (Simlung Side)

Data collected by site investigation and secondary data collection and preliminary project cost are tabulated in Table 3.2.15. Average travel speed of Manu side is high range of 42km/hour, while Simlung side is range from 13km/hour to 29km/hour and this low travel speed is evidence of steep mountainous terrain and low pavement surface condition.

Table 3.2.15 Present Conditions and Provisional Improvement Cost of NH44A

No.	Data Items	Type / Unit	Road			
			NH44A (KM distance from Manu)			
			0-16	16-67	67-97	97-110
			-	-	-	-
1	Number of Lanes	Four (4): Carriageway Width (7m+7m), Double (2): Carriageway Width (7m/10m), Intermediate (1.5): Carriageway Width (5m/5.5m), Single (1): Carriageway Width (3.5m/3.75m) New (0)	1	0: New section	1	1: Unpaved section
2	Carriageway Width	m	3.5		3.5	3.5
3	Shoulder Width	Average in section / m	0.5		0.5	
4	Shoulder Type	Paved or Unpaved	unpaved		unpaved	
5	Average Altitude	m	90		350	167
6	Average Roughness	IRI	6		5.8	20
7	Total Area of Crack	%	25		20	
8	Ravelled Area	%	5		5	
9	No. of Pot Holes	per km	20		52	
10	Edge Break Area	m2/km	50		100	
11	Road Side Friction	%	5		3	3
12	Average Travel Speed	km/h	42		29	13
13	Road Capacity	PCU – IRC73-1980	1,000	1,000	1,000	1,000

14	Improvement Project Cost (W=12m: Carriageway 3.5mx2+ Shoulder 2.5mx2)	Mountainous (INR crore/km)	9	0	0	51	459	22	198	8	72
		Rolling (INR crore/km)	5.5	9	49.5	0	0	8	44	5	27.5
		Level (INR crore/km)	4	7	28	0	0	0	0	0	0
		Long Bridge (INR crore/km)	120	0	0	0	0	0	0	0	0
		Total (INR crore)		77.5		459		242		99.5	

Source: JICA Study Team

There is no critical limitation and issue on improvement of NH44A based on interview survey to road administrators and secondary data collection.

Table 3.2.16 Findings and Issues of NH44A

Items	Findings	Issues
Conservation area	No	OK
Restrictions of foreigner	No	OK
Obtaining a topographical maps	No	OK
Administrative Jurisdiction	No	OK
Bypass Plan	No	OK
Competing plan	No	OK
Others	No	OK

Source: JICA Study Team

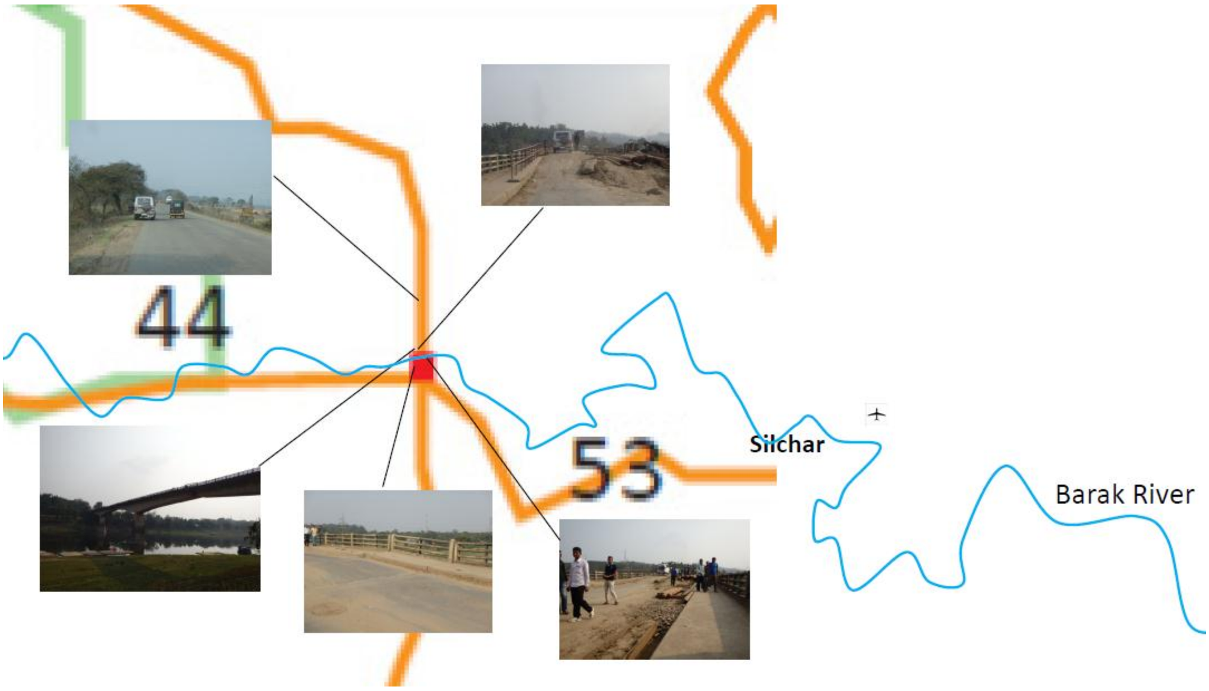
3.2.9 NH44 Badarpurghat Bridge

Badarpurghat Bridge locates on NH44 near Silchar in Assam state. The bridge was constructed in 1974 as RC Box Girder Bridge and total length is 359.44m consisting of five cantilever span (56.20mx2+108.50mx2+30.04m x1). Carriage way width of the bridge is 12m and footpath is installed on both outside of carriageway with 1.5m width.

Some defects have been observed and repair works for the defects has implemented as follows:

A) 20cm level difference between the cantilever tips in 2002
B) Replacement of all gap slab in 2002
C) Replacement of all the 8 pairs of bearings in 2002
D) Fitting and fixing of 8 nos of expansion joint in 2003
E) Cantilever end between pier 1 and pier 2 of North side (Damage of Pedestal, saddle plate, steel girder) in 2012
F) Displacement bearing in 2012
G) Gap developed between saddle plate and bearing in 2012
H) Cantilever end between pier 2 and pier 3 of North side (Damage of Pedestal, saddle plate) in 2012
I) Pier 4 from North side (Roller bearing corrugated) in 2012

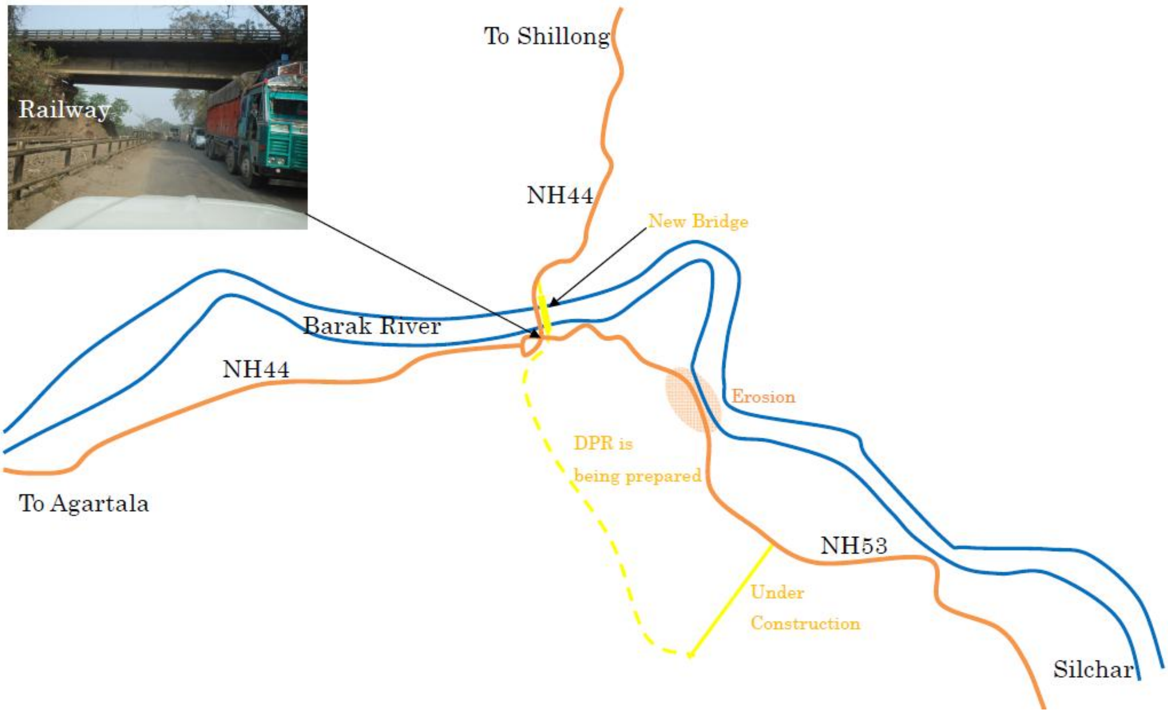
Remedial measures for G, H, and I above were proposed in 2012, while implementation has not been made. To pass traffic temporarily, steel bridge is constructed over the gap slab between pier 2 and pier 3 of North side.



Source: JICA Study Team

Figure 3.2.19 Present Condition of NH44 Badarpurghat Bridge

New bridge plan with bypass route has been implemented as shown in Figure 3.2.20. Bypass route is planned to avoid erosion section on NH53 by Barak River.



Source: JICA Study Team

Figure 3.2.20 Bypass Plan of NH44 Badarpurghat Bridge

Since examination of detail remedial measure and costing of existing bridge is difficult and new bridge plan has been implemented, preliminary project cost is estimated based on new bridge construction as shown in Table 3.2.17.

Table 3.2.17 Present Conditions and Provisional Improvement Cost of NH44 Badarpurghat Bridge

No.	Data Items	Type / Unit		Bridge	
				NH44 Badarpurghat Bridge	
				0-0.36	
				-	
1	Number of Lanes	Four (4): Carriageway Width (7m+7m), Double (2): Carriageway Width (7m/10m), Intermediate (1.5): Carriageway Width (5m/5.5m), Single (1): Carriageway Width (3.5m/3.75m) New (0)		0: New Bridge	
2	Carriageway Width	m			
3	Shoulder Width	Average in section / m			
4	Shoulder Type	Paved or Unpaved			
5	Average Altitude	m			
6	Average Roughness	IRI			
7	Total Area of Crack	%			
8	Ravelled Area	%			
9	No. of Pot Holes	per km			
10	Edge Break Area	m2/km			
11	Road Side Friction	%			
12	Average Travel Speed	km/h			
13	Road Capacity	PCU – IRC73-1980		10,000	
14	New Construction Project Cost (Bridge: W=12m, Carriageway 3.5mx2+ Safety Strip 2.5mx2)	Mountainous (INR crore/km)	9	0	0
		Rolling (INR crore/km)	5.5	0	0
		Level (INR crore/km)	4	0	0
		New Long Bridge (INR crore/km)	120	0.36	43.2
		Total (INR crore)		43.2	

Source: JICA Study Team

Rehabilitation of existing bridge needs to be made urgently by prompt budgetary scheme.

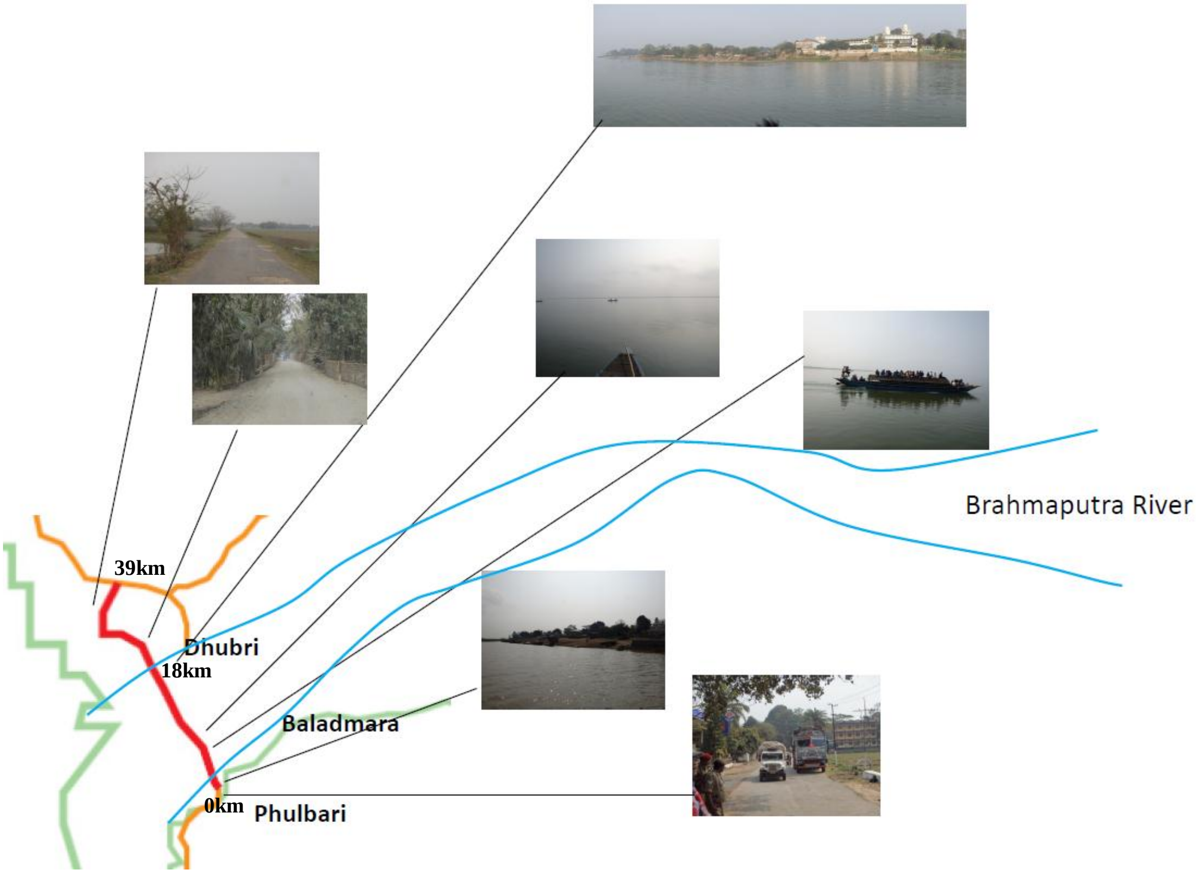
Table 3.2.18 Findings and Issues of NH44 Badarpurghat Bridge

Items	Findings	Issues
Conservation area	No	OK
Restrictions of foreigner	No	OK
Obtaining a topographical maps	No	OK
Administrative Jurisdiction	No	OK
Bypass Plan	New bridge with bypass plan	Need confirmation
Competing plan	No	OK
Others	Urgent rehabilitation of existing bridge is necessary	Need confirmation

Source: JICA Study Team

3.2.10 NH127B Dhubri – Phulbari Bridge

Dhubri – Phulbari Bridge is planned to locate on NH127B near Dhubri in Assam state. The bridge has been studied with approach road, and 18km new bridge construction and 21km approach road in Dhubri side are proposed in previous study. Phulbari is proposed as bridge approach point due to stable river bank.



Source: JICA Study Team

Figure 3.2.21 Present Condition of NH127B Dhubri-Phulbari Bridge

Data collected by site investigation and secondary data collection and preliminary project cost are tabulated in Table 3.2.19. Average travel speed on approach road is 25km/hour due to deteriorated pavement condition.

Table 3.2.19 Present Conditions and Provisional Improvement Cost of NH127B Dhubri-Phulbari Bridge

No.	Data Items	Type / Unit	Bridge & Approach Road	
			NH127B Dhubri - Phulbari Bridge & Approach Road	
			0-18	18-39
			-	-
1	Number of Lanes	Four (4): Carriageway Width (7m+7m), Double (2): Carriageway Width (7m/10m), Intermediate (1.5): Carriageway Width (5m/5.5m), Single (1): Carriageway Width (3.5m/3.75m), New (0)	0: New Bridge	1
2	Carriageway Width	m		3.5
3	Shoulder Width	Average in section / m		0.5
4	Shoulder Type	Paved or Unpaved		unpaved
5	Average Altitude	m		31
6	Average Roughness	IRI		6.5
7	Total Area of Crack	%		50
8	Ravelled Area	%		5
9	No. of Pot Holes	per km		50
10	Edge Break Area	m2/km		100
11	Road Side Friction	%		35
12	Average Travel Speed	km/h		25
13	Road Capacity	PCU – IRC73-1980	10,000	1,000

No.	Data Items	Type / Unit		Bridge & Approach Road			
				NH127B Dhubri - Phulbari Bridge & Approach Road			
				0-18		18-39	
				-		-	
13	Improvement and New Construction Project Cost (W=12m: Carriageway 3.5mx2+ Shoulder 2.5mx2) (Bridge: W=12m, Carriageway 3.5mx2+ Safety Strip 2.5mx2)	Mountainous (INR crore/km)	9	0	0	0	0
		Rolling (INR crore/km)	5.5	0	0	0	0
		Level (INR crore/km)	4	0	0	21	84
		New Long Bridge (INR crore/km)	120	18	2160	0	0
		Total (INR crore)		2160		84	

Source: JICA Study Team

There is no critical limitation and issue on improvement of NH127B Dhubri – Phulbari Bridge based on interview survey to road administrators and secondary data collection.

Table 3.2.20 Findings and Issues of NH127B Dhubri-Phulbari Bridge

Items	Findings	Issues
Conservation area	No	OK
Restrictions of foreigner	No	OK
Obtaining a topographical maps	No	OK
Administrative Jurisdiction	No	OK
Bypass Plan	No	OK
Competing plan	No	OK
Others	No	OK

Source: JICA Study Team

CHAPTER 4 TRAFFIC SURVEY, ANALYSIS AND FORECAST

4.1 General

Traffic surveys have been carried out on the study road sections with a view to meet the requirements of the present study. The traffic surveys were performed by following the standard practices in vogue in India and elsewhere in other countries to determine the present traffic volumes (classified according to the type of vehicles) as well as the pattern of traffic flows in the study area.

The present chapter covers the following sections:

- Study Road Network/ Sections
- Traffic Survey & Forecast Methodology
- Past Traffic Data
- Traffic Surveys
  - ➢ Classified Traffic Count Survey (CTCS)
  - ➢ Roadside Origin-Destination Survey (RSI)
- Traffic Forecast

4.2 Study Road Network/ Sections

The road network/ sections included in the present study are set out in Table 4.2.1. There are a total of 10 road and bridges projects, adding up to 1325.36 Kms, and spread over 6 states. The traffic survey, analysis and projects are done for these 10 roads.

Table 4.2.1 Study Road Network/ Sections

Road ID	Road Section	Target Length (Km)	Type for Intervention
1.0	Mizoram State, Aizawl – Tuipang Section, NH54	381	Improvement
2.0	Meghalaya State, Dudhanal – Dalu Section, NH62	183	Improvement
3.0	Meghalaya State, Tura – Dalu Section, NH51	54	Improvement
4.0	Meghalaya State, Shillong – Dawki Section, NH40	84	Improvement
5.0	Manipur State, Imphal – Jiribam Section, NH53	221	Improvement
6.0	Manipur State, Imphal - Nagaland State, Kohima Section, NH39	138	Improvement
7.0	Manipur State, Ukhrul – Tadubi Section, NH102A	115	Improvement
8.0	Tripura State, Manu - Simlung Section NH44	110	Improvement/New
9.0	Assam State, Badarpurghat Bridge near Silchar	0.36	Improvement/New
11.0	Assam State, Dhubri – Phulbari Section, New Bridge (Main Bridge)	18	New Bridge
	Assam State, Dhubri – Phulbari Section, New Bridge (Access Road)	21	
	Total	**1325.36**	

Source: JICA Study Team

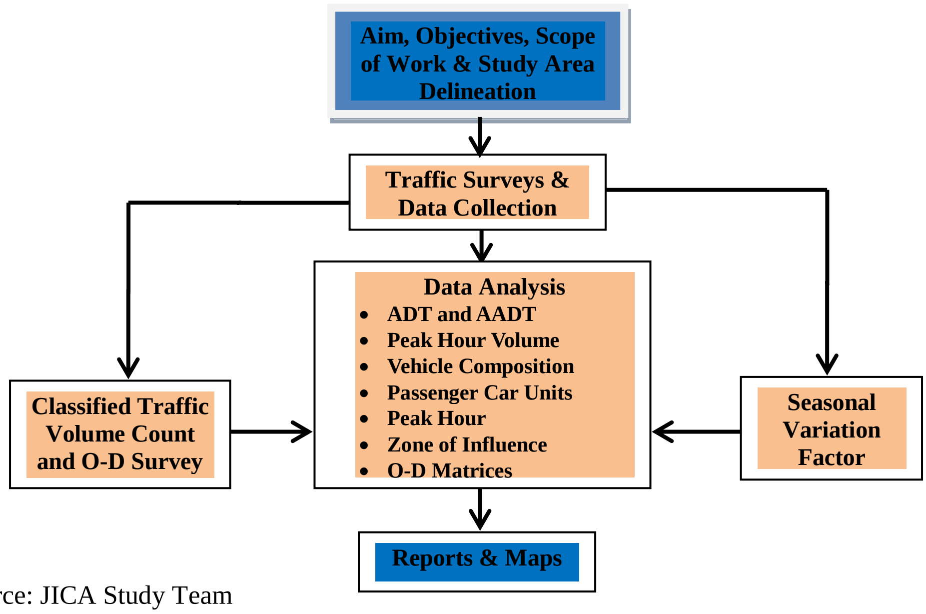
4.3 Traffic Survey Methodology

The objectives of the traffic surveys are listed below:

- To obtain the latest information or data on road transport situation around North-Eastern States
- To identify the zone of influence for the project stretch and extent of influence based on O-D Survey
- To determine characteristics of traffic movement around the zones of influence
- To determine the travel pattern of goods and passenger vehicles
- To analyze transport characteristics through interview to road users, and
- To provide basic data for traffic demand forecast.

O-D survey was conducted on normal working day through Road Side Interview (RSI) method for 24 continuous hours in 2 shifts on random sample basis. A sample of well above 20% was targeted for RSIs, to obtain a fairly representative data.

In order to capture the entire traffic along the project roads, Classified Volume Count surveys were carried out at locations after detailed investigations of each road sections. The survey data collected were analyzed for calculating the Average Daily Traffic (ADT), by taking simple average for the 7 days traffic figures. The Average Annual Daily Traffic (AADT) was calculated after applying seasonal correction factors (to capture the seasonality in traffic movement on the project road sections). RSI was conducted at specified traffic count survey locations for 24 hours for one normal day (excluding holidays & weekends). Vehicles were stopped with the help of local police on a random basis. Trained enumerators will be engaged for collecting information as per questionnaire and compiling the same. A schematic diagram showing Traffic Survey Methodology is presented in Figure 4.3.1.



Source: JICA Study Team

Figure 4.3.1 Traffic Survey Methodology

4.4 Past Traffic Data

The Study Team collected past traffic count data (source MORTH) available in the website. Also traffic data were available in the Detailed Project Reports (DPRs) for NH 54 and NH 51, prepared by the consultants engaged by MORTH. It was observed that the traffic count locations and period of traffic surveys mentioned in these data sources were different than the ones taken by the Study Team.

Since the traffic count data was not available for all the road network/ sections being considered under the present study, the Consultant carried out their own independent traffic surveys at representative locations, identified by them, on each of the 10 road sections/ bridges that are part of the road network considered in the present study.

The past traffic count data, apart from being not available for the entire road sections considered in the present study, was not available for sufficient number of years to use it for regression analysis for forecasting the traffic for future years. Therefore in absence of traffic data series, the past data on registered vehicles (state-wise) were used for the purpose of estimating future traffic.

The past traffic data (vehicle-wise) collected by the Consultant is presented in Appendix -1.

4.5 Traffic Survey

Following the methodology described above, Study Team studied the road network in the project area and conducted a reconnaissance survey to identify the exact survey locations. The traffic count survey was to be conducted, round the clock, continuously for 7 days. However due the prevailing security concerns in the project area, the survey locations, days and period (time) of survey at some target roads were revised, in consultation with JICA. The list indicating the survey locations at each study roads, number of survey days and daily survey hours is set out in Table 4.5.1.

Table 4.5.1 Classified Traffic Count & O-D Survey - Locations & Schedule

Road ID	Road Section	Survey Location	Traffic Count Survey		Origin - Destination Survey	
			Start Date	End Date	Date	Day
1	Mizoram State, Aizawl – Tuipang Section, NH54	1. -Khualazin Tawangtaina Village	23-02-2015	02-03-2015	24-02-2015	Tuesday
		2.Serchhip	23-02-2015	02-03-2015	25-02-2015	Wednesday
		3.Hirakundi	23-02-2015	02-03-2015	26-02-2015	Thursday
		4.Tuipang Police Post	23-02-2015	02-03-2015	27-02-2015	Friday
2	Meghalaya State, Dudhanal – Dalu Section, NH62	1. Nengkhar	15-02-2015	22-02-2015	17-02-2015	Tuesday
		2. Rongra	15-02-2015	22-02-2015	18-02-2015	Wednesday
		3.Dudhnoi	15-02-2015	22-02-2015	19-02-2015	Thursday
3	Meghalaya State, Tura – Dalu Section, NH51	1. Danakgre	15-02-2015	22-02-2015	17-02-2015	Tuesday
		2 . Karoggre Village	15-02-2015	22-02-2015	18-02-2015	Wednesday
4	Meghalaya State, Shillong – Dawki Section, NH40	1. Mylliem Nagar	19-02-2015	26-02-2015	23-02-2015	Monday
		2.Dawki Bridge	19-02-2015	26-02-2015	24-02-2015	Tuesday
5	Manipur State, Imphal – Jiribam Section, NH53	1. Potsoi	22-03-2015	24-03-2015	23-03-2015& 24-03-2015	Monday & Tuesday
		2. Jirighat	19-03-2015	21-03-2015	19-03-2015& 20-03-2015	Thursday & Friday
6	Manipur State, Imphal - Nagaland State, Kohima Section, NH39	1. Awang Sekmai	22-03-2015	24-03-2015	23-03-2015& 24-03-2015	Monday & Tuesday
		2. P.R Hills Near Zakhama	19-03-2015	21-03-2015	19-03-2015 & 20-03-2015	Thursday & Friday
7	Manipur State, Ukhrul – Tadubi Section, NH102A	Shajouba	19-03-2015	21-03-2015	19-03-2015& 20-03-2015	Thursday & Friday
8	Tripura State, Manu - Simlung Section NH44	1.Manu Police Check Post	19-02-2015	26-02-2015	23-02-2015	Monday
		2. Chailengta Village	19-02-2015	26-02-2015	24-02-2015	Tuesday
9	Assam State, Badarpur Bridge	Badarpur Ghat	04-03-15	11-03-2015	09-03-2015	Monday
11	Assam, New Bridge at Dhubri	Existing Goalpara Bridge	04-03-15	11-03-2015	06-03-2015	Friday

Source: JICA Study Team

4.5.1 Classified Traffic Count Survey (CTCS)

The vehicle classification system was followed as per IRC: SP- 19:2001 with minor modifications representing the local aspects. Classified manual traffic counts were recorded in 15 minutes intervals using Tally marks on pre-prepared standard format. The survey data was analyzed to bring out the following traffic characteristics:

- Daily variation of traffic volume
- Average hourly variation of traffic volume
- Average composition of traffic
- Average Daily Traffic (ADT)
- Passenger Car Units (PCU)
- Annual Average Daily Traffic (AADT)
- Directional distribution of traffic

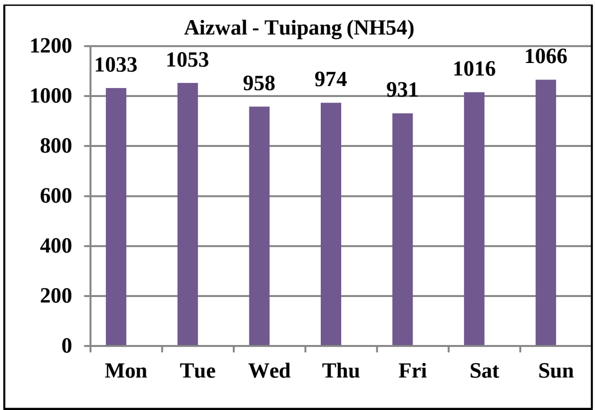
It may be noted that the traffic count survey for the three road sections (on NH 53, NH39 & NH 102A) falling in Manipur was carried out for only three days and for limited hours (morning 6:30 to evening 4:30), due to security concerns.

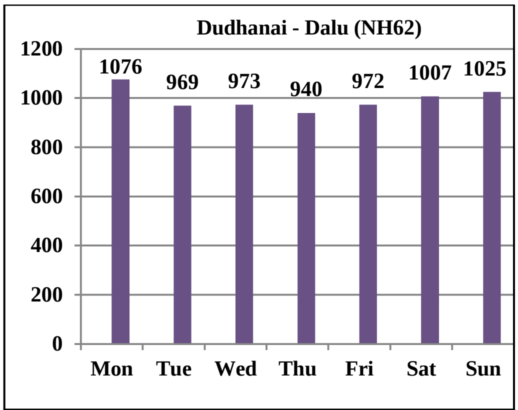
4.5.1.1 Daily Variation of Traffic Volume

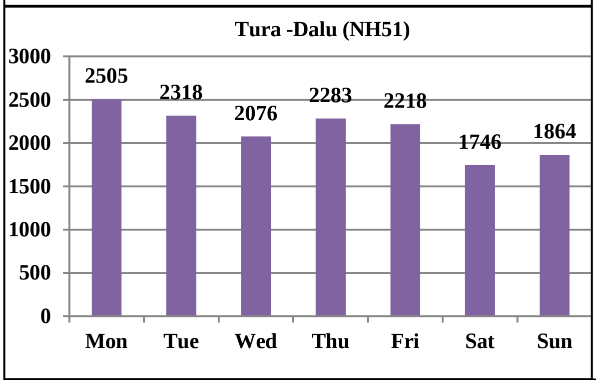
The day wise average traffic volume count index (with respect to the day for which the traffic volume is the highest) for the 10 road sections is given in Figure 4.5.1.

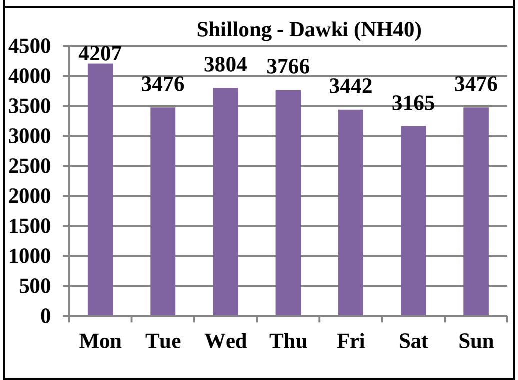
It is observed that for the roads where 7 days traffic count was conducted, the highest volume of traffic is on Monday/ Tuesday, except on Aizawl – Tuipang road section (NH54), where the highest traffic volume is observed on Sunday. Broadly, a general traffic movement pattern followed on the project road sections is that traffic volume is high at the on-set of a week this pattern is also observed on the three roads in Manipur where the traffic count survey was done for only 3 days. The traffic volume on weekends is not low as is normally expected.

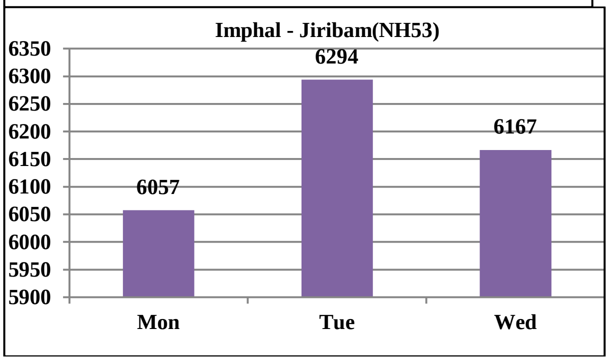
Except for Manu – Simlung (NH 44A) road section, the variation in daily traffic volumes is not found to be significant. Therefore the average daily traffic (and for that matter the average annual daily traffic) which is based on the average of the 7 days traffic volumes, does significantly represent the traffic volumes on the project road sections.

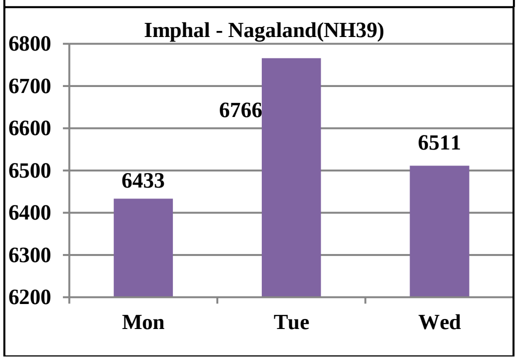


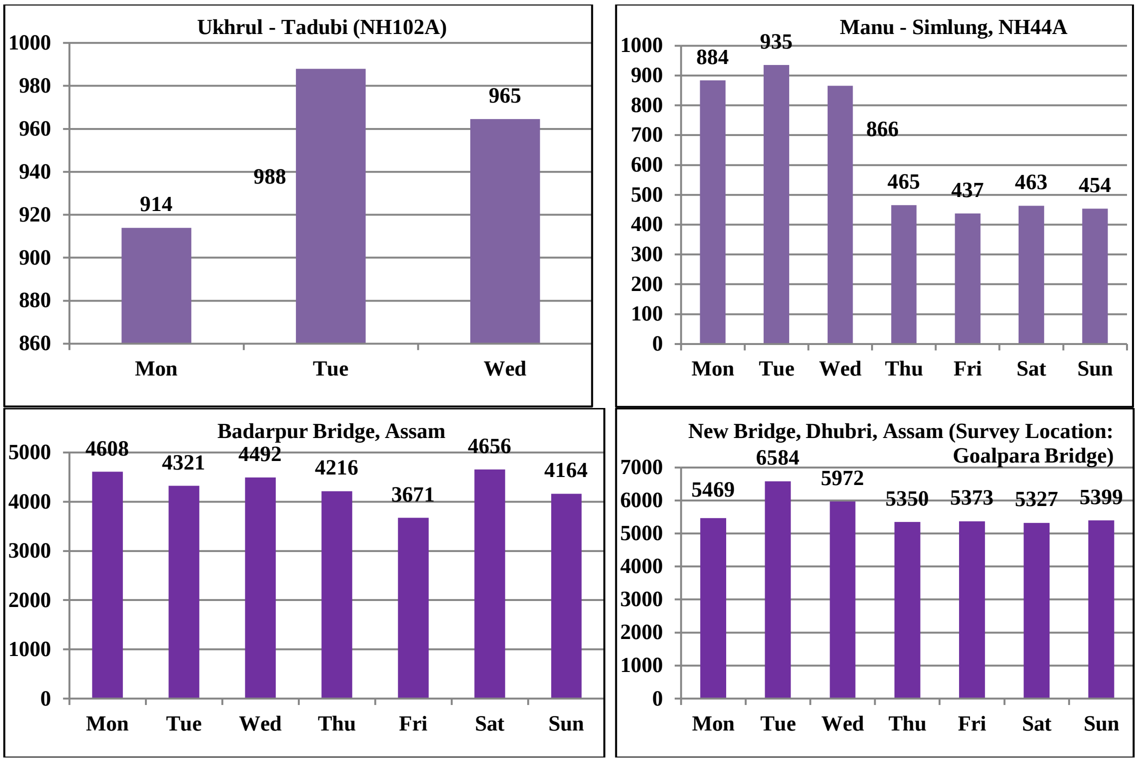










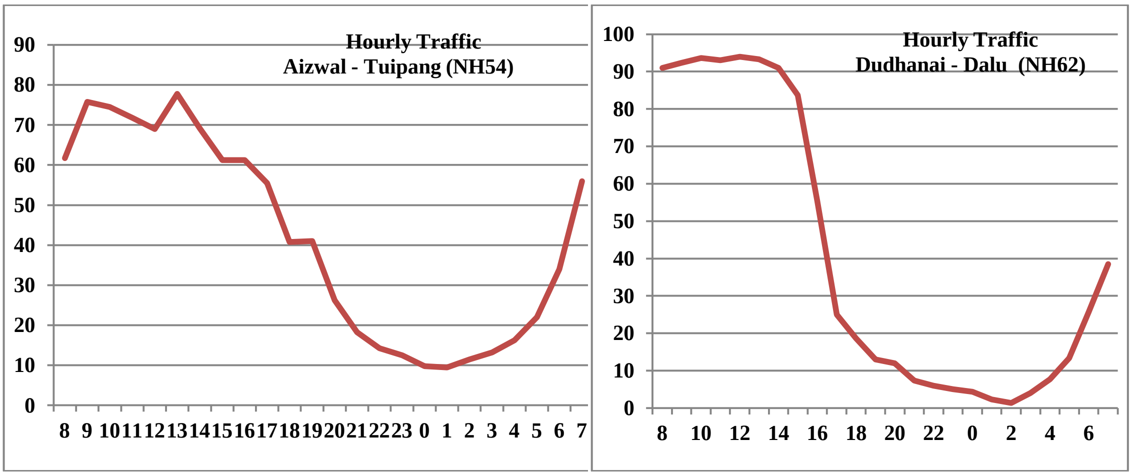


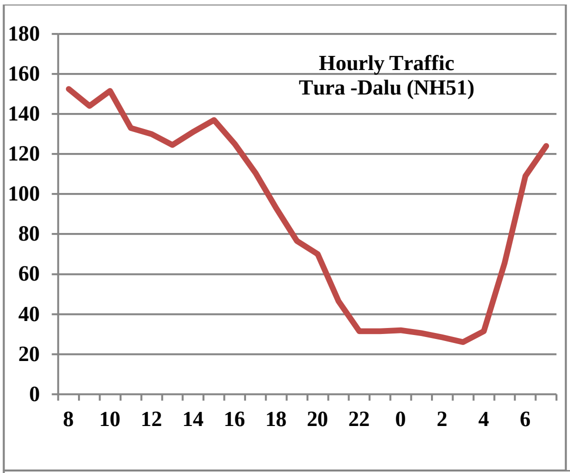
Source: JICA Study Team

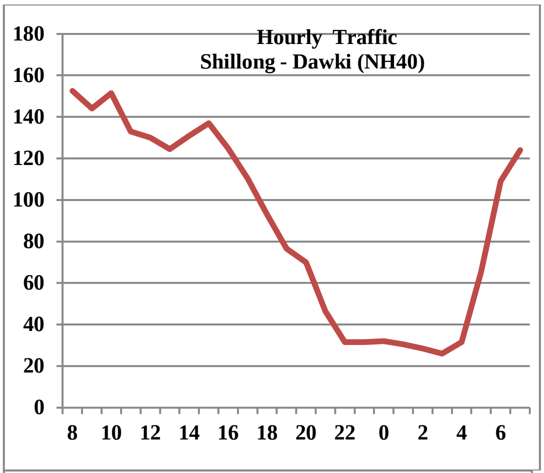
Figure 4.5.1 Daily Variation of Traffic Volume on Ten Study Road Sections

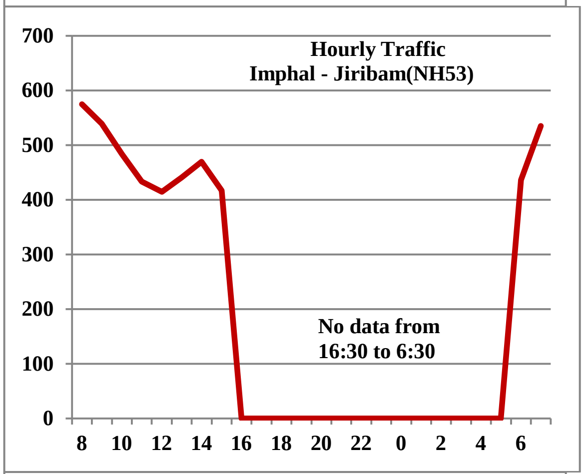
4.5.1.2 Average Hourly Variation of Traffic

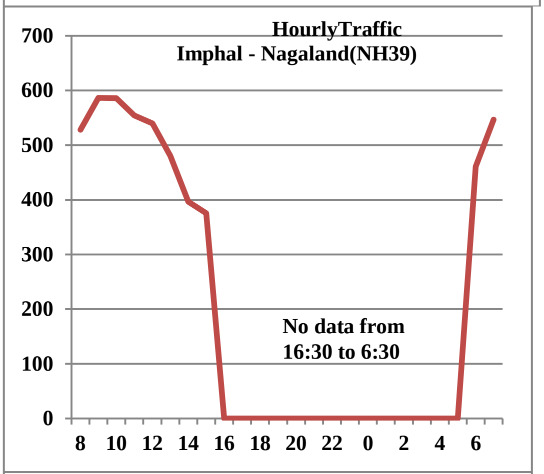
The hourly flow pattern of passenger and goods vehicles on 10 study road sections is depicted in charts shown in Figure 4.5.2. As normally expected, the traffic volume is high during forenoon, and after that it starts falling till mid night and picks up from early morning.

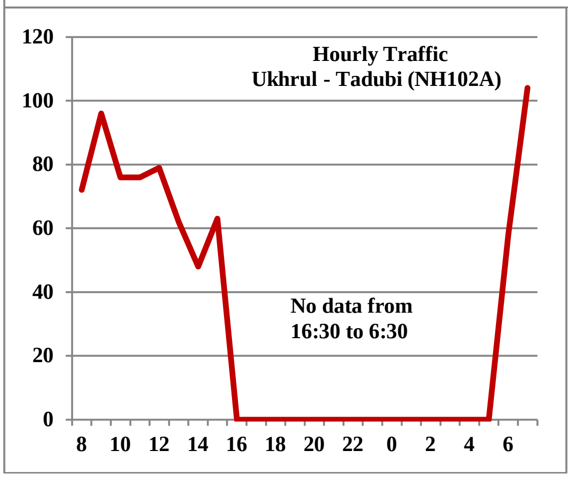


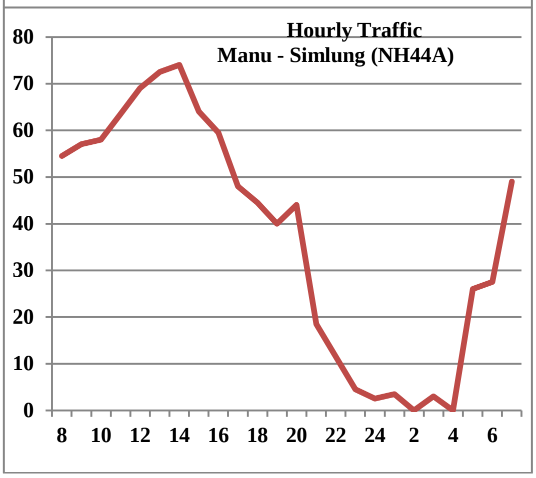

Hourly Traffic
Tura -Dalu (NH51)
180 160 140 120 100 80 60 40 20 0
8 10 12 14 16 18 20 22 0 2 4 6

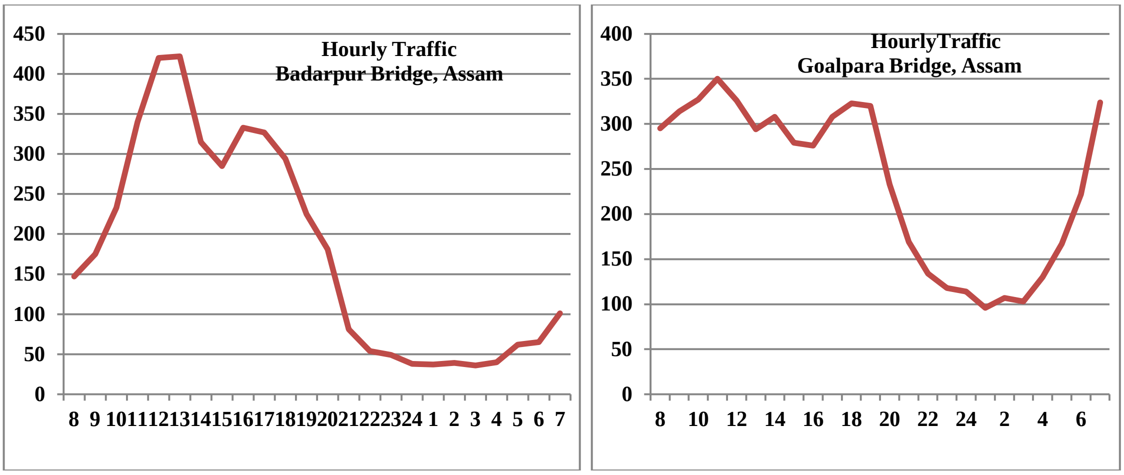

Hourly Traffic
Shillong - Dawki (NH40)
180 160 140 120 100 80 60 40 20 0
8 10 12 14 16 18 20 22 0 2 4 6


Hourly Traffic
Imphal - Jiribam(NH53)
No data from
16:30 to 6:30
700 600 500 400 300 200 100 0
8 10 12 14 16 18 20 22 0 2 4 6


HourlyTraffic
Imphal - Nagaland(NH39)
No data from
16:30 to 6:30
700 600 500 400 300 200 100 0
8 10 12 14 16 18 20 22 0 2 4 6


Hourly Traffic
Ukhrul - Tadubi (NH102A)
No data from
16:30 to 6:30
120 100 80 60 40 20 0
8 10 12 14 16 18 20 22 0 2 4 6


Hourly Traffic
Manu - Simlung (NH44A)
80 70 60 50 40 30 20 10 0
8 10 12 14 16 18 20 22 24 2 4 6



Source: JICA Study Team

Figure 4.5.2 Hourly Variation of Traffic Volume on Ten Study Road Sections

Table 4.5.2 presents the peak period hourly follow of traffic in terms of percentage traffic flow (hourly) to total traffic flow during the day. The percentage of traffic flow (hourly) defined as peak hour factor (PHF) varies from 6.21% (near the existing bridge at Goalpara, Assam) to as high as 14.17% at Ukhrul – Tadubi Section (NH102A, Manipur State). While a PHF in the range of 6% to 8% is normally expected on National Highways, high values (of PHF) for some of the project road sections indicates skewed traffic flow pattern, possibly due to security situation prevailing in the area of influence of these roads.

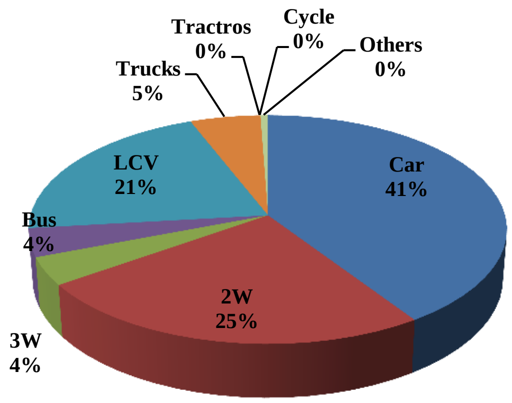
Table 4.5.2 Peak Hour Factor (%) for Ten Study Road Sections

Road ID	Study Road Sections	Peak - Hr	Peak-Hr Factor
1.0	Mizoram State, Aizawl – Tuipang Section, NH54	12 :00 – 13:00 Hrs	7.75%
2.0	Meghalaya State, Dudhanal – Dalu Section, NH62	11 :00 – 12:00 Hrs	9.68%
3.0	Meghalaya State, Tura – Dalu Section, NH51	08 :00 – 09:00 Hrs	7.14%
4.0	Meghalaya State, Shillong – Dawki Section, NH40	09 :00 – 10:00 Hrs	7.88%
5.0	Manipur State, Imphal – Jiribam Section, NH53	08 :30 – 09:30 Hrs	12.11%
6.0	Manipur State, Imphal - Nagaland State, Kohima Section, NH39	10 :30 – 11:30 Hrs	11.59%
7.0	Manipur State, Ukhrul – Tadubi Section, NH102A	07 :30 – 08:30 Hrs	14.17%
8.0	Tripura State, Manu - Simlung Section NH44 A	14 :00 – 15:00 Hrs	8.27%
9.0	Assam State, Badarpurghat Bridge near Silchar	12 :00 – 13:00 Hrs	9.82%
11.0	Assam State, Goalpara Bridge	11 :00 – 12:00 Hrs	6.21%

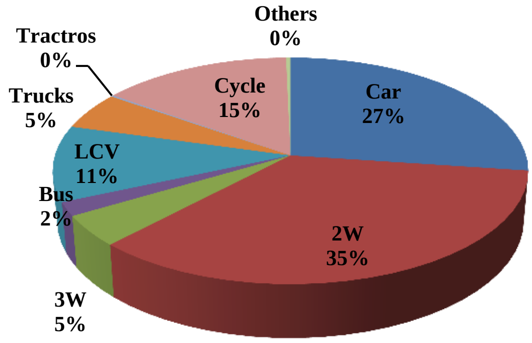
Source: JICA Study Team

4.5.1.3 Composition of Traffic

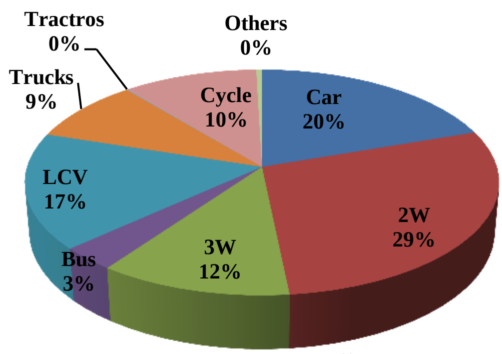
The average percentage composition of classified vehicles is depicted in Figure 4.5.3. It can be observed for all the 10 study road sections that the percentage of car/ jeeps/ taxis and two-wheelers is high. On Shillong – Dawki road section (NH40), the percentage of car/ jeeps/ taxis is75%. The highest percentage (23%) of trucks to the average daily traffic is observed at survey location at the existing bridge at Goalpara (Assam). The traffic count survey at Goalpara Bridge is for estimating the potential divergence of traffic to the proposed new bridge at Dhubri, a location west of Goalpara bridge.



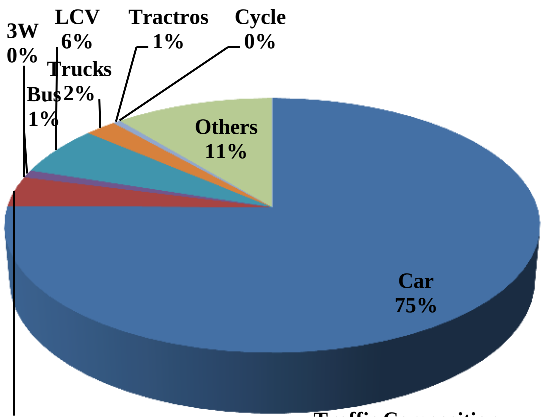
Traffic Composition
Aizwal - Tuipang (NH54)



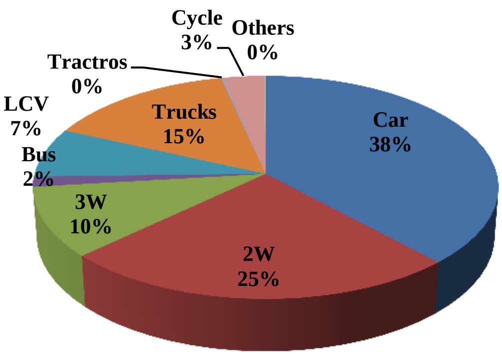
Traffic Composition
Dudhanai - Dalu (NH62)



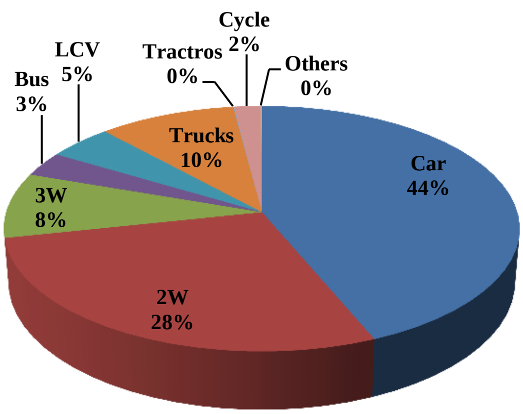
Traffic Composition
Tura -Dalu (NH51)



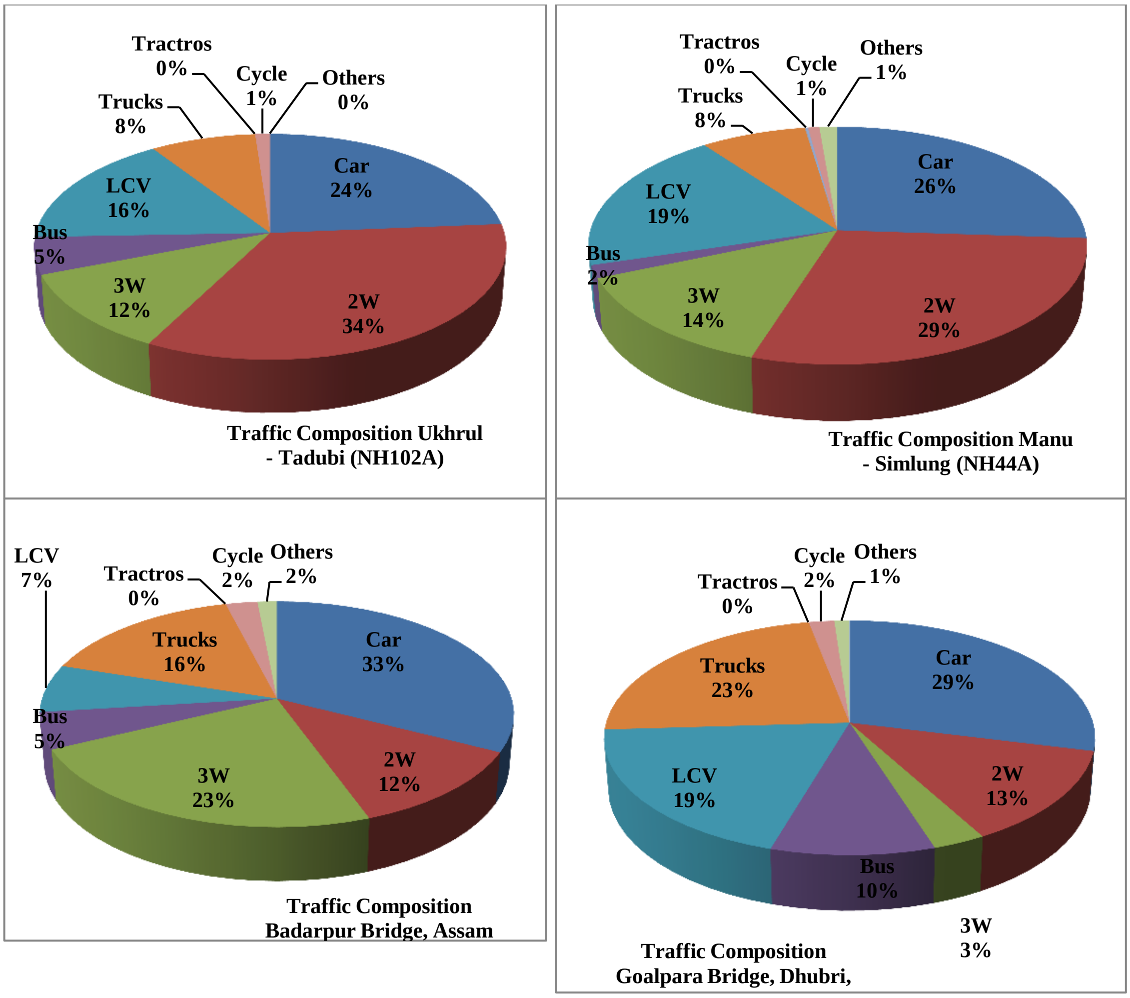
Traffic Composition
Shillong - Dawki (NH40)



Traffic Composition
Imphal - Jiribam(NH53)



Traffic Composition
Imphal - Nagaland(NH39)



Source: JICA Study Team

Figure 4.5.3 Composition of Traffic Volume on Ten Study Road Sections

4.5.1.4 Average Daily Traffic (ADT) & Average Annual Daily Traffic (AADT)

The ADT for all the ten road sections was worked out both in terms of "number of vehicles" as well as in "Passenger Car Units" (PCU). The PCU values have been adopted as given in IRC 64-1990, and are presented in the Table 4.5.3.

Table 4.5.3 Equivalent Passenger Car Units (PCU) Adopted

Vehicle	PCU Value	Vehicle	PCU Value
Car	**1.0**	Standard Bus	3.0
Mini Bus	**1.5**	2 -Wheeler	0.5
3- Wheeler	1.0	Light Commercial Vehicles	1.5
2-Axle Truck	3.0	3 -Axle Truck	4.5
Multi Axle Truck	4.5	Tractor	1.5
Tractor Trailer	4.5	Cycle	0.5
Cycle Rickshaw	2.0	Animal Drawn	8.0
Hand Drawn	3.0		

Source: IRC 64 – 1990

To arrive at ADT an arithmetic mean of seven days count was considered (in case of road sections in Manipur state, three days were considered). The ADT traffic figures were converted to Annual Average Daily Traffic (AADT) by applying seasonality variation factors (SVF) given in Table 4.5.4.

Base year (2015) AADT is computed by multiplying ADT with respective seasonal factor. Seasonal

Factor has been arrived based on the fuel sales data along the study road section. The traffic survey along the corridor was carried out during February and March months in the year 2015. The computed seasonal factors for petrol and diesel using vehicles for the month of February and March was estimated and applied to the ADT traffic to arrive at the AADT.

Table 4.5.4 Seasonality Variation Factors (SVF) Adopted

Road ID	Road Section	Fuel station location	Petrol (SVF)	Diesel (SVF)	TVC Location	Petrol (SVF) adopted	Diesel (SVF) adopted
1	Mizoram State, Aizawl – Tuipang Section, NH54	Singson filling station	0.96	0.99	1. Khualazin Tawangtaina Village	0.96	0.99
		Lalzuithanga filling station	1.03	1.06	2.Serchhip	1.03	1.06
		ADC filling station	0.98	1.02	3.Hirakundi	0.98	1.02
		Near Theiri	0.97	1.05	4.Tuipang Police Post	0.97	1.05
2	Meghalaya State, Dudhanal – Dalu Section, NH62	Nengkhar service station	1.05	0.97	1. Nengkhar	1.05	0.97
		Near Baghmara	0.97	1.01	2. Rongra	0.97	1.01
		Near Wagiasi	0.97	0.96	3.Dudhnoi	0.97	0.96
3	Meghalaya State, Tura – Dalu Section, NH51	Near Debasipara	1.04	0.98	1. Daronggre	1.04	0.98
		Police reserve petrol pump	0.97	1.04	2 . Karoggre Village	0.97	1.04
4	Meghalaya, Shillong – Dawki Section, NH40	Myllium service station	0.99	1.02	1. Mylliem Nagar	0.99	1.02
					2.Dawki Bridge	0.99	1.02
5	Manipur State, Imphal – Jiribam Section, NH53	Indian oil pamp Near taxi Stand in imphal	0.98	0.96	Sagolband on NH-53	0.98	0.96
6	Manipur State, Imphal - Nagaland State, Kohima Section, NH39	Tendongyan petrol station	0.97	0.97	Awang Sekhmai	0.97	0.97
	Manipur State, Imphal – Jiribam Section, NH53	Maa Durga Filling Station near Jiribam	0.99	1.00	Jirighat	0.99	1.00
7	Manipur State, Ukhrul – Tadubi Section, NH102A	Tadubi Petrol pump	1.04	0.98	Shajouba	1.04	0.98
8	Tripura State, Manu - Simlung Section NH44	Akhil chandra gosh petrol station	1.02	0.98	1.Manu Police Check Post	1.02	0.98
		Lalthanzua filling station	1.06	0.97	2. Chailengta Village	1.06	0.97
9	Assam State, Badarpurghat Bridge near Silchar	Petrol pump in Tezpur	1.03	0.99	1. Tez Pur Bridge	1.03	0.99
		Joghigopa service station	0.98	0.98	2. Goal Para Bridge	0.98	0.98
		Mazumdar filling station	0.99	1.01	3. Badarpur Ghat	0.99	1.01
10	Kohima section NH-39	Petrol pump near P. R. Hills	1.02	1.03	P.R HILLS Near Zakhama	1.02	1.03

Source: JICA Study Team

The AADT figures for all the project road sections are set out in Table 4.5.5.

Table 4.5.5 Average Daily Traffic for Ten Road Sections

Road ID	Road/Section	Unit	2 W	3 W	Car	Bus	Mini Bus	Truck (2-Axle)	Truck (3-Axle)	Truck (4 to 6-Axle)	Truck (7 & more Axle)	LCV	Bicycle	Animal Vehicle	Agri. Tractors	Others	Total
RD-1	**Aizawl - Tuipang (NH 54)**																
RD-1.1	Km 0 - Km 55	Veh.	598	42	1193	71	55	149	50	0	0	577	0	0	0	23	2760
		PCU	299	42	1193	214	83	448	227	0	0	866	0	0	0	69	3441
RD-1.2	Km 55- Km125	Veh.	164	20	168	12	21	0	0	0	0	89	0	0	0	0	474
		PCU	82	20	168	35	32	0	0	0	0	134	0	0	0	0	471
RD-1.3	Km 125 - Km 250	Veh.	97	0	125	0	0	13	0	0	0	53	0	0	0	0	288
		PCU	49	0	125	0	0	40	0	0	0	80	0	0	0	0	294
RD-1.4	Km 250 - Km 381	Veh.	119	96	130	0	0	0	0	0	0	110	0	0	0	0	455
		PCU	60	96	130	0	0	0	0	0	0	165	0	0	0	0	451
RD-2	**Dudhanal - Dalu (NH 62)**																
RD-2.1	Km 0 -Km30	Veh.	586	89	473	12	17	115	0	0	0	201	416	0	0	0	1909
		PCU	293	89	473	35	26	346	0	0	0	301	208	0	0	0	1771
RD-2.2	Km 30-Km 87	Veh.	233	28	244	3	16	26	0	0	0	57	4	1	6	6	625
		PCU	117	28	244	9	25	79	0	0	0	86	2	8	27	18	643
RD-2.3	Km 87-Km 91	Veh.	207	12	78	4	5	16	0	0	0	60	13	0	0	4	399
		PCU	103	12	78	12	8	48	0	0	0	89	7	0	0	12	369
RD-2.4	Km 91-Km 183	Veh.	207	12	78	4	5	16	0	0	0	60	13	0	0	4	399
		PCU	103	12	78	12	8	48	0	0	0	89	7	0	0	12	369
RD-3	**Tura - Dalu (NH51)**																
RD-3.1	Km 0 -Km 10	Veh.	441	232	351	9	79	41	6	2	0	209	0		1	18	1390
		PCU	220	232	351	26	119	123	26	9	0	313	0	0	5	54	1478
RD-3.2	Km16 -Km 60	Veh.	794	266	499	11	45	343	0	0	0	509	450	9	4	1	2932
		PCU	397	266	499	34	67	1030	0	0	0	763	225	72	18	3	3374
RD-4	**Shillong - Dawki (NH40)**																
RD-4.1	Km 0 -Km 28	Veh.	180	0	3829	30	36	608	0	0	0	737	0	0	0	16	5436
		PCU	90	0	3829	89	54	1824	0	0	0	1106	0	0	0	48	7040
RD-4.2	Km 28-Km 43	Veh.	78	0	1213	0	0	146	0	0	0	423	0	0	0	2	1862
		PCU	39	0	1213	0	0	438	0	0	0	635	0	0	0	6	2331
RD-4.3	Km 43-Km75	Veh.	78	0	1213	0	0	146	0	0	0	423	0	0	0	2	1862
		PCU	39	0	1213	0	0	438	0	0	0	635	0	0	0	6	2331
RD-4.4	Km 75 -Km 82	Veh.	78	0	1213	0	0	146	0	0	0	423	0	0	0	2	1862
		PCU	39	0	1213	0	0	438	0	0	0	635	0	0	0	6	2331
RD-4.5	Km 82 -Km 84	Veh.	78	0	1213	0	0	146	0	0	0	423	0	0	0	2	1862
		PCU	39	0	1213	0	0	438	0	0	0	635	0	0	0	6	2331
RD-5	**Imphal - Jiribam (NH53)**																
RD-5.1	Km 0 -Km 3	Veh.	1767	880	2122	50	46	379	90	22	0	461	344	10	19	5	6196
		PCU	883	880	2122	150	69	1138	406	99	0	691	172	80	86	15	6791
RD-5.2	Km 3 -Km 145	Veh.	1251	352	2501	41	40	1018	234	48	0	408	46	0	1	5	5946
		PCU	626	352	2501	123	60	3054	1053	216	0	612	23	0	5	15	8640
RD-5.3	Km 145 -Km 221	Veh.	1251	352	2501	41	40	1018	234	48	0	408	46	0	1	5	5946
		PCU	626	352	2501	123	60	3054	1053	216	0	612	23	0	5	15	8640
RD-6	**Imphal - Kohima (NH39)**																
RD-6.1	Km 0 -Km 8	Veh.	2159	458	3332	138	275	817	157	130	0	263	167	0	8	5	7909
		PCU	1080	458	3332	413	413	2450	707	585	0	394	84	0	36	15	9967
RD-6.2	Km 8 -Km 107	Veh.	1482	664	2359	5	9	138	26	4	0	340	80	0	0	6	5113
		PCU	741	664	2359	15	14	414	116	19	0	510	40	0	0	18	4910
RD-6.3	Km 107 -Km 138	Veh.	1482	664	2359	5	9	138	26	4	0	340	80	0	0	6	5113
		PCU	741	664	2359	15	14	414	116	19	0	510	40	0	0	18	4910
RD-7	**Ukhrul - Tadubi (NH102A)**																
RD-7.1	Km 0 -Km 115	Veh.	327	111	228	24	27	64	15	0	0	157	11	0	0	0	963
		PCU	163	111	228	71	41	191	66	0	0	235	6	0	0	0	1112
RD-8	**Manu -Simlung (NH44A)**																
RD-8.1	Km 0 -Km 16	Veh.	332	144	305	7	6	74	5	1	0	242	5	0	1	20	1142
		PCU	166	144	305	21	9	223	22	4	0	363	3	0	5	60	1325
RD-8.2	Km 16 -Km 67	Veh.	191	104	166	10	9	44	15	2	0	111	10	0	3	4	667
		PCU	95	104	166	29	13	131	65	9	0	166	5	0	14	12	809
RD-8.3	Km67-Km 97	Veh.	191	104	166	10	9	44	15	2	0	111	10	0	3	4	667
		PCU	95	104	166	29	13	131	65	9	0	166	5	0	14	12	809
RD-8.4	Km97-Km 110	Veh.	191	104	166	10	9	44	15	2	0	111	10	0	3	4	667
		PCU	95	104	166	29	13	131	65	9	0	166	5	0	14	12	809

Road ID	Road/Section	Unit	2 W	3 W	Car	Bus	Mini Bus	Truck (2-Axle)	Truck (3-Axle)	Truck (4 to 6-Axle)	Truck (7 & more Axle)	LCV	Bicycle	Animal Vehicle	Agri. Tractors	Others	Total
RD-9	**Badarpur Bridge, Assam**	Veh.	514	1012	1405	94	131	382	202	111	0	296	107	0	0	65	4320
		PCU	257	1012	1405	282	197	1145	909	500	0	444	54	0	0	195	6400
RD-11	**Goalpara Bridge, Assam**	Veh.	725	170	1594	250	279	781	398	87	0	1077	105	0	0	63	5531
		PCU	363	171	1594	750	419	2343	1790	392	0	1616	53	0	0	189	9680

Source: JICA Study Team

4.5.2 RSI (Origin & Destination Data Analysis)

In order to understand the travel demand pattern in the region, Origin & Destination (O & D) survey was carried out at the locations mentioned in Table 4.5.1. Police assistance was arranged to ensure successful completion of the survey. Both passenger & commercial vehicles plying on the project road were stopped on a random sampling basis and interviewed. The travel characteristics obtained by O-D Survey facilitate the identification of traffic flows and possibility of diversion.

Trained enumerators under the supervision of transport planners collected the trip characteristics using survey forms designed for this purpose. The origin & destination survey elicited characteristics like Origin, Destination, frequency, commodity distribution of trip for commercial vehicles. The information pertaining to origin and destination of trips collected during roadside interviews was analyzed to obtain the trip distribution based on a zoning system presented as Appendix-2.

Table 4.5.6 provides the trip distribution for main vehicle categories at Goalpara survey location. This analysis was used to work out the potential diversion of traffic from Goalpara Bridge to the proposed new bridge at Dhubri.

Table 4.5.6 Trip Distribution of Vehicles at Goalpara (Assam) Bridge Location

Vehicle Type	Total vehicles	Intra District (Goalpara)	Inter District (Goalpara)	Intra State (Assam)	Inter State (Assam)	Intra - NE region	Inter NE and rest of Indian states
Car	366	0%	63%	90%	8%	98%	2%
Bus	59	0%	68%	95%	5%	100%	0%
Mini Bus	73	0%	77%	96%	4%	100%	0%
2W	162	0%	83%	83%	17%	100%	0%
LCV	257	0%	59%	92%	8%	100%	0%
Truck	247	0%	53%	74%	7%	81%	19%
MAV	27	0%	44%	67%	0%	67%	33%

Source: JICA Study Team

4.6 Traffic Projections

Traffic growth on a road facility is generally estimated on the basis of historical trends. Demand changes usually because of shifts in the pattern of economic activities in the surrounding regions. Hence, future traffic estimation necessitates a preview, however imprecise, of the probable pattern of future growth of the economy.

The exercise on normal traffic growth rate estimation has been carried out by the Study Team using the elasticity approach. The total traffic that is likely to patronize the improved road facility will comprise three distinct streams viz i) normal traffic, ii) generated (or induced) traffic, and iii) diverted traffic.

4.6.1 Traffic Type

Normal Traffic: refers that stream of traffic which is currently using the study road and will continue to grow even without the proposed improvement.

Generated/Induced Traffic: connotes that stream of traffic which will get generated on account of the improved service (e.g reduction in transport cost, reduced transit time, safe and comfortable travel, etc.,) attributes to the proposed improvements on the study road. As study road passes through the industrial zone and several villages and towns, with the widening / improvement of roads, the trip frequencies is expected to increase, thus a minimum of 5% of normal traffic is considered as generated/induced traffic to the study road where there is sufficient road capacity for at least 5 years after the improvement of roads.

Diverted Traffic: denotes that stream of traffic which will get diverted from other routes / modes of transport to the study road because of the improved transport services traceable to the proposed improvements. The study corridor is the only major road in the study region and there are no competitive roads. As such diverted traffic is not anticipated for the project road. However, with the construction of new bridge at Dhubri, a lot of savings in distance is expected for the traffic, at present, using Goalpara Bridge. Based on the analysis of O-D survey, it is expected that two stream of traffic shall be benefit considerably due to savings in distance, by diverting to the new bridge proposed at Dhubri. It is estimated that about 40% of the traffic intercepted at the traffic station at Goalpara, shall be saving about 118 Kms and another 20% shall be saving about 26 kms.

Kaladan Multimodal Transit Transport Project

Apart from the above, it is expected that due to taking-up of already planned/ earmarked major projects, traffic volumes may increase on some of the study roads. In respected, the impact of Kaladhan Project shall have in increasing the traffic volume on NH54 is expected and studied.

Ministry of External Affairs (MEA), Govt. of India entered into a Framework Agreement with the Govt. of Myanmar in April 2008 to facilitate implementation of the project. The Framework Agreement is for development of the Multimodal Transit Transport system to the North Eastern states through Myanmar. The transit route envisaged between Kolkata (nearest Indian port / commercial hub) and comprises of following segments.

Table 4.6.1 Components of Kaladan Multimodal Transit Transport Project

Stretch	Mode	Distance
Kolkata to Sittwe port in Myanmar	Shipping	539 km
Sittwe to Paletwa (River Kaladan)	IWT	158 km
Paletwa to Indo-Myanmar Border(in Myanmar	Road	110 km
Border to NH.54 (Lawngtlai) (in India)	Road	100 km

Source: Ministry of Development of North Eastern Region

The work on the project has substantially been completed, and shall function shortly. The traffic due to this project is expected to increase considerable on NH54 and from there on to other roads in NER. It is assumed that on this account the traffic on the NH54 will increase by 30% in next by the year 2017, and thereby increase at a rate of 7% per annum.

4.6.2 Traffic Projection Methodology

The traffic projections have been carried out by using the elasticity approach. The elasticity method relates traffic growth to changes in the related economic parameters.

Step1: Determining Vehicle-wise Elasticity
Step 2: Estimating Vehicle Growth Rates

The exercise on normal traffic growth rate estimation has been carried out by the Study Team using the Vehicle Registration method and elasticity approach mentioned in the IRC: 108-1996, using the following form:

Table 4.6.2 Step of Traffic Projection

Item	Function	Parameters
Step 1		
Elasticity	Log e (P) = A0 + A1 Log e (EI)	• P = Traffic volume (of any vehicle type) • EI = Economic Indicator (GDP/NSDP/Population/PCI) • A0 = Regression constant; • A1 = Regression co-efficient (Elasticity Index)
Step2		
Passenger Vehicles	Grp = [(1+Rp) (1+ rpci x Em) – 1]	• Grp- Growth Rate Passenger Vehicle • Rp= Population Growth • Rpci= Per capita Income Growth • Em= Elasticity
Goods Vehicles	Grg = Em * R(nsdp)	• Grg- Growth Rate Goods Vehicle • Em= Elasticity Value • R(nsdp) = NSDP Growth Rate

Source: Derived from IRC: 108-1996

4.6.3 Registered Vehicles

Following the forecast methodology stated above, the data on traffic volume was collected. In absence of the traffic count figures series for the project road sections, the series (year 2005 to 2012) was used as a surrogate for traffic volume. The state – level registered vehicle data is presented in Table 4.6.3 for the 6 North-Eastern states considered in the study.

Table 4.6.3 Registered Vehicles in 6 Study Area States

State	Two Wheeler	Autos Rickshaw	Cars / Jeep Taxi	Bus	Truck	LCV
Assam						
2005	476378	32386	150523	10776	87118	16852
2006	541275	34906	172780	11378	91801	19371
2007	610529	37691	194828	13091	97790	22587
2008	667788	41267	215817	13732	105565	25451
2009	740420	45266	240811	14460	114485	29703
2010	830836	51185	277376	15084	124132	32473
2011	958935	59742	318627	15984	136090	35788
2012	1101265	67921	366884	17035	144183	47296
CAGR (%)	11.61%	10.57%	12.46%	6.41%	7.49%	13.73%
Manipur						
2005	80557	2630	18170	3150	6314	1490
2006	86931	2721	20178	3371	6746	1854
2007	93595	3787	20819	3549	7078	2005
2008	105465	4071	21635	3977	7216	2245
2009	105465	4071	21635	3977	7216	2245
2010	139650	7266	28180	4293	7639	2871
2011	145286	9954	30816	4376	8249	3207
2012	148942	11854	32107	4473	8599	4054
CAGR (%)	9.61%	22.59%	8.35%	5.15%	4.04%	12.89%
Meghalaya						
2005	27237	3001	36856	3285	15819	1907
2006	31008	3569	42083	3497	17060	2565
2007	36112	4081	47076	3639	17937	3222
2008	40953	4433	51637	3779	18572	3781
2009	45747	4842	57999	3905	19747	4425
2010	51709	5348	64916	4008	21372	4955
2011	56790	6000	73419	4117	23064	6058

State	Two Wheeler	Autos Rickshaw	Cars / Jeep Taxi	Bus	Truck	LCV
2012	65712	6744	81615	4326	25451	7210
CAGR (%)	12.36%	10.91%	11.22%	3.65%	6.46%	17.92%
Mizoram						
2005	21816	1336	13457	672	4061	0
2006	24737	1534	14986	704	4475	5
2007	27776	1758	20870	907	3000	2566
2008	30062	1931	22367	954	3167	2981
2009	32267	2105	23551	1003	3343	3397
2010	39902	2219	25660	1036	3507	4003
2011	47978	2477	28040	1088	3844	4862
2012	60278	2955	31233	1141	4285	6194
CAGR (%)	13.79%	10.40%	11.55%	7.54%	0.16%	17.25%
Nagaland						
2005	39989	9100	61586	4079	44002	10733
2006	42851	9548	64998	4410	47089	11804
2007	45961	10408	69192	4683	51466	13319
2008	48976	12939	72997	4896	55974	14043
2009	52119	13143	76681	5172	60684	15068
2010	55208	13403	80300	5538	65729	16345
2011	61085	14284	83278	6074	77968	25158
2012	61546	14429	87127	6047	84008	17799
CAGR (%)	6.43%	7.16%	4.96%	5.85%	9.36%	9.53%
Tripura						
2005	34450	11881	11299	1877	7664	1872
2006	61968	13237	12330	1974	8138	2535
2007	69830	14544	13653	2097	8593	3336
2008	76952	15829	14942	2200	9000	4037
2009	85455	16968	16323	2241	9524	4819
2010	97895	15749	25634	2212	10432	6199
2011	117486	18074	29126	2313	10934	7568
2012	129343	19203	31462	2330	11166	8452
CAGR (%)	16.16%	6.22%	16.01%	2.96%	5.65%	21.50%

Source: NEC, Shillong

4.6.4 Economic Indicators

NSDP at Constant Prices is presented in Table 4.6.4. It was used as independent variable for estimating the elasticity of the goods vehicles such as trucks, LCVs etc.

Table 4.6.4 NSDP at Constant Prices

(in INR Million)

Year	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Tripura
2004-05	471807	46033	58457	23996	54215	81697
05-06	486016	49070	63028	25773	59861	87082
06-07	507965	49920	67777	26927	64537	94580
07-08	529680	52661	69909	29885	69784	100822
08-09	561230	56421	78893	34370	74217	111463
09-10	612939	60395	83964	38320	78420	122873
10-11	657260	58619	92261	45389	85872	132149
11-12	690348	64201	102988	44053	92912	143389

Source: Ministry of Statistics & Programme Implementation, Government of India

The per capita income data used as independent variables for estimating elasticity for passenger vehicles, such as cars, buses, two wheelers etc., is presented in Table 4.6.5.

Table 4.6.5 Per Capita Income (in INR)

Year	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Tripura
2004-05	16782	18640	24086	24662	30441	24394
05-06	17050	19478	25642	25826	33072	25688
06-07	17579	19430	27242	26308	35074	27558
07-08	18089	20104	27764	28467	37317	29022
08-09	18922	21131	30963	31921	39041	31711
09-10	20406	22197	32569	34699	40590	34544
10-11	21611	21147	35363	40072	43992	36718
11-12	22420	22739	34217	37921	46340	39382

Source: Ministry of Statistics & Programme Implementation, Government of India

4.6.5 Elasticity

The projected elasticity values established for the vehicles categories and for the 6 states, are given in Table 4.6.6.

Table 4.6.6 Vehicle-wise Elasticity Values

Assam						
Year/ Period	**2005 - 14**	**2014 - 17**	**2017 -20**	**2020 - 25**	**2025-30**	**Beyond 2030**
NSDP Growth Rate (%)	5.80%	6.09%	6.40%	6.08%	5.78%	5.49%
Population Growth Rate (%)	1.27%	1.21%	1.15%	1.15%	1.09%	1.04%
PCI Growth Rate (%)	4.53%	4.92%	5.29%	4.97%	4.72%	4.49%
Elasticity w.r.t PCI						
Two Wheeler, ($y=2.551x-11.65$, $R^2 = 0.969$)	2.55	2.30	1.84	1.65	1.57	1.49
Autos Rickshaw, ($y = 2.363x - 12.57$, $R^2 = 0.989$)	2.36	2.12	1.70	1.53	1.45	1.38
Cars / Jeep Taxi, ($y = 2.740x - 14.64$, $R^2 = 0.972$)	2.74	2.33	1.86	1.68	1.59	1.51
Bus, ($y = 1.368x - 3.950$, $R^2 = 0.894$)	1.37	1.23	1.17	1.05	1.00	0.95
Elasticity w.r.t NSDP						
Truck, ($y = 1.296x - 5.547$, $R^2 = 0.992$)	1.30	1.24	1.17	1.11	1.06	1.01
LCV, ($y = 2.347x - 20.86$, $R^2 = 0.957$)	2.35	2.00	1.60	1.44	1.37	1.30
Manipur						
Year/ Period	**2005 - 14**	**2014 - 17**	**2017 -20**	**2020 - 25**	**2025-30**	**Beyond 2030**
NSDP Growth Rate (%)	4.53%	5.44%	5.98%	6.58%	5.92%	5.33%
Population Growth Rate (%)	2.09%	1.88%	1.69%	1.52%	1.37%	1.23%
PCI Growth Rate (%)	2.44%	3.56%	4.30%	5.08%	4.58%	4.13%
Elasticity w.r.t PCI						
Two Wheeler, ($y = 3.220x - 20.37$, $R^2 = 0.858$)	3.22	2.25	1.80	1.53	1.38	1.24
Autos Rickshaw, ($y = 7.266x - 63.64$, $R^2 = 0.774$)	7.27	2.91	2.04	1.42	1.14	0.97
Cars / Jeep Taxi, ($y = 2.748x - 17.21$, $R^2 = 0.795$)	2.75	1.93	1.44	1.23	1.10	0.99
Bus, ($y = 1.736x - 8.982$, $R^2 = 0.868$)	1.74	1.22	1.10	1.04	0.99	0.94
Elasticity w.r.t NSDP						
Truck, ($y = 0.824x - 0.085$, $R^2 = 0.870$)	0.82	0.90	0.99	1.04	0.94	0.94
LCV, ($y = 2.695x - 21.60$, $R^2 = 0.923$)	2.69	1.61	1.21	1.03	0.98	0.93
Meghalaya						
Year/ Period	**2005 - 14**	**2014 - 17**	**2017 -20**	**2020 - 25**	**2025-30**	**Beyond 2030**
NSDP Growth Rate (%)	7.82%	7.82%	7.04%	6.69%	6.35%	6.03%
Population Growth Rate (%)	3.06%	2.60%	2.21%	1.88%	1.59%	1.36%
PCI Growth Rate (%)	4.76%	5.19%	4.82%	4.82%	4.78%	4.71%
Elasticity w.r.t PCI						
Two Wheeler, ($y = 2.103x - 10.98$, $R^2 = 0.948$)	2.10	1.79	1.70	1.61	1.53	1.45
Autos Rickshaw, ($y = 1.860x - 10.70$, $R^2 = 0.944$)	1.86	1.58	1.50	1.43	1.36	1.29
Cars / Jeep Taxi, ($y = 1.922x - 8.862$, $R^2 = 0.961$)	1.92	1.63	1.55	1.47	1.40	1.33
Bus, ($y = 0.619x + 1.871$, $R^2 = 0.93$)	0.62	0.68	0.75	0.83	0.78	0.74
Elasticity w.r.t NSDP						
Truck, ($y = 0.817x + 0.703$, $R^2 = 0.994$)	0.82	0.90	0.99	1.04	0.94	0.94
LCV, ($y = 2.229x - 16.78$, $R^2 = 0.963$)	2.23	1.56	1.25	1.19	1.13	1.07
Mizoram						
Year/ Period	**2005 - 14**	**2014 - 17**	**2017 -20**	**2020 - 25**	**2025-30**	**Beyond**

						2030
NSDP Growth Rate (%)	9.30%	7.91%	7.11%	6.40%	6.08%	5.78%
Population Growth Rate (%)	2.53%	2.03%	1.62%	1.46%	1.31%	1.25%
PCI Growth Rate (%)	6.77%	5.88%	5.51%	4.97%	4.80%	4.57%
Elasticity w.r.t PCI						
Two Wheeler, ($y = 1.766x - 7.831$, $R^2 = 0.902$)	1.77	1.59	1.43	1.29	1.16	1.05
Autos Rickshaw , ($y = 1.299x - 5.834$, $R^2 = 0.875$)	1.30	1.24	1.17	1.11	1.11	1.11
Cars / Jeep Taxi, ($y = 1.425x - 4.741$, $R^2 = 0.809$)	1.42	1.35	1.28	1.22	1.22	1.22
Bus $y = 0.929x - 2.774$, ($y = 0.929x - 2.774$, $R^2 = 0.772$)	0.93	0.93	0.93	0.93	0.93	0.93
Elasticity w.r.t NSDP						
Truck. ($y = 0.584x + 2.031$, $R^2 = 0.875$)	0.58	0.73	0.83	0.96	0.96	0.96
LCV, ($y = 1.475x - 7.219$, $R^2 = 0.904$)	1.47	1.32	1.19	1.07	1.02	0.97

Nagaland

Year/ Period	2005 - 14	2014 - 17	2017 -20	2020 - 25	2025-30	Beyond 2030
NSDP Growth Rate (%)	7.26%	6.53%	6.21%	5.90%	5.60%	5.32%
Population Growth Rate (%)	1.80%	1.71%	1.54%	1.39%	1.25%	1.12%
PCI Growth Rate (%)	5.46%	4.84%	4.69%	4.54%	4.39%	4.24%
Elasticity w.r.t PCI						
Two Wheeler, ($y = 1.109x - 0.866$, $R^2 = 0.989$)	1.11	1.11	1.11	1.11	1.11	1.11
Autos Rickshaw, ($y = 1.240x - 3.683$, $R^2 = 0.905$)	1.24	1.18	1.18	1.12	1.06	1.01
Cars / Jeep Taxi, ($y = 0.853x + 2.211$, $R^2 = 0.990$)	0.85	0.98	1.12	1.12	1.12	1.12
Bus, ($y = 1.009x - 2.109$, $R^2 = 0.983$)	1.01	0.91	0.91	0.91	1.00	1.10
Elasticity w.r.t NSDP						
Truck, ($y = 1.258x - 3.077$, $R^2 = 0.983$)	1.26	1.01	0.96	0.91	0.91	0.91
LCV, ($y = 1.282x - 4.713$, $R^2 = 0.773$)	1.28	1.15	1.15	1.04	1.04	1.04

Tripura

Year/ Period	2005 - 14	2014 - 17	2017 -20	2020 - 25	2025-30	Beyond 2030
NSDP Growth Rate (%)	8.24%	7.42%	7.05%	6.70%	6.36%	6.04%
Population Growth Rate (%)	1.19%	1.07%	0.96%	0.87%	0.78%	0.70%
PCI Growth Rate (%)	7.06%	6.41%	6.15%	5.90%	5.65%	5.41%
Elasticity w.r.t PCI						
Two Wheeler, ($y = 2.257x - 12.05$, $R^2 = 0.873$)	2.26	1.81	1.63	1.46	1.32	1.19
Autos Rickshaw, ($y = 0.866x + 0.697$, $R^2 = 0.878$)	0.87	0.96	1.05	1.16	1.27	1.40
Cars / Jeep Taxi, ($y = 2.295x - 13.92$, $R^2 = 0.956$)	2.29	1.60	1.28	1.28	1.28	1.28
Bus, ($y = 0.410x + 3.428$, $R^2 = 0.853$)	0.41	0.62	0.74	0.81	0.89	0.89
Elasticity w.r.t NSDP						
Truck, ($y = 0.687x + 1.183$, $R^2 = 0.991$)	0.69	0.90	0.90	0.90	0.90	0.90
LCV, ($y = 2.598x - 21.73$, $R^2 = 0.980$)	2.60	1.30	1.17	1.05	0.95	0.95

Source: JICA Study Team

4.6.6 Traffic Projections

Traffic projections for the project road have been made on the basis of the growth rates given in Table 4.6.7. It can be observed that the growth rates are given state-wise. Depending on in which state the project road section is located, the growth rates of that state have been applied to project the traffic on the road section.

Table 4.6.7 Growth Rates Adopted for Traffic Projections

Assam

Year/ Period	2005 - 14	2014 - 17	2017 -20	2020 - 25	2025-30	Beyond 2030
Two Wheeler	12.97%	12.64%	10.98%	9.46%	8.59%	7.80%
Autos Rickshaw	12.10%	11.79%	10.25%	8.84%	8.03%	7.30%
Cars / Jeep Taxi	13.84%	12.81%	11.13%	9.58%	8.70%	7.90%
Bus	7.56%	7.35%	7.42%	6.45%	5.88%	5.36%
Mini Bus	7.56%	7.35%	7.42%	6.45%	5.88%	5.36%
Truck (2-Axle)	7.55%	7.53%	7.51%	6.78%	6.12%	5.52%
Truck (3-Axle)	7.55%	7.53%	7.51%	6.78%	6.12%	5.52%
Truck (4 to 6-Axle)	7.55%	7.53%	7.51%	6.78%	6.12%	5.52%

Truck (7 & more Axle)	7.55%	7.53%	7.51%	6.78%	6.12%	5.52%
LCV	13.64%	12.17%	10.23%	8.74%	7.89%	7.12%
Bicycle	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%
Animal Drawn Vehicle	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%
Agricultural Tractors	2.00%	2.00%	2.00%	1.00%	1.00%	1.00%
Others	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%

Manipur

Year/ Period	2005 - 14	2014 - 17	2017 -20	2020 - 25	2025-30	Beyond 2030
Two Wheeler	10.12%	10.06%	9.58%	9.43%	7.77%	6.42%
Autos Rickshaw	20.23%	12.43%	10.60%	8.87%	6.66%	5.28%
Cars / Jeep Taxi	8.95%	8.87%	8.01%	7.85%	6.50%	5.38%
Bus	6.43%	6.30%	6.49%	6.89%	5.96%	5.16%
Mini Bus	6.43%	6.30%	6.49%	6.89%	5.96%	5.16%
Truck (2-Axle)	3.71%	4.90%	5.93%	6.85%	5.55%	5.00%
Truck (3-Axle)	3.71%	4.90%	5.93%	6.85%	5.55%	5.00%
Truck (4 to 6-Axle)	3.71%	4.90%	5.93%	6.85%	5.55%	5.00%
Truck (7 & more Axle)	3.71%	4.90%	5.93%	6.85%	5.55%	5.00%
LCV	12.19%	8.77%	7.24%	6.77%	5.79%	4.95%
Bicycle	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%
Animal Drawn Vehicle	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%
Agricultural Tractors	2.00%	2.00%	2.00%	1.00%	1.00%	1.00%
Others	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%

Meghalaya

Year/ Period	2005 - 14	2014 - 17	2017 -20	2020 - 25	2025-30	Beyond 2030
Two Wheeler	13.37%	14.70%	16.17%	16.98%	15.28%	8.29%
Autos Rickshaw	12.19%	11.02%	9.61%	8.88%	8.17%	7.50%
Cars / Jeep Taxi	12.48%	11.29%	9.85%	9.10%	8.38%	7.70%
Bus	6.10%	6.23%	5.90%	5.92%	5.40%	4.91%
Mini Bus	6.10%	6.23%	5.90%	5.92%	5.40%	4.91%
Truck (2-Axle)	6.41%	7.05%	6.98%	6.97%	5.96%	5.66%
Truck (3-Axle)	6.41%	7.05%	6.98%	6.97%	5.96%	5.66%
Truck (4 to 6-Axle)	6.41%	7.05%	6.98%	6.97%	5.96%	5.66%
Truck (7 & more Axle)	6.41%	7.05%	6.98%	6.97%	5.96%	5.66%
LCV	17.44%	12.21%	8.79%	7.93%	7.16%	6.46%

Mizoram		0	0	0		
Year/ Period	**2005 - 14**	**2014 - 17**	**2017 -20**	**2020 - 25**	**2025-30**	**Beyond 2030**
Two Wheeler	14.81%	11.58%	9.65%	7.97%	6.96%	6.08%
Autos Rickshaw	11.55%	9.43%	8.20%	7.08%	6.74%	6.40%
Cars / Jeep Taxi	12.39%	10.12%	8.80%	7.60%	7.24%	6.87%
Bus	8.99%	7.60%	6.83%	6.15%	5.84%	5.55%
Mini Bus	8.99%	7.60%	6.83%	6.15%	5.84%	5.55%
Truck (2-Axle)	5.39%	5.73%	5.93%	6.14%	5.83%	5.54%
Truck (3-Axle)	5.39%	5.73%	5.93%	6.14%	5.83%	5.54%
Truck (4 to 6-Axle)	5.39%	5.73%	5.93%	6.14%	5.83%	5.54%
Truck (7 & more Axle)	5.39%	5.73%	5.93%	6.14%	5.83%	5.54%
LCV	13.67%	15.72%	18.08%	6.86%	6.19%	5.59%

Nagaland

Year/ Period	2005 - 14	2014 - 17	2017 -20	2020 - 25	2025-30	Beyond 2030
Two Wheeler	7.97%	7.17%	6.82%	6.49%	6.18%	5.88%

Autos Rickshaw	8.69%	7.51%	7.15%	6.54%	5.97%	5.45%
Cars / Jeep Taxi	6.53%	6.52%	6.89%	6.56%	6.24%	5.94%
Bus	7.41%	6.18%	5.87%	5.57%	5.69%	5.83%
Min Bus	7.41%	6.18%	5.87%	5.57%	5.69%	5.83%
Truck (2-Axle)	9.15%	6.59%	5.94%	5.37%	5.10%	4.84%
Truck (3-Axle)	9.15%	6.59%	5.94%	5.37%	5.10%	4.84%
Truck (4 to 6-Axle)	9.15%	6.59%	5.94%	5.37%	5.10%	4.84%
Truck (7 & more Axle)	9.15%	6.59%	5.94%	5.37%	5.10%	4.84%
LCV	9.29%	7.53%	7.15%	6.11%	5.81%	5.52%
Tripura						
Year/ Period	**2005 - 14**	**2014 - 17**	**2017 -20**	**2020 - 25**	**2025-30**	**Beyond 2030**
Two Wheeler	17.32%	12.78%	11.06%	9.57%	8.28%	7.16%
Autos Rickshaw	7.40%	7.27%	7.50%	7.75%	8.03%	8.34%
Cars / Jeep Taxi	17.54%	11.45%	8.92%	8.49%	8.08%	7.69%
Bus	4.12%	5.05%	5.54%	5.69%	5.86%	5.57%
Min Bus	4.12%	5.05%	5.54%	5.69%	5.86%	5.57%
Truck (2-Axle)	5.69%	6.66%	6.32%	6.01%	5.71%	5.42%
Truck (3-Axle)	5.69%	6.66%	6.32%	6.01%	5.71%	5.42%
Truck (4 to 6-Axle)	5.69%	6.66%	6.32%	6.01%	5.71%	5.42%
Truck (7 & more Axle)	5.69%	6.66%	6.32%	6.01%	5.71%	5.42%
LCV	21.43%	9.65%	8.25%	7.05%	6.03%	5.73%

Source: JICA Study Team

The Traffic projections for the period 2020, 2025, 2030 and 2035 are set out in Table 4.6.8. The capacity requirement in terms of number of lanes as defined in Indian Road Congress publication (IRC: 64-1990, Guidelines for Capacity of Roads in Rural Areas). The existing road sections are a mix of single lane, intermediate lane and 2 lane (with a negligible length with 4 lane) roads. These study roads are expected to be improved to 2 lanes (7m carriageway) with 1.5m paved shoulder on each side, and 1.0m un-paved area beyond the shoulders. Thus the capacity of the improved 2 lane roads will be higher than the normal 2 lane road with earthen shoulders.

As per the IRC guidelines, the capacity of a road with 7m carriageway, and good earthen shoulder (peak hour traffic in the range of 8% to 10% and Level of Service B) is as under:

Terrain	Design Service Volume (PCU/ day)
Plain/ Level	: 12,500 to 15,000
Rolling	: 10,000 to 11,000
Hilly/ Mountainous	: 5,000 to 7,000

The above capacity can increase by 15% if the shoulders are at least 1.5m in width, and are paved and surfaced. Thus with the proposed improvement under the present study, the following PCU values for design service volume for the study roads have been considered. These values form the basis for deciding the number of lane requirements for study road sections, as presented in Table 4.6.8.

Terrain	Design Service Volume (PCU/ day)
Plain/ Level	: 17,250
Rolling	: 12,650
Hilly/ Mountainous	: 8,050

Table 4.6.8 Traffic Projections

Road ID	Road/Section & Terrain	Unit	2020	2025	2030	2035
RD-1	**Aizawl - Tuipang (NH 54)**					
RD-1.1	Km 0 - Km 55, Mountainous	Veh.	6131	8782	12216	16541
		PCU	6090	8611	11876	16010
		No. of Lanes	2	2	>2	>2
RD-1.2	Km 55- Km125, Mountainous	Veh.	1905	2732	3802	5148

Road ID	Road/Section & Terrain	Unit	2020	2025	2030	2035
		PCU	1916	2716	3749	5057
		No. of Lanes	2	2	2	2
RD-1.3	Km 125 - Km 250 , Mountainous	Veh.	1558	2237	3123	4242
		PCU	1598	2268	3142	4246
		No. of Lanes	2	2	2	2
RD-1.4	Km 250 - Km 381 Mountainous	Veh.	1882	2690	3741	5072
		PCU	1865	2646	3664	4957
		No. of Lanes	2	2	2	2
RD-2	**Dudhanal - Dalu (NH 62)**					
RD-2.1	Km 0 -Km30 Mountainous/ Level	Veh.	3246	5543	9490	13659
		PCU	2938	4699	7470	10585
		No. of Lanes	2	2	2	>2 (Mountainous part)
RD-2.2	Km 30-Km 87 , Mountainous/ Rolling	Veh.	1151	2072	3658	5350
		PCU	1082	1760	2847	4077
		No. of Lanes	2	2	2	2
RD-2.3	Km 87-Km 91 , Mountainous	Veh.	754	1429	2637	3866
		PCU	639	1090	1842	2646
		No. of Lanes	2	2	2	2
RD-2.4	Km 91-Km 183 , Mountainous/ Rolling	Veh.	754	1429	2637	3866
		PCU	639	1090	1842	2646
		No. of Lanes	2	2	2	2
RD-3	**Tura - Dalu (NH51)**					
RD-3.1	Km 0 -Km 10, Rolling	Veh.	2524	4435	7653	11123
		PCU	2498	3999	6328	8996
		No. of Lanes	2	2	2	2
RD-3.2	Km16 -Km 60 , Rolling	Veh.	5001	8420	14135	20251
		PCU	5482	8489	12997	18176
		No. of Lanes	2	2	2	2
RD-4	**Shillong - Dawki (NH40)**					
RD-4.1	Km 0 -Km 28 , Mountainous/ Rolling	Veh.	9248	14286	21441	30671
		PCU	11616	17467	25443	35835
		No. of Lanes	>2	>2	>2	>2
RD-4.2	Km 28 -Km 43 , Mountainous	Veh.	3195	4956	7477	10694
		PCU	3904	5901	8648	12208
		No. of Lanes	2	2	2	2
RD-4.3	Km 43 -Km75, Mountainous/ Rolling	Veh.	3195	4956	7477	10694
		PCU	3904	5901	8648	12208
		No. of Lanes	2	2	2	>2 (Mountainous part)
RD-4.4	Km 75 -Km 82 , Mountainous	Veh.	3195	4956	7477	10694
		PCU	3904	5901	8648	12208
		No. of Lanes	2	2	2	2
RD-4.5	Km 82 -Km 84 ¸ Mountainous	Veh.	3195	4956	7477	10694
		PCU	3904	5901	8648	12208
		No. of Lanes	2	2	2	>2
RD-5	**Imphal - Jiribam (NH53)**					
RD-5.1	Km 0 -Km 3 , Level	Veh.	9801	14462	19977	26201
		PCU	10400	15032	20405	26456
		No. of Lanes	Already 4 L	Already 4 L	Already 4 L	Already 4 L
RD-5.2	Km 3 -Km 145 , Mountainous/ Level	Veh.	9224	13536	18717	24373
		PCU	12769	18281	26617	31818
		No. of Lanes	>2(Mountainous part)	>2	>2	>2
RD-5.3	Km 145 -Km 221 ¸ Mountainous	Veh.	9224	13536	18617	24373
		PCU	12769	18281	26617	31818
		No. of Lanes	>2(Mountainous part)	>2	>2	>2
RD-6	**Imphal - Kohima (NH39)**					
RD-6.1	Km 0 -Km 8. Level	Veh.	12369	18256	25256	33199
		PCU	14923	21509	29156	37835
		No. of Lanes	Already 4 L	Already 4 L	Already 4 L	Already 4 L
RD-6.2	Km 8 -Km 107 ,	Veh.	8236	12280	17081	22488

Road ID	Road/Section & Terrain	Unit	2020	2025	2030	2035
	Mountainous/ Rolling	PCU	7764	11397	15651	20408
		No. of Lanes	2	>2(Mountainous part)	>2	>2
RD-6.3	Km 107 -Km 138 , Mountainous	Veh.	8236	12280	17081	22488
		PCU	7764	11397	15651	20408
		No. of Lanes	2	>2	>2	>2
RD-7	**Ukhrul - Tadubi (NH102A)**					
RD-7.1	Km 0 -Km 115 , Mountainous	Veh.	1534	2280	3164	4172
		PCU	1710	2476	3365	4379
		No. of Lanes	2	2	2	2
RD-8	**Manu -Simlung (NH44A)**					
RD-8.1	Km 0 -Km 16 Rolling/ Level	Veh.	1878	2780	3995	5618
		PCU	2066	2942	4106	5663
		No. of Lanes	2	2	2	2
RD-8.2	Km 16 -Km 67, Mountainous	Veh.	1090	1615	2319	3263
		PCU	1261	1798	2507	3456
		No. of Lanes	2	2	2	2
RD-8.3	Km 67 -Km 97 , Mountainous/ Rolling	Veh.	1090	1615	2319	3263
		PCU	1261	1798	2507	3456
		No. of Lanes	2	2	2	2
RD-8.4	Km 97 -Km 110, Mountainous/ Rolling	Veh.	1090	1615	2319	3263
		PCU	1261	1798	2507	3456
		No. of Lanes	2	2	2	2
RD-9	**Badarpur Bridge (Near Silchar),** Level	Veh.	7744	11703	17122	24278
		PCU	10952	16064	22877	31658
		No. of Lanes	2	2	>2	>2
RD-11	**Dhubri-Phulbari Bridge, Assam** , Level	Veh.	5867	8780	12727	17897
		PCU	9796	14200	19988	27357
		No. of Lanes	2	2	>2	>2

Source: JICA Study Team

CHAPTER 5 ECONOMIC ANALYSIS

5.1 General

The proposed project aims at improvement of the defined road network in 6 states of NE Region. These roads are existing roads that warrants improvements in terms of design, slopes, deteriorated conditions, congested stretches, etc. The goals of these improvements are to encourage socio economic development, trade and tourism in NER, as well as increasing external trade with neighboring countries and beyond.

The economic evaluation methodology considers the magnitude of the impact of the project road improvements as compared to their existing situation. The improvement of road sections will result in savings to road users in the form of reduced ‘vehicle operating cost’ (VOC) and reduction in travel time for passengers and freight traffic, expressed in ‘value of time’ (VOT) terms. These savings/ reduced costs, calculated over the project life, are compared with construction costs for road improvement option. The results are expressed in Economic Internal Rates of Return (EIRR).

In the present context, the HDM-4 model has been used to establish the economic viability of the proposed road improvement. This has enabled the Study Team to estimate the economic internal rate of return (EIRR) and net present values (NPV) of the investment proposition for the road sections in the NER.

5.2 Methodology for Economic Analysis

The various steps considered for economic analysis are summarized as follows.

- Preparing Homogeneous Road Sections (HRS)
- Preparing Inputs for HDM 4 Analysis & Calibration
- Defining Improvement (Investment) Option
- Assigning Works Standards and Costs
- Assigning Maintenance Standards and Costs
- Incorporating exogenous Cost & Benefits (if considered)
- Carrying-out Economic Analysis using HDM 4
- Establishing Economic Feasibility (EIRR) and Conducting Sensitivity Analysis

The economic analysis framework follow the ‘with’ (i.e., project alternatives) and ‘without’ (i.e., base case or do minimum/ nothing) project approach, whereby the cost to the economy for moving a specified and projected volume of traffic on the road sections would be estimated in both the ‘with’ and ‘without’ the project situations, and compare theses costs to obtain the net benefit to the economy. The framework adopted for economic analysis is presented in Table5.2.1.

Table 5.2.1 Framework for Economic Analysis

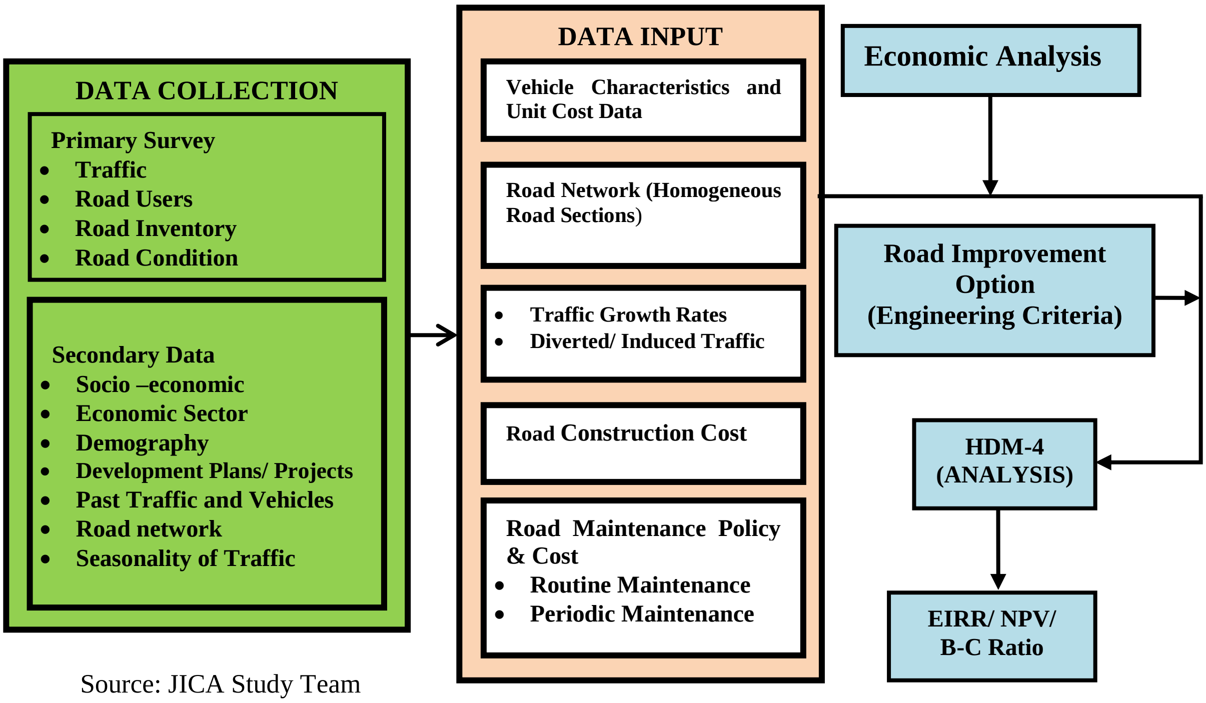
Cost to Economy	‘Without’ the Project case (Project Benefit)	‘With’ the Project Case (Project Cost)
Capital Cost		Construction cost of improvement/ upgrading/ strengthening etc. of the road
Maintenance Cost	Exiting maintenance cost (annual and periodic)	Considered by the Study Team for the desired maintenance of the new/ improved road assets created and the future level of performance expected from these assets
Vehicle Operating Cost (VOC)	Operating cost of the different vehicle types captured in the Classified Traffic Count Survey (and projected for future years) under the prevailing operating condition on the project road (estimated by using HDM 4)	Operating cost of the different vehicle types captured in the Classified Traffic Count Survey (and projected for future years) under the improved operating condition on the target roads; operating cost of ‘diverted’ and ‘induced’ traffic, if applicable (estimated by using HDM 4)
Value of Time (VOT)	Estimates of the time value of the projected passengers and goods traffic in transit under the prevailing road condition and the resulting speed of the vehicles (estimated by using HDM 4)	Estimates of the time value of the projected passengers and goods traffic in transit under the improved road condition and the resulting speed of the vehicles (estimated by using HDM 4)

Source: JICA Study Team

The project cost and benefits have been estimated for the project analysis period of 25 years, including 3 years construction period. At the terminal year of the analysis period a salvage value of 10% has been considered. The social discount rate for the purpose of working out net present value (NPV) is taken at 12%. This is the rate considered for similar kinds of projects in developing countries, and also reflecting the premium on 'decision to invest today' vis-à-vis 'saving it for future consumption'.

Constant base year (Yr. 2015) prices are used for economic evaluation. Since the project costs such as capital, vehicle, consumables, etc., are based on the market prices, these costs have been converted into economic costs by applying appropriate factors established for resource costs. For this, all the costs items (under 'with' and 'without' project cases) estimated at base year prices are adjusted for transfer of payments such as taxes, duties and subsidies on materials and equipments. Standard conversion factor (SCF) of 0.80 for road construction and for road maintenance has been used for converting the cost estimates at market prices to economic prices. The project capital cost comprises the costs relating to physical works implemented under the project.

The details on economic analysis have been provided in the subsequent sections of this chapter. The methodological frame has been illustrated as Figure 5.2.1.



Source: JICA Study Team

Figure 5.2.1 Methodology for Economic Analysis of Target Roads in NER

5.3 Homogeneous Road Sections

The traffic, engineering and cost data are major inputs for the economic analysis of roads sections. It is observed that a particular road section may not have uniform characteristics such as pavement width, traffic volume, roughness, etc. due to which data input in HDM-4 may become tedious and impractical. To overcome this situation, the concept of Homogeneous Road Section (HRS) is applied while performing data input and economic analysis. The project roads are divided into homogeneous sections, mainly on the basis of parameters – traffic, lane configuration, terrain and road condition (roughness of the road defined by IRI), whereby, each road is divided into homogeneous road sections on the basis of these parameters. The framework for combining is set out in Table 5.3.1. It also presents the HRS for each of the roads.

Table 5.3.1 Homogeneous Road Sections

Road ID	Road/Section	Length (Km)	Traffic (AADT)	Traffic (AADT)-PCU	Lane Configuration	Shoulder Width (Mt)	Adopted Lane Configuration	Terrain	Wt. Avg. IRI
MIZORAM STATE									
RD-1	**Aizawl - Tuipang (NH 54)**	**381**							
RD-1.1	Km 0 - Km 55 (Ref: Aizawl)	55	2760	3320	5.5 (IL)	0.4 (UP)	IL	Mountainous	4.50
RD-1.2	Km 55- Km125 (Ref: Aizawl)	70	474	471	3.75 (SL)	0.5 (UP)	SL	Mountainous	5.00
RD-1.3	Km 125 - Km 250 (Ref: Aizawl)	125	288	293	3.75 (SL)	0.4 (UP)	SL	Mountainous	6.20
RD-1.4	Km 250 - Km 381 (Ref: Aizawl)	131	455	451	3.75 (SL)	0.45 (UP)	SL	Mountainous	9.10
MEGHALAYA STATE									
RD-2	**Dudhanal - Dalu (NH 62)**	**183**							
RD-2.1 L	Km 0 -Km 20 (Ref: Dudhanai)	20	1909	1770	7.0 (DL)	0.85 (UP)	DL	Level	4.10
RD-2.1M	Km 20 -Km 30 (Ref: Dudhanai)	10	1909	1770	7.0 (DL)	0.85 (UP)	DL	Mountainous	4.10
RD-2.2 M	Km 30-Km 82 (Ref: Dudhanai)	52	625	610	5.5 (IL)	1.0 (UP)	IL	Mountainous	4.50
RD-2.2 R	Km 82-Km 87 (Ref: Dudhanai)	5	625	610	5.5 (IL)	1.0 (UP)	IL	Rolling	4.50
RD-2.3	Km 87-Km 91 (Ref: Dudhanai)	4	399	362	3.75 (SL)	1.0 (UP)	SL	Mountainous	8.00
RD-2.4 M	Km 91-Km 153 (Ref: Dudhanai)	62	399	362	3.75 (SL)	1.0 (UP)	SL	Mountainous	7.20
RD-2.4 R	Km 153-Km 183 (Ref: Dudhanai)	30	399	362	3.75 (SL)	1.0 (UP)	SL	Rolling	7.20
RD-3	**Tura - Dalu (NH51)**	**54**							
RD-3.1	Km 0 -Km 10 (Ref: Tura)	10	1390	1432	3.75 (SL)	1.0 (UP)	SL	Rolling	5.20
RD-3.2	Km16 -Km 60 (Ref: Tura)	44	2932	3343	3.75 (SL)	1.0 (UP)	SL	Rolling	6.50
RD-4	**Shillong - Dawki (NH40)**	**84**							
RD-4.1 R	Km 0 -Km 6 (Ref: Shillong)	6	5240	6901	7.0 (DL)	0.5 (UP)	DL	Rolling	3.60
RD-4.1 M	Km 6 -Km 28 (Ref: Shillong)	22	5240	6901	7.0 (DL)	0.5 (UP)	DL	Mountainous	3.60
RD-4.2	Km 28 -Km 43 (Ref: Shillong)	15	1862	2327	5.5 (IL)	0.5 (UP)	IL	Mountainous	5.50
RD-4.3 M	Kmv43 -Km 62 (Ref: Shillong)	19	1862	2327	7.0 (DL)	0.4 (UP)	DL	Mountainous	5.00
RD-4.3 R	Kmv 62 -Km 75 (Ref: Shillong)	13	1862	2327	7.0 (DL)	0.4 (UP)	DL	Rolling	5.00
RD-4.4	Km 75 -Km 82 (Ref: Shillong)	7	1862	2327	3.75 (SL)	0.5 (UP)	SL	Mountainous	7.00
RD-4.5	Km 82 -Km 84 (Ref: Shillong)	2	1862	2327	7.0 (DL)	0.5 (UP)	DL	Mountainous	5.50
MANIPUR STATE									
RD-5	**Imphal - Jiribam (NH53)**	**221**							
RD-5.1	Km 0 -Km 3 (Ref: Imphal)	3	6196	6569	14.0 (4L)	0.4 (UP)	4 L	Level	4.00
RD-5.2 L	Km 3 -Km 15 (Ref: Imphal)	12	5946	8640	7.0 (DL)	0.4 (UP)	DL	Level	5.00
RD-5.2 M	Km 15 -Km 145 (Ref: Imphal)	130	5946	8640	7.0 (DL)	0.4 (UP)	DL	Mountainous	5.00
RD-5.3 M	Km 145 -Km 207 (Ref: Imphal)	62	6196	6569	7.0 (DL)	0.5 (UP)	DL	Mountainous	5.50
RD-5.3 R	Km 207 -Km 221 (Ref: Imphal)	14	5946	8640	7.0 (DL)	0.5 (UP)	DL	Rolling	5.50
RD-6	**Imphal - Kohima (NH39)**	**138**							
RD-6.1	Km 0 -Km 8 (Ref: Imphal)	8	7909	9697	14.0 (4L)	0.5 (UP)	4 L	Level	4.50
RD-6.2 R	Km 8 -Km 33 (Ref: Imphal)	25	5113	4859	7.0 (DL)	0.5 (UP)	DL	Rolling	5.00
RD-6.2 M	Km 33 -Km 107 (Ref: Imphal)	74	5113	4859	7.0 (DL)	0.5 (UP)	DL	Mountainous	5.00
RD-6.3	Km 107 -Km 138 (Ref: Imphal)	31	5113	4859	7.0 (DL)	0.5 (UP)	DL	Mountainous	5.50
RD-7	**Ukhrul - Tadubi (NH102A)**	**115**							
RD-7.1	Km 0 -Km 115 (Ref: Ukhrul)	115	963	1112	3.5 (SL)	0.5 (UP)	SL	Mountainous	5.00
TRIPURA STATE									
RD-8	**Manu -Simlung (NH44A)**	**110**							
RD-8.1 L	Km 0 -Km 7 (Ref: Manu)	7	1142	1274	3.5 (SL)	0.5 (UP)	SL	Level	6.00
RD-8.1 R	Km 7 -Km 16 (Ref: Manu)	9	1142	1274	3.5 (SL)	0.5 (UP)	SL	Rolling	6.00
RD-8.2	Km 16 -Km 67 (Ref: Manu)	51	667	771	New Section			Mountainous	10.0
RD-8.3 R	Km 67 -Km 75 (Ref: Manu)	8	667	771	3.5 (SL)	0.5 (UP)	SL	Rolling	5.80
RD-8.3 M	Km 75 -Km 97 (Ref: Manu)	22	667	771	3.5 (SL)	0.5 (UP)	SL	Mountainous	5.80
RD-8.4 M	Km 97 -Km 105 (Ref: Manu)	8	667	771	3.5 (SL)	0.5 (UP)	SL	Mountainous	20.00
RD-8.4 R	Km 105 -Km 110 (Ref: Manu)	5	667	771	3.5 (SL)	0.5 (UP)	SL	Rolling	20.00
ASSAM STATE									
RD-9	**Badarpur Bridge (Near Silchar)**	0.36	4320	6400	Realignment of Existing Bridge 0.36 Km				
RD-11	**Dhubri (Dhubri - Phulbari Section)***	39	5531	9680	18 Km New Bridge + 21 KM Access Road (DL)				
	Grand Total	**1325.36 Km**							

Source: JICA Study Team

It can be observed from the above table that the road network included in the present study consists of 8 roads (RD-1 to RD-8) that are part of different National Highway (NH) and add up to a length of 1286 Kms. These 8 roads are further divided into 37 HSs. Road No. 9 (RD-9) is the existing bridge of 0.36 Km length, at Badarpur (near Silchar, Assam) and Road No. 11 is a new bridge of 18 Km with 21 Km of approach/ access road on River Brahmaputra at Dhubri (Dhubri – Phulbari Section, Assam). The economic analysis has been conducted for the 8 roads, as well as, the two bridges.

5.4 Application of Improvement Option

The Study Team has formulated improvement option after having detailed interaction on the engineering and local aspects concerning the study roads and bridges. The identified improvement options are presented in Table 5.4.1.

Table 5.4.1 Project Road & Bridges Improvement Option

Project Road/ Bridge	Project Option	Description
RD-1 to RD-8	Base Case (Without the Project Case)	'No-construction/ improvement' (do-nothing or do-minimum) situation, where in, the current practices that are adopted by the PWD for the routine and periodic maintenance of the roads forms the part of the works, without any new investments on the project roads
	Improvement Option (With the Project Case)	Improvement to 2 Lane (Wide) road with carriageway width 7 mt (adjusted to lower width in urban areas) and 2.5mtX2 shoulder (un paved)
RD-9 (Badarpur Bridge)	Base Case (Without the Project Case)	no-construction/ improvement' (do-nothing or do-minimum) situation, where in, the current practices that are adopted by the PWD for the routine and periodic maintenance of the bridge forms the part of the works, without any new investments on the project bridge
	Improvement Option (With the Project Case)	Construction of new 2 lane bridge adjacent to the existing bridge
RD-11 (New Bridge at Dhubri)	Base Case (Without the Project Case)	'no-construction/ improvement' (do-nothing or do-minimum) situation, where in, the current practices that are adopted by the PWD for the routine and periodic maintenance of existing road from where the traffic will divert to the new bridge location, without any new investments on the roads
	Improvement Option (With the Project Case)	Construction of new 2 Lane bridge of 18km with 21 km of 2 Lane approach/ access road

Source: JICA Study Team

The improvement option indicated above has been applied to each of the homogeneous road sections. As observed in the chapter on traffic analysis, in some of the study roads the traffic volumes shall reach capacity limits (V/C ratio close to 1) within the project analysis period (2017 to 2041), warranting further widening, otherwise the intended benefits shall not occur due to congestion on the improved roads after the capacity limits have reached. Since no such investments on capacity augmentation for such cases is envisaged in the present study, for the purpose of economic analysis, the increase in traffic have been frozen for the roads, after the year when the V/C ratio is close to 1.

5.5 HDM 4 Data Inputs

HDM 4 requires data input in a structured manner. The data requirements relate to road network, vehicle and traffic details. These data were obtained by different means such as road survey of the network; collecting vehicle characteristics, costs, vehicle performance etc.; traffic surveys for estimating traffic composition and forecasting growth rates. These data are combined into structured input files for running the programme. It may be mentioned that the Project Analysis utility available in HDM 4 was used for carrying out the economic analysis as it has facility to include diverted traffic in economic analysis.

5.5.1 Project Road Network

As specified earlier, the road network consists of the 37 Homogeneous Sections representing 8 project roads and 2 bridges (one bridge along with approach road) totaling to 1325.36 kms. A summary of the road-network and bridges is given in Table 5.5.1. The economic analysis has been conducted for the 8 roads, as well as, the two bridges.

Table 5.5.1 Details of Road Network and Homogenous Sections

Region	No. of Roads	No. of Homogenous Road Sections	Total Road Length (Km)
Assam	2 (Bridges)	-	39.36 (including approach road)
Mizoram	1	4	381
Meghalaya	3	16	321
Manipur/Nagaland	3	10	474 (31Km in Nagaland)
Tripura	1	7	110
Grand Total	**10**	**37**	**1325.36**

Source: JICA Study Team

Inputs to the road-network included defining the parameters such as speed-flow, traffic-flow, climatic condition, carriageway width, and shoulder width, number of lanes, section lengths, traffic (AADT in base year for motorized and non-motorized vehicles), geometry and pavement details and pavement conditions of each of the homogeneous road sections. The data for it was obtained from the surveys such as road surveys and traffic surveys. Accordingly the road-network files were prepared as an input to economic analysis.

5.5.2 Vehicle Fleet Data Inputs

Vehicle fleet data is used for estimating the operating cost of the vehicles (motorized and non-motorized). The inputs relate to vehicle cost, cost of tire, fuel prices, maintenance labor cost, and crew cost, etc., details on vehicle specification and performance. These input costs are given in Table 5.5.2. All the cost items are at economic cost, estimated on the basis of the method described earlier in this chapter.

Table 5.5.2 Unit Economic Cost and Vehicle Fleet Data

Item	Car	Two Wheel	Three Wheel	Bus	Mini Bus	2-Axle Truck	Multi Axle Truck	LCV	Tractor
Vehicle Price (Rs. 000)	400	51	132	880	620	960	1064	648	432
No. of Wheels	4	2	3	6	4	6	10	4	4
No. of Axles	2	2	1	2	2	2	3	2	2
Passengers	4	1	3	30	15	-	-	-	-
Tire (Rs.000)	3.1	0.73	0.96	8.75	8.75	8.75	8.75	5.60	8.75
Fuel Per/Lt. (Rs.)	36.79	36.79	36.79	37.86	37.86	37.86	37.86	37.86	37.86
Maint. Labor (Rs. per hr.)	100	60	100	180	150	180	200	150	200
Crew Wages (Rs. per hr)	16	-	14	64	39	36	41	27	-
Annual Overhead (Rs 000)	20	-	10	40	30	30	40	30	10
Interest Rate (%)	12	12	12	12	12	12	12	12	12
Pass. Time Value* (Rs. per/hr.)	76.25	60.99	60.99	51.14	51.14	-	-	-	-
PCSE	1.0	0.5	1.0	1.8	1.5	1.8	2.4	1.5	2.4
Working Hours	850	240	950	2200	1400	2600	2800	1400	650
Annual km (000)	40	12	25	75	55	85	85	50	10
Avg. life (Yrs)	8	8	8	8	8	10	10	8	8

Source: Market Survey & Previous Studies in India

The cost and performance data given in the above table was collected by the study team from vehicle dealers, operators, oil companies, etc. located in and around Hyderabad. The data were readily available with these sources, however, the estimation of 'fuel cost' and 'value of time' for passenger and freight traffic, needs further elaboration.

Fuel Cost

Fuel cost relates to the price of petrol and diesel duly netted for taxes and duties. The market price for one liter of petrol in Guwahati is Rs. 61.67 and that of diesel is Rs. 49.58. The total taxes and levies on petrol amounts to about 40.34% and that on diesel it adds up to 23.64%. By this account the economic cost of one litre of petrol works out at Rs. 36.79 and for diesel it works out to be Rs.37.86.

The above economic costs for petrol and diesel were cross-checked by an alternate method. Considering the price of crude in the international market to be at about $ 70 per barrel (in the long term), the shipping & refining cost for petrol can be taken as about 30% to 35% of crude price, the transportation & distribution cost of the refined product as about 10% to 15% of the crude and refining cost; thus on this basis the economic price of petrol amounts to $ 0.59 per liter (one barrel = 158litres). In rupee terms the economic cost of petrol works out to Rs.36.58 per liter (one USD = Rs.62).

On comparing the economic cost of petrol arrived at from two different methods, it may be observed that the economic price of petrol is almost close and therefore economic price of Rs.36.79 per liter for petrol and Rs. 37.86 per liter for diesel, is considered for the present study.

Value of Time

Assessment of value of time of passengers and cargo held in transit is a difficult task. For estimating the value of time of passengers, one method is to consider the per capita income (PCI) of the state as a surrogate for income/wages of the passengers and the other is to estimate the average income levels of the passengers. While the first method leads to under estimation of the income/ wages of passengers and the later methods suffers with biased-reporting by the passengers.

For the present study the per capita income approach has been adopted. Based on the available data, the average per capita income for the 6 NE states for year 2014-15 (extrapolated to year 2014-15 by using past growth rates) was Rs. 63,085/-. Considering a normal working hour as 240 in a month and adjusting for 42.84% work force participation rate in the state, the value of time per hour for work related trips is estimated at Rs. 51.14 per hour and has been assumed to represent the class of passengers travelling by bus. For the other passenger vehicles appropriate factors based on the similar studies done in India, were used. For car passengers a 1.5 times higher value than the bus passengers has been considered and for passengers travelling by auto-rickshaw (three-wheelers) and two-wheelers, the value has been assumed as 80% of that of car passengers.

The value of passenger time (per hr) for different class of vehicles is set out in Table 5.5.3.

Table 5.5.3 Value of Time – Passenger and Freight Vehicles

Vehicle	Value of Time (Rs./ Hr)	
	Work-time	Non-work*
Car	76.25	19.06
2-wheelers	60.99	15.25
3-Wheelers	60.99	15.25
Bus/ Mini Bus	51.14	12.79

* Estimated by applying the ratio of work to non-work values given in SP 30[1]

Source: JICA Study Team

Assigning Traffic (normal, diverted and generated) to HDM

The normal, diverted and generated traffic for each of the homogeneous section has been taken from the

1 Special Publication 30: Manual on Economic Evaluation of Highway Projects in India, Indian Road Congress, 1993.

chapter on traffic analysis. It may be indicated that separate treatment is given to 'generated traffic' for project options where considerable increase in traffic flows is expected due to increase in road capacity/ speed. The generated traffic has been included (in HDM 4) in the 'improvement assignment' concerning the individual road sections.

Generated Traffic

Generated traffic is expected to materialize due to improved road condition. However, it will also depend on the capacity saturation on the roads after improvement. In the event of capacity saturation the LOS will decrease, and would discourage Generated Traffic to materialize. A detail analysis of the capacity of the Study roads and expect saturation years was carried out in Section 4.6.6 (Chapter 4: Traffic Survey, Analysis & Forecast). Based on the capacity analysis, the expected Generated Traffic on Study roads has been considered.

As discussed in the chapter on "Traffic Survey, Analysis & Forecast", generated traffic to the extent of 5% of the normal traffic has been considered for the road sections where the capacity saturation (after improvement) is expected to be after at least 5 years of the start of operations (i.e., from year 2020). Table 5.5.4 presents the list of road sections that will attain saturation within the project analysis period (2017 to 2041), the remaining road sections that are not in the list will attain capacity saturation after the year 2041. For the two bridges (RD–9 and RD-11) the generated traffic has been considered as 10%, on the assumption that improvement/ new construction of bridges will increase accessibility for road users, more as compared to improvement of road sections.

For all the road sections marked "Yes", the Generated Traffic has been considered, and in addition to it, for all the roads not included in the list, Generated Traffic has been considered.

Table 5.5.4 Expected Capacity Saturation on Road Sections after Improvement

Road ID	Road Section	Capacity Saturation Year	Generated Traffic Considered
RD-1	**Aizawl - Tuipang (NH 54)**		
RD-1.1	Km 0 - Km 55 (Ref: Aizawl)	2026	Yes
RD-3	**Tura - Dalu (NH51)**		
RD-3.2	Km16 -Km 60 (Ref: Tura)	2030	Yes
RD-4	**Shillong - Dawki (NH40)**		
RD-4.1	Km 0 -Km 28 (Ref: Shillong)	2020	No
RD-4.2	Km 28 -Km 43 (Ref: Shillong)	2030	Yes
RD-4.3	Km 43 -Km75 (Ref: Shillong)	2030	Yes
RD-4.4	Km 75 -Km 82 (Ref: Shillong)	2030	Yes
RD-4.5	Km 82 -Km 84 (Ref: Shillong)	2030	Yes
RD-5	**Imphal - Jiribam (NH53)**		
RD-5.2	Km 3 -Km 145 (Ref: Imphal)	2015	No
RD-5.3	Km 145 -Km 221 (Ref: Imphal)	2015	No
RD-6	**Imphal - Kohima (NH39)**		
RD-6.2	Km 8 -Km 107 (Ref: Imphal)	2022	No
RD-6.3	Km 107 -Km 138 (Ref: Imphal)	2022	No

Source: JICA Study Team

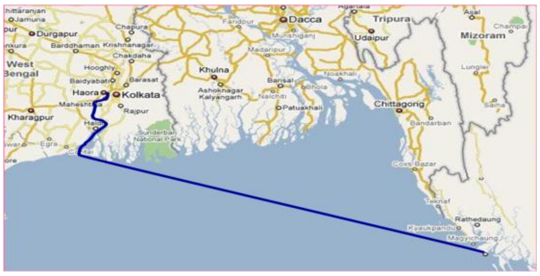
Diverted Traffic

The diverted traffic is applicable for only the new bridge construction at Dhubri, and for all other road sections no diverted traffic is expected. The diversion as discussed in the Chapter on "Traffic Survey, Analysis & Forecasts" has been considered for the purpose of economic analysis. Based on the pattern of traffic movement at the existing bridge at Goalpara, it is expected that there is a potential, in number terms, for about 60% of the traffic to divert to the new bridge, mainly on account of saving in distance. On an average the reduction in distance is expected to be of the order of about 52 km.

Kaladan Multimodal Transit Transport Project

The project is expected to start before the operation of the present project (expected by 2020). With the commissioning of Kaladan project, it is expected that a part of the traffic entering NER from Kokrajhar (West Bengal side) shall get re-routed, and enter NER via NH54 (Mizoram). In a way it is a diverted traffic, but in absence of details about its quantity, it is not possible to quantify it for the purpose of economic analysis. But the net benefit is expected to be substantial when the transportation cost through the proposed route mentioned below is compared with the existing route.

Stretch	Mode	Distance
Kolkata to Sittwe port in Myanmar	Shipping	539 km
Sittwe to Paletwa (River Kaladan)	IWT	158 km
Paletwa to Kaletwa	Road	67 Km
Kaletwa to Myeikwa (IM Border)	Road	62 km
Border to NH.54 (Lawngtlai) (in India)	Road	100 km
Lawngtlai to Aizawl	Road	334 Km
Kolkata – Aizawl	**Multi-Modal**	**1260 Km**



Source: Ministry of Development of North Eastern Region

Figure 5.5.1 Kaladan Multi Modal Transit Transport Project

However, for the present analysis, it is expected that an increase by 20% of the normal traffic on NH54 (first section) shall make up, though not entirely, for the net benefit to the economy. The traffic on the other sections is accordingly increased by adding the net 20% increase in traffic of first section, to the respective traffic on the remaining three road sections (NH54).

Kaladan project shall also result in generated traffic on NH54. In addition to the 5% generated traffic discussed in the precious section, a 5% more is considered for NH54 on account of Kaladan project. Thus a total of 10% generated traffic is considered for NH54.

5.5.3 Works Standards and Costs

Based on the treatment required for improving each of the homogeneous road section, cost estimates were prepared by the highway engineer. It may be noted that the proposed construction works is only applicable for the improvement of the roads ('with' the project cases), and are not applicable for the base case alternative ('without' the project case).

The first year of construction period is considered as Yr. 2017, with the construction period lasting for three years (i.e., up to Yr. 2019). The opening year of traffic operations is expected to be Yr. 2020. The construction is expected to be completed in a phased manner as indicated as follows.

Table 5.5.5 Investment Schedule for Construction

Construction Year	Percentage Investment
2017	40%
2018	30%
2019	40%

Source: JICA Study Team

5.5.4 Maintenance Standards and Costs

The maintenance (annual and periodic) cost has been taken separately for the base case alternative (do-nothing\ do-minimum) and the project alternatives. While the maintenance cost for 'base case' alternative is based on the existing practices being followed by the road agency. For the project alternatives, the maintenance cost has been defined by the Study Team.

5.6 Economic Analysis

Having applied the project options and completed the data input in the HDM 4, the next step is to undertake economic analysis of the homogeneous road sections for each of the defined project options.

The economic analysis based on the method elaborated above, allowed the Study Team to obtain the economic indicators for each of the project roads. The economic indicators such as economic internal rate of return (EIRR) and net present value (NPV) are, important for judging the economic feasibility of projects as well prioritizing the study roads. The results of economic analysis are set out in Table 5.6.1.

Table 5.6.1 Results of Economic Analysis of Study Road Sections

Road ID	Road Section	EIRR (%)
1.0	Aizawl – Tuipang Section, NH54	15.1
2.0	Dudhanal – Dalu Section, NH62	7.3
3.0	Tura – Dalu Section, NH51	22.0
4.0	Shillong – Dawki Section, NH40	16.8
5.0	Imphal – Jiribam Section, NH53	22.6
6.0	Imphal - Nagaland, NH39	18.9
7.0	Ukhrul – Tadubi Section, NH102A	14.0
8.0	Manu - Simlung Section NH44	3.5
9.0	Badarpurghat Bridge near Silchar	(-) 0.2
11.0	Dhubri – Phulbari Section	18.7

Source: JICA Study Team

5.7 Sensitivity Analysis

In order to know the economic strength of the study roads and to identify its robustness, sensitivity analysis of the improvement option has been carried out under the adverse situation of cost and benefits. Through the sensitivity analysis the changes in the project EIRR/ NPV is estimated and compared to the minimum acceptable criteria (Table 5.7.1).

Normally, the crucial parameters impacting the performance of road projects are cost-overrun and time-overrun related to the project implementation aspect. The other important parameter is the decrease in estimated traffic that results in the decrease in benefits of the project. The possibility of adverse change in these three parameters has been studied by the Study Team, and accordingly the expected change in their values have been assessed and incorporated in the sensitivity analysis.

Based on the past experience of the Study Team in similar projects, and the general practice followed in appraisal of road projects in India, the following sensitivity cases have been considered.

Case 1: Increase in Project Cost by 15%

Case 2: Decrease in Project Benefit by 15%

Case 3: Combined Impact of Case 1 and Case 2

Table 5.7.1 Results of Sensitivity Analysis of Study Road Sections

Road ID	Road Section	EIRR (%)			
		Base Case	**Case 1**	**Case 2**	**Case 3**
1.0	Aizawl – Tuipang Section, NH54	15.1	12.6	12.2	9.8
2.0	Dudhanal – Dalu Section, NH62	7.3	6.1	5.9	4.7
3.0	Tura – Dalu Section, NH51	22.0	18.0	17.4	13.9
4.0	Shillong – Dawki Section, NH40	16.8	15.2	14.9	13.2
5.0	Imphal – Jiribam Section, NH53	22.6	20.4	20.1	18.0
6.0	Imphal - Nagaland, NH39	18.7	17.1	16.8	15.2
7.0	Ukhrul – Tadubi Section, NH102A	14.0	10.7	11.5	9.4
8.0	Manu - Simlung Section NH44	3.5			
9.0	Badarpurghat Bridge near Silchar	(-) 0.2			
11.0	Dhubri – Phulbari Section	18.7	15.7	15.2	12.4

Source: JICA Study Team

CHAPTER 6 PRIORITIZATION OF PROJECT IMPLEMENTATION AND SELECTION OF PROJECT FOR JICA LOAN SCHEME

6.1 Prioritization of Project Implementation

6.1.1 Evaluation Criteria

Evaluation criteria is selected to apply prioritization of project implementation for Yen Loan Scheme based on study results in foregoing sections of present conditions and major issues, traffic demand forecast, and economic analysis. Proposed evaluation criteria to identify effectiveness and urgency are consistency with upper plan, project maturity, traffic demand, and EIRR. Table 6.1.1 shows proposed evaluation criteria and weighting of scoring. The total length of priority project will be around 450km based on the annual budgetary quota for road sector project loan for India.

Table 6.1.1 Evaluation Criteria of Project Prioritization

Criteria		Evaluation Contents (Score)			Weighting (Average:10)
		High (10 - 8)	Middle (7-4)	Low (3-0)	
1	Consistency with upper plan	Listed in National Road Development Plan (e.g. SARDP-NE)	Listed in International Road Development Plan (e.g. Asia Highway)	Others	5
2	Project maturity	DPR、EIA、RAP are prepared	DPR、EIA、RAP are being prepared	DPR、EIA、RAP are not yet prepared	10
3	Traffic demand supply Gap (V/C)	Demand supply gap in year 2020 (V/C>0.75)	Demand supply gap in year 2020 (V/C 0.75-0.50)	Demand supply gap in year 2020 (V/C <0.50)	10
4	EIRR	EIRR>15%	EIRR 12% - 15%	EIRR<12%	25

Source: JICA Study Team

6.1.2 Results of Project Prioritization

Result of project prioritization based on the evaluation criteria is shown in Table 6.1.2.

Table 6.1.2 Results of Project Prioritization

Criteria		1				2			
		NH54: Aizawl-Tuipang				NH62: Dudhanai-Dalu			
		0-55	55-125	125-250	250-381	0-30	30-87	87-91	91-183
1	Consistency with upper plan	*SARDP NE, Phase-B	*SARDP NE, Phase-B	*SARDP NE, Phase-B	*SARDP NE, Phase-B		*SARDP NE, Phase-B	*SARDP NE, Phase-B	*SARDP NE, Phase-B
		10	10	10	10		10	10	10
2	Project maturity	*DPR is being prepared	*DPR is being prepared	*DPR is mostly prepared	*DPR is mostly prepared	*DPR Consultant is being procured	*DPR Consultant is being procured	*DPR Consultant is being procured	*DPR Consultant is being procured
		6	6	8	8	3	3	3	3
3	Traffic demand (V/C)	1.22	1.92	1.60	1.87	0.29	0.22	0.64	0.64
		10	10	10	10	3	2	6	6
4	EIRR	15.1				7.3			
		8				2			
Total Score		**41**	**41**	**43**	**43**	**11**	**15**	**19**	**19**
Combined Score (Cost Weight Base)		**42**				**17**			
Ranking		**2**				**9**			

Criteria		3		4				
		NH51: Tura-Dalu		**NH40: Shillong-Dawki**				
		0-10	16-60	0-28	28-43	43-75	75-82	82-84
1	Consistency with upper plan			*Asia Highway No.1	*Asia Highway No.1	*Asia Highway No.1	*Asia Highway No.1	*Asia Highway No.1
				7	7	7	7	7
2	Project maturity	*DPR is mostly prepared	*DPR is mostly prepared	*DPR Consultant is being procured	*DPR Consultant is being procured	*DPR Consultant is being procured	*DPR Consultant is being procured	*DPR Consultant is being procured
		8	8	3	3	3	3	3
3	Traffic demand (V/C)	2.50	5.48	1.16	0.78	0.39	3.90	0.39
		10	10	10	7	4	10	4
4	EIRR	22.0		16.8				
		10		9				
Total Score		**43**	**43**	**39**	**36**	**33**	**39**	**33**
Combined Score (Cost Weight Base)		**43**		**36**				
Ranking		**1**		**4**				

Criteria		5			6			7
		NH53: Imphal-Jiribam			**NH39: Imphal-Kohima**			**NH102A: Ukhrul-Tadubi**
		0-3	3-145	145-221	0-8	8-107	107-138	0-115
1	Consistency with upper plan				*Asia Highway No.1	*Asia Highway No.1	*Asia Highway No.1	
					7	7	7	
2	Project maturity	*DPR Consultant is being procured	*DPR Consultant is being procured	*DPR Consultant is being procured	*DPR Consultant is being procured	*DPR Consultant is being procured	*DPR Consultant is being procured	*DPR Consultant is being procured
		3	3	3	3	3	3	3
3	Traffic demand (V/C)	0.17	1.28	1.28	0.25	0.78	0.78	1.71
		2	10	10	2	7	7	10
4	EIRR	22.6			18.7			14.0
		10			9			4
Total Score		**30**	**38**	**38**	**31**	**36**	**36**	**23**
Combined Score (Cost Weight Base)		**38**			**36**			**23**
Ranking		**3**			**4**			**7**

Criteria		8				9	11	
		NH44A: Manu-Simlung				**Badarpurghat Bridge**	**NH127B: Dhubri-Phulbari Bridge**	
		0-16	16-67	67-97	97-110	0-0.36	0-18	18-39
1	Consistency with upper plan	*SARDP NE, Phase-B	*SARDP NE, Phase-B	*SARDP NE, Phase-B	*SARDP NE, Phase-B			
		10	10	10	10			
2	Project maturity	*DPR Consultant is being procured	*DPR Consultant is being procured	*DPR Consultant is being procured	*DPR Consultant is being procured	*DPR Consultant is being procured	*DPR Consultant is being procured	*DPR Consultant is being procured
		3	3	3	3	3	3	3
3	Traffic demand (V/C)	2.07	1.26	1.26	1.26	1.10	0.98	9.80
		10	10	10	10	10	9	10
4	EIRR	3.5				-0.2	18.7	
		2				0	9	
Total Score		**23**	**23**	**23**	**23**	**18**	**35**	**36**
Combined Score (Cost Weight Base)		**23**				**13**	**35**	
Ranking		**7**				**10**	**6**	

Source: JICA Study Team

6.2 Conclusion of Project Priority for Yen Loan Scheme

The project road is categorized into three priority group based on the project prioritization result and remarks for project implementation are also mentioned in Table 6.1.3. Priority Group B projects will be considered under future Yen Loan Schemes after safety clearances.

Table 6.1.3 Conclusion of Project Priority for Yen Loan Scheme

Priority Group	Project	Remarks
A	NH54, Aizawl – Tuipang Section NH51, Tura – Dalu Section	i) Design review of two project is being carried out by JICA Study Team by October 2015
B	NH127B, Dhubri – Phulbari Section NH40, Shillong – Dawki Section NH53, Imphal – Jiribam Section NH39, Imphal - Kohima Section	i) Submission of the DPR and transferring administrative jurisdiction from BRO to MORTH are necessary ii) Security of the study team at Manipur State is essential
C	NH44, Badarpurghat Bridge NH44A, Manu - Simlung Section NH102A, Ukhrul – Tadubi Section NH62, Dudhanal – Dalu Section	

Source: JICA Study Team

CHAPTER 7 PRELIMINARY DESIGN OF NH54

7.1 Natural Condition Surveys

7.1.1 Meteorological and Hydrological Surveys

(1) General
National Highway shall facilitate drainage system enough and properly to drain out rainy water fallen at road surface and flown from mountain upstream. Specially, hill road is suffered from large volume of crossing water flown from mountain slope. It is essential to protect the improved highway from such rainy water by appropriate arrangement of drainage facilities.
The hydrological study based on meteorological and topographical condition at project area is conducted.

(2) Meteorological condition
Mizoram has a mild climate, relatively cool in summer 20 to 29 °C and winter temperatures range from 7 to 22 °C. The region is influenced by monsoons, raining heavily from May to September with little rain in the dry-season. The climate pattern is moist tropical to moist sub-tropical, with average state rainfall 254 centimeters per annum. In the capital Aizawl, rainfall is about 215 centimeters and in Lunglei, another major centre, about 350 centimeters. The state is in a region where cyclones and landslides can cause weather-related emergencies.
In addition, the rainfall intensity has being increased in the North-east state of India due to climate changes in recent as explained in Chapter7.3

(3) Topographical condition
Mizoram has the most variegated hilly terrain in eastern part of India. The hills are steep and are separated by rivers, which flow either to the north or south creating deep gorges between the hill ranges. The highest peak in Mizoram is the Blue Mountain with a height of 2210 meters.
In the project area of NH54 between Aizawl to Tuipang, the project route passes several rivers and its tributaries, including following Rivers.

- Tuirial River at Aizawl District
- Mat River at Lunglei District
- Kawchaw River at Saiha District

(4) Hydrological study
a) Methodology
The hydrological study is conducted with referred on IRC:SP:13 “Guidelines for the design of small bridges and culverts” and IRC:SP42 “Guidelines of road drainage”, which is well used technical standard for hydrological study in Indian highway design.
The analysis is conducted based on Rational Formulae for peak-off from catchment. The size of the flood are determined by factors such as rainfall intensity, distribution in time and space, duration, catchment area, shape, slope and permeability of the soil and vegetable cover.

Ratinal Formulae

$Q = 0.028 \times C \times I \times A$

C : Runoff coefficient

I : Critical intensity of rainfall (cm/hr), $I = F/T \times ((T+1)/(tc+1))$

F : Rainfall intensity (mm/hr)

T : Duration of storm (hrs)

tc : Time of concentration (hrs)

A : Catchment area (hectares)

b) Return period

The return period is described on IRC:SP42 as follows.

-For side drain for N.H. : 25 years (at valley points)

-For cross-drainage for N.H. : 25 years (up to 2m span) / : 50 years (2 to 6m span)

It is also suggested on IRC:SP42 that to assure the discharge not only for design flood but also for check flood in order to protect an area from prolonged inundation when a flood rarer that the design flood hits the area. A check flood is a flood having next higher commonly followed recurrence interval.

The project highway locates at highly hill, the water flood may causes high risk of fatal accidental. Also increase of rainfall intensity in recent years, an application of 50 years for all drainage is not overestimate.

Therefore, the structural dimension of all drainage is determined to be capable for the discharge of 50 years return period.

c) Rainfall Intensity

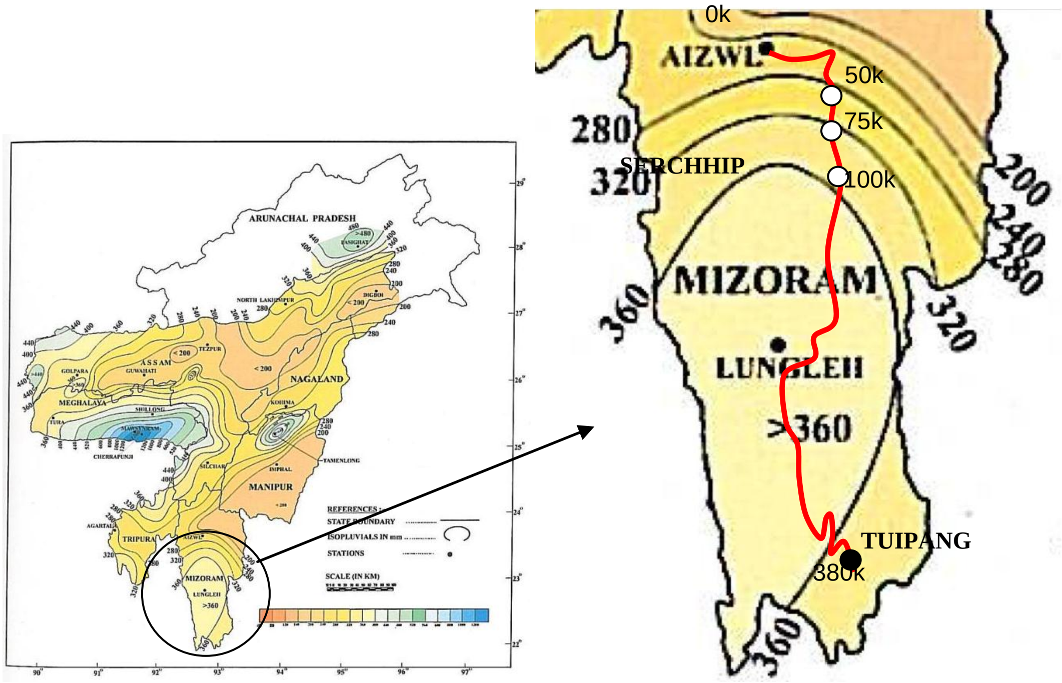
The rainfall intensity is based on the ATLAS of Statewise Generalised ISOPLUVIAL MAPs of Eastern India (Part-II), published by India Meteorological Department, Government of India. Location of project site is identified on the isopluvial map. The isopluvial map with the project location is shown in Figure below. It is sectioned by range of rainfall intensity which value is read from higher edge of counter value.

Rainfall intensity for each sections in NH54 us shown in Table below.

Table 7.1.1 Rainfall intensity for each section in NH54

City From	City To	50Years- 24hours Rainfall intensity
Aizawl (Near 0k)	Tlungvel (Near 50k)	280mm/hr
Tlungvel (Near 50k)	Chhingchhip (Near 75k)	320mm/hr
Chhingchhip (Near 75k)	Serchhip(Near 100k)	360mm/hr
Serchhip (Near 100k)	Tuipang (End Point)	400mm/hr

Source: JICA Study Team



Source: ATLAS of Statewise Generalised ISOPLUVIAL (Return Period) Maps of Eastern India (Part – II)

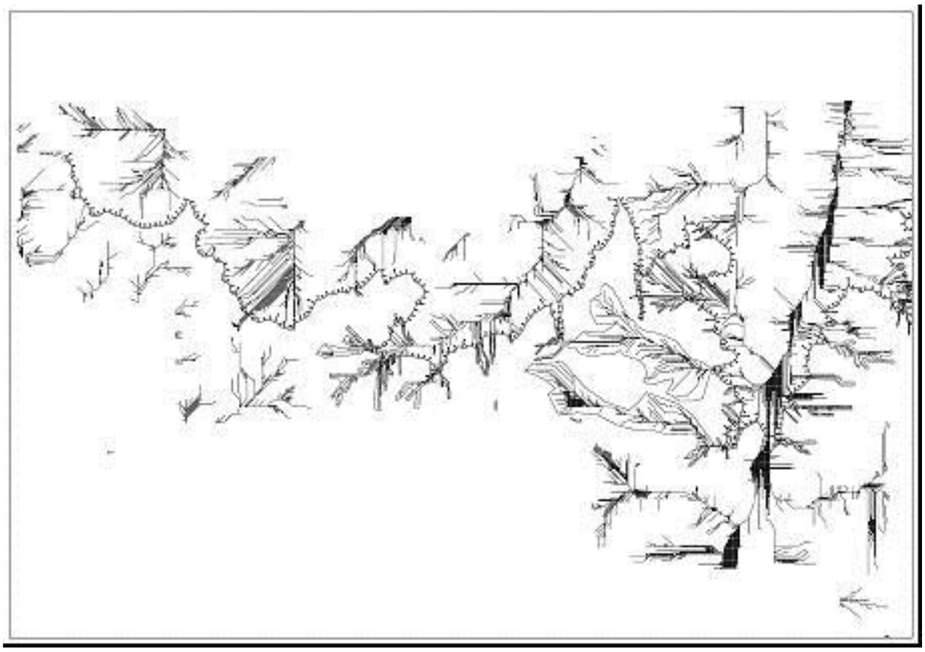
Figure 7.1.1 Isopluvial map with project location for NH-54 (For 50years)

d) Runoff coefficient
The guidance of runoff-coefficient is described on IRC:SP:13.
The topographical condition at project area on NH54 is wholly rocky mountainous to steep terrain. Hence, Runoff coefficient C: 0.8 is applied. (Rock, steep but wooded)

e) Catchment parameters
Catchment parameters such as catchment area, length of tributary and difference of elevation along the project highway is obtained by computation with satellite data and GIS software.

- Satellite data : CatoSat I
- Software : Arc GIS 10.1 & Erdas

An example of catchment area map obtained by computation for NH54 is shown in Figure below.



Source: JICA Study Team

Figure 7.1.2 An example of catchment area map obtained by computation for NH54

(5) Discharge result
By hydrological study, discharge results for water crossing point with catchment area are obtained. The discharge summary for large discharge (Q>4m3/s) is summarized in table below.
For all discharge result including small catchment area is estimated.

It is noted that cross-drainage is planned not only for the location where crossing water is appeared on the hydrological computation but also the location of existing cross-drainage. Also at some location to complement between long intervals. It is explained in chapter of Drainage Design.

Table 7.1.2 **Discharge summary for large discharge (NH54)**

Cheinage (Project Alignment)	Catchment Area (m2)	Length of Tributry (m)	Difference of elevation (m)	Discharge Q50 (m3/s)	Remark
11+220	101,743	582	226	7.91	Existing culvert location
17+745	61,680	622	298	7.09	Existing culvert location
18+025	94,592	865	264	9.72	Existing culvert location
20+695	365,983	1,221	285	22.64	Existing culvert location
21+650	435,435	948	237	27.21	Existing culvert location
24+390	54,933	622	163	5.01	Existing culvert location
25+840	51,107	458	156	4.84	
103+780	30,065	368	155	4.37	
103+890	61,680	622	298	7.09	Existing culvert location
105+625	94,592	865	264	9.72	Existing culvert location
159+300	32,654	373	146	4.60	Existing culvert location
161+705	32,654	373	146	4.60	
183+430	46,371	629	73	5.59	Existing culvert location
184+960	46,371	629	73	5.59	Existing culvert location
185+210	54,764	594	166	6.44	
190+940	38,630	580	27	4.84	Existing culvert location
191+660	80,079	671	299	8.66	
192+820	177,925	1,527	121	14.99	
193+100	258,475	1,823	448	22.03	
193+630	41,446	614	278	5.32	Existing culvert location
197+120	249,795	921	216	22.60	
197+330	349,554	152	56	33.38	Existing culvert location
197+440	296,185	787	231	26.94	
197+550	263,012	643	176	24.34	Existing culvert location
198+430	1,533,068	1,900	350	119.52	Existing culvert location
200+990	80,544	782	216	8.55	
206+495	31,895	262	71	4.55	Existing culvert location
217+025	73,730	100	39	8.42	Existing culvert location
217+800	93,975	1,142	277	9.44	Existing culvert location
217+920	161,093	1,145	276	14.96	Existing culvert location
222+370	30,731	922	331	4.31	Existing culvert location
223+460	214,105	816	325	20.07	Existing culvert location
223+550	63,263	607	145	4.33	
223+610	57,796	758	223	6.64	Existing culvert location
224+340	55,562	564	163	6.52	Existing culvert location
225+930	1,190,320	1,664	341	95.31	Existing culvert location
226+060	219,856	860	332	20.49	Existing culvert location
227+570	328,353	1,238	471	15.34	Existing culvert location
228+600	57,585	100	39	4.09	Existing culvert location
229+480	168,882	139	96	8.72	Existing culvert location
229+630	740,870	1,075	486	32.48	Existing culvert location
232+440	223,552	951	416	10.99	Existing culvert location
235+260	1,684,589	688	276	147.63	Existing culvert location
235+355	95,120	157	63	10.32	Existing culvert location
236+500	189,615	548	210	18.28	Existing culvert location
238+090	85,354	533	277	9.22	Existing culvert location
434+170	125,195	837	75	11.84	Existing culvert location
437+280	48,331	484	243	5.97	
437+660	38,527	87	46	5.23	Existing culvert location
439+230	33,894	561	267	4.67	Existing culvert location
441+600	15,920	304	194	3.13	Existing culvert location

Cheinage (Project Alignment)	Catchment Area (m2)	Length of Tributry (m)	Difference of elevation (m)	Discharge Q50 (m3/s)	Remark
469+735	44,732	485	144	5.61	Existing culvert location
484+250	134,424	665	278	13.38	Existing culvert location
485+400	31,566	439	233	4.50	Existing culvert location
486+120	28,893	115	49	4.33	Existing culvert location
486+940	148,674	923	336	14.33	Existing culvert location
490+110	26,444	515	188	4.02	Existing culvert location
490+260	55,494	604	211	6.52	Existing culvert location
491+280	320,429	1,259	487	28.39	Existing culvert location
491+440	395,465	1,423	563	34.34	Existing culvert location
491+650	230,896	1,168	489	20.10	Existing culvert location
492+315	304,607	1,542	586	26.62	Existing culvert location
492+370	513,839	47	23	48.93	Existing culvert location
492+520	59,097	683	254	6.81	
493+030	100,443	1,149	254	9.94	
493+305	146,484	1,158	248	13.68	Existing culvert location
494+740	578,042	406	109	52.51	Existing culvert location
495+215	27,022	374	88	4.08	Existing culvert location
495+845	237,195	1,579	428	20.75	
496+010	492,881	657	176	44.04	Existing culvert location
496+200	47,628	523	116	5.82	
496+825	100,372	733	194	10.26	Existing culvert location
496+900	26,150	119	36	4.07	Existing culvert location
497+210	381,311	1,131	277	33.15	
497+395	47,417	343	98	5.90	Existing culvert location
497+600	34,682	243	65	4.80	
497+780	878,655	1,057	231	74.23	Existing culvert location
500+260	209,268	606	155	19.73	Existing culvert location
500+340	27,755	506	137	4.12	
500+460	30,651	1,258	376	4.23	Existing culvert location
500+540	101,019	1,251	397	10.05	Existing culvert location
500+620	251,661	1,192	375	22.58	
500+940	271,365	1,365	393	23.87	
501+300	148,928	773	201	14.36	Existing culvert location
501+375	133,252	725	220	13.12	Existing culvert location
501+510	128,782	834	245	12.64	Existing culvert location
501+580	39,231	814	241	5.04	
501+870	77,668	630	257	8.46	
502+150	43,900	557	253	5.55	
502+230	40,530	713	404	5.23	Existing culvert location
502+380	120,742	793	465	12.18	
502+550	28,376	144	99	4.29	
503+040	30,636	814	241	4.51	
503+870	51,360	371	120	6.24	Existing culvert location
504+040	158,175	1,324	456	14.76	Existing culvert location
504+300	29,864	285	41	4.33	
504+630	58,351	576	154	6.75	Existing culvert location
504+880	101,516	946	296	10.27	
505+830	49,190	617	201	5.96	Existing culvert location
505+910	75,347	580	202	8.26	Existing culvert location
506+110	888,017	2,000	554	71.26	Existing culvert location
506+680	49,521	479	153	6.04	
506+800	51,066	412	131	6.20	Existing culvert location

Cheinage (Project Alignment)	Catchment Area (m2)	Length of Tributry (m)	Difference of elevation (m)	Discharge Q50 (m3/s)	Remark
506+980	35,343	480	148	4.79	Existing culvert location
507+635	52,231	366	159	6.35	Existing culvert location
508+080	966,820	1,685	456	78.82	Existing culvert location
508+375	36,693	368	113	4.94	Existing culvert location
509+425	526,073	166	83	49.43	Existing culvert location
510+060	68,179	526	141	7.62	Existing culvert location
511+190	514,133	1,135	424	44.80	Existing culvert location
512+615	31,084	315	148	4.48	Existing culvert location
512+850	24,089	540	162	4.48	Existing culvert location
513+050	3,877	198	84	4.46	Existing culvert location
513+970	55,446	620	283	6.54	Existing culvert location
514+100	33,508	292	145	4.70	
515+130	31,630	553	233	4.47	
525+035	31,403	198	91	4.54	Existing culvert location
527+240	38,127	504	162	5.03	Existing culvert location
528+930	29,760	358	135	4.34	Existing culvert location
530+185	60,584	563	196	6.98	Existing culvert location
530+510	30,557	485	193	4.39	
530+760	54,394	427	190	6.52	
530+870	40,714	314	133	5.34	
531+140	29,576	287	145	4.35	
531+350	28,904	365	198	4.28	Existing culvert location
531+620	31,310	300	138	4.50	Existing culvert location
532+925	29,920	294	110	4.37	Existing culvert location
533+255	32,045	256	142	4.59	
542+670	42,221	409	261	5.46	Existing culvert location
542+870	48,106	332	226	6.02	
543+685	100,310	43	28	10.93	Existing culvert location
543+770	80,466	758	345	8.66	Existing culvert location
544+965	224,928	163	95	22.14	Existing culvert location
545+100	28,127	393	189	4.20	Existing culvert location
548+700	28,500	80	34	4.31	

Source: JICA Study Team

7.1.2 Topographic Survey

(1) General (Objectives, Methodology)

(2) Location of Survey Works

7.1.3 Geological Survey

1) General

In order to clarify the geology and geological condition along NH54 and utilize the result for the road design, the JICA study team conducted geological survey including data collection, site reconnaissance, slope inventory survey, and boring survey.

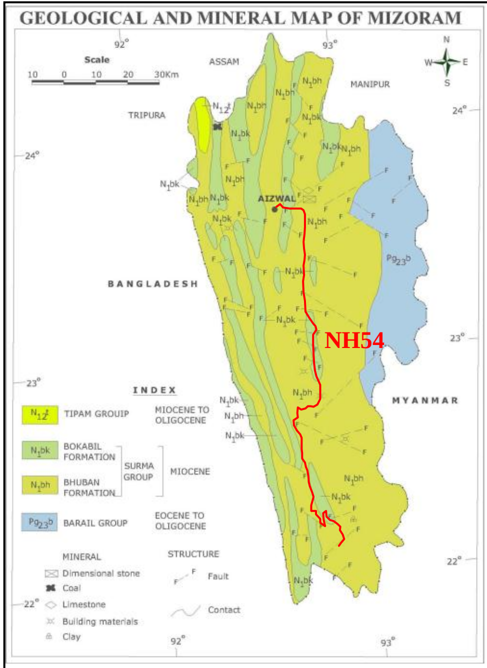
Before starting the site survey, JICA study team collected existing data and information on geological and topographical setting, earthquake occurrence, and landslide disaster in the study area. Although several organizations such as Mizoram Remote Sensing Application Centre and Geological Survey of India have established a landslide zonation map and a geological map, they were not identified landslide distribution and so large scale that the survey needed to clarify exact location of those risk sites in details for design of road and landslide countermeasure.

<u>Geological and Topographical Setting</u>

The North-East India is located on the north-east edge of the Himalayan orogenic belt resulted from Indo-Eurasian continental plate collision that took place during Cenozoic, and represents one of the youngest and the highest mountain range in the world. The Himalayan orogenic belt has a unique agglomeration with a diversified geological setup. The various topographic features include the Himalayan mountain belt in the north, the Indo-Myanmar Range in the east, Shillong Massif Plateu in the west, and the expansive Brahmaputra forming the Assam plains in between.

Mizoram state is predominately composed of mountainous terrain of tertiary rocks. The mountain ridges strike north to south direction in parallel series. The mountain ranges are separated from one another by narrow deep river valleys. The elevation ranges from 40 meters to 2,157 meters, the highest point at Phawngpui. There are only a few and small patches of flat lands, which are mostly intermontane basins.

Figure 7.1.3 shows the geological map of the Mizoram state. The geology of the state is represented by repetitive succession of Neogene sedimentary rocks of Surma groups that mostly include sandstone, siltstone, and shale. In the formations, there are many folds caused by the plate collision. Mizoram fold belt is composed of tight linear folds with their axes mostly trending north to south and longitudinally plunging anticlines and synclines. The density of folds increases from west to east where Indian plate has been subducting below the Burmese plate. The sedimentary rocks such as shale distributing in the Mizoram state are very vulnerable to weathering, which is often causes collapsing and sliding along the bedding plane.



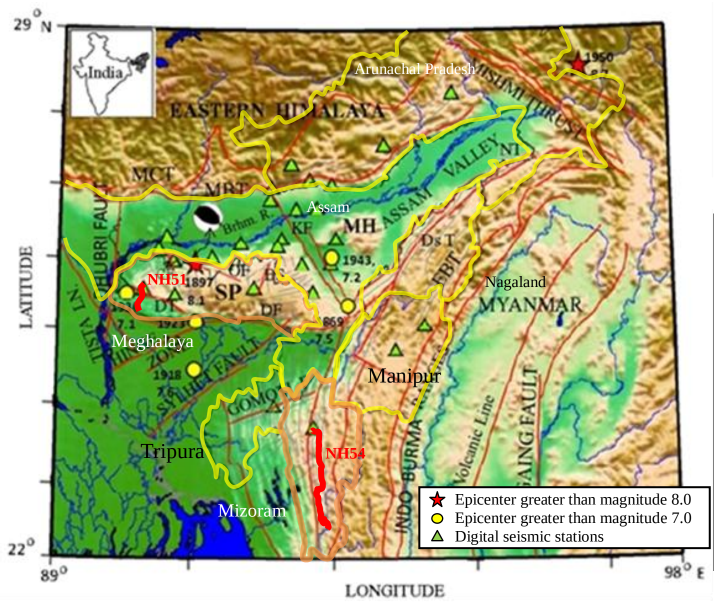
Source: Geological Survey of India

Figure 7.1.3 Geological Map of Mizoram

Seismologic Situation

The North-east states are located between the northern collision and eastern seduction margins of the Indian plate. Two big earthquakes with a magnitude of greater than 8.0 on the Richter scale occurred in north of Meghalaya and north-east of Arunachal Pradesh in 1897 and 1950 respectively as shown in Figure 7.1.5. And also earthquake with a magnitude of more than 7.0 on the Richter scale has occurred in and around the Meghalaya state along main tectonic faults.

On the other hand, earthquake is not frequent in the Mizoram states. In the past, the biggest historic earthquake was magnitude 6.1 which occurred in Chittagong near the border with Bangladesh, and other earthquakes are a low magnitude from 4.0 to 5.7 on the Richter scale and comparatively low intensities from IV (Light) to VI (Strong) out of 12 levels in Indian earthquake intensity scales.



Source: Geological Survey of India

Figure 7.1.5 Epicenter Distribution Map

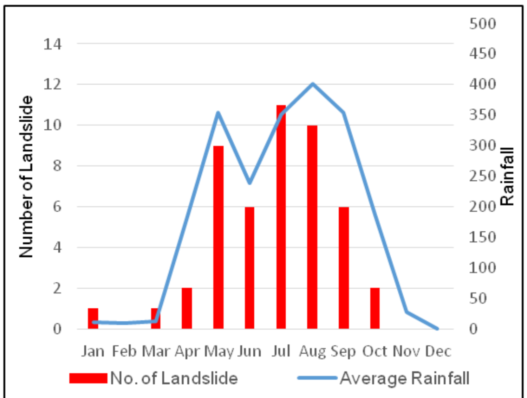
Table 7.1.3 Historical Earthquake in Mizoram

Year	Date	Location	Mag.	Intensity
1997	22-Nov	Chittagong	6.1	VI-VII
2011	19-Apr	10km from Kolasib	4.3	IV
2014	4-Apr	Champhai	4.0	IV
2014	4-Jun	42km from Saiha	4.6	IV-V
2014	9-Sep	40km from Saiha	5.4	V
2014	20-Nov	74km from Serchhip	5.7	V-VI
2014	21-Nov	Chittagong	5.4	V
2014	23-Dec	19-km from Saiha	4.4	IV
2015	15-Jan	39km from Lunglei	4.2	IV

Source: Government of Mizoram

<u>Past Landslide Disaster</u>

JICA study team collected information on past landslide disaster in and around Mizoram states because the area is extremely high rainfall region and mountainous area. Figure 7.1.4 shows the number of landslide reported in newspapers and academic paper from 1992 to 2015 and plotted by month. In September 2014, a large landslide occurred near PWD office at Laipuitang in Aizawl and killed 17 people and destroyed 15 houses including PWD office buildings. As above, landslide has often occurred in this area and clearly tends to increase in monsoon season from May to September.



Source: JICA Study Team

Figure 7.1.4 Landslide Frequency Distribution by Month

2) Geological Investigation for Bridges

In order to verify a foundation depth of planned new bridge, boring survey was conducted at the Chhingchhip bridge site. Two boreholes were drilled up to 15m in depth with standard penetration test (SPT) on the center line of planned new bridge and at the top of slope along existing road. The Summary of the survey is shown in Table 7.1.4.

Table 7.1.4 Summary of Boring Survey at the Chhingchhip Bridge Site

Borehole No.			BH-1		BH-2	
		Depth (GL-m)	Beginning (Aizawl) Side		End (Serchhip) Side	
Geotechnical Condition	N-value	0 ~ 0.5	Surface Soil	-	Surface Soil	-
		0.5 ~ 3.0	Weathered Rock	27~37	Weathered Rock	32~41
		3.0 ~15.0	Hard Rock	50	Hard Rock	50

Source: JICA Study Team

According to the result of the boring survey, the site is consisted of shale and sandstone rocks and covered by surface soil with 0.5m in thickness. Under the surface soil, there are highly weathered rocks 2m thick with around 20~30 blows in SPT which cover the hard and intact bedrock layer with more than 50 blows of N-value. Therefore, the foundation layer for the planned bridge is evaluated below the highly weathered rock and around 3m below the ground level.

3) Geological Investigation for Slope

In this study, JICA study team conducted slope inventory survey (as mentioned later) to indentify location, dimension, and stability of landslide along NH54 first. Then, geological survey was conducted at three landslide sites in order to clarify thickness and geotechnical characteristics of the landslides and design those countermeasures. Those three representative landslides were selected out of around 100 critical slopes identified in the slope inventory survey based on landslide scale and stability. Table 7.1.5 shows list of the geological survey sites. After drilling, perforated pipes were installed into the borehole and monitoring of groundwater level was carried out for 8 weeks.

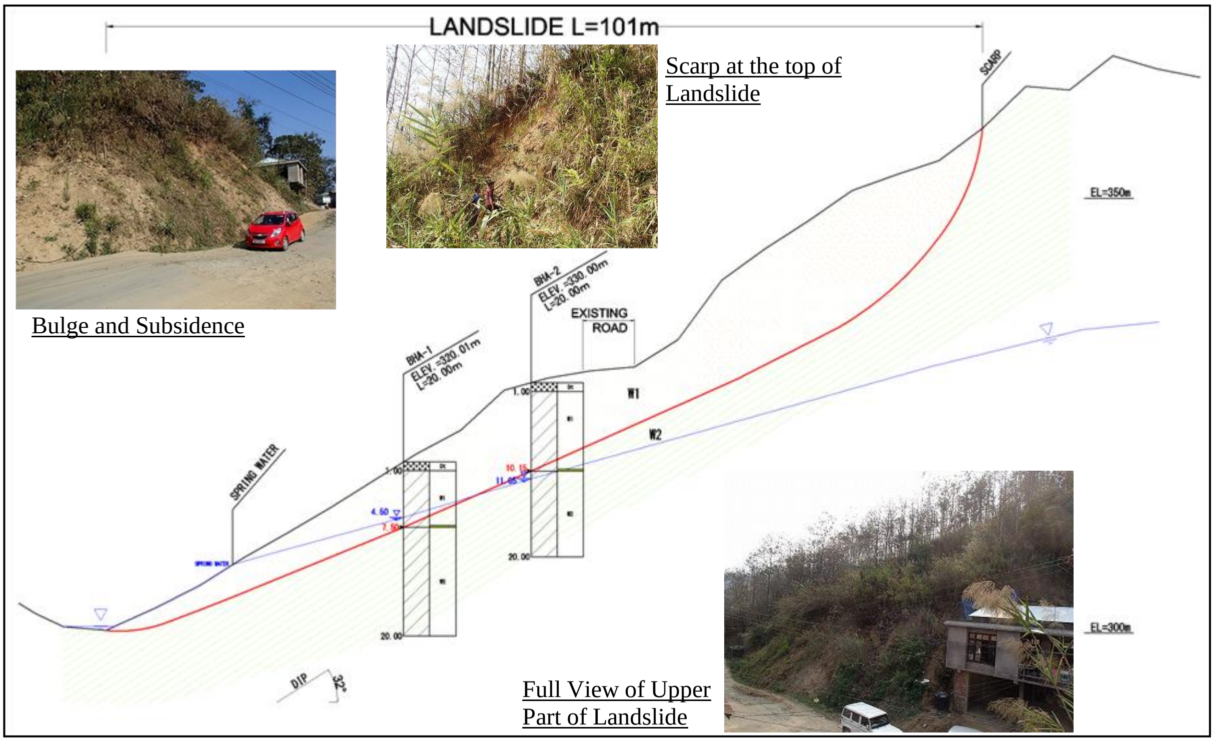
Table 7.1.5 Location of Geological Survey Sites

Landslide Site	District	Existing Road Chainage		No. of Boreholes	Borehole Depth per hole (m)
		Start	End		
Landslide A (Medium mass movement)	Aizawl	20+380	20+420	2	20
Landslide B (Large mass movement)	Serchhip	64+550	64+650	3	30
Landslide C (Small mass movement)	Lunglei	208+430	208+530	2	25

Source: JICA Study Team

Landslide A

Figure 7.1.6 presents the landslide profile based on the geological survey conducted in landslide A. The road surface in the landslide area has sunk maximum 1.0m in depth and slid toward valley side along 40m long of the road. Road slope on the hill side has been bulging, and colluvium has fallen on the road. At the top of the landslide, continuous horse-shoe shaped scarp is clearly observed. As the result of the geological survey, depth of slip plane is considered to be around 7~12m. Although spring water is observed on the right bank of the stream at the toe of the landslide slope, groundwater level is monitored low and assumed to be lower than slip plane in the upper part of the landslide.

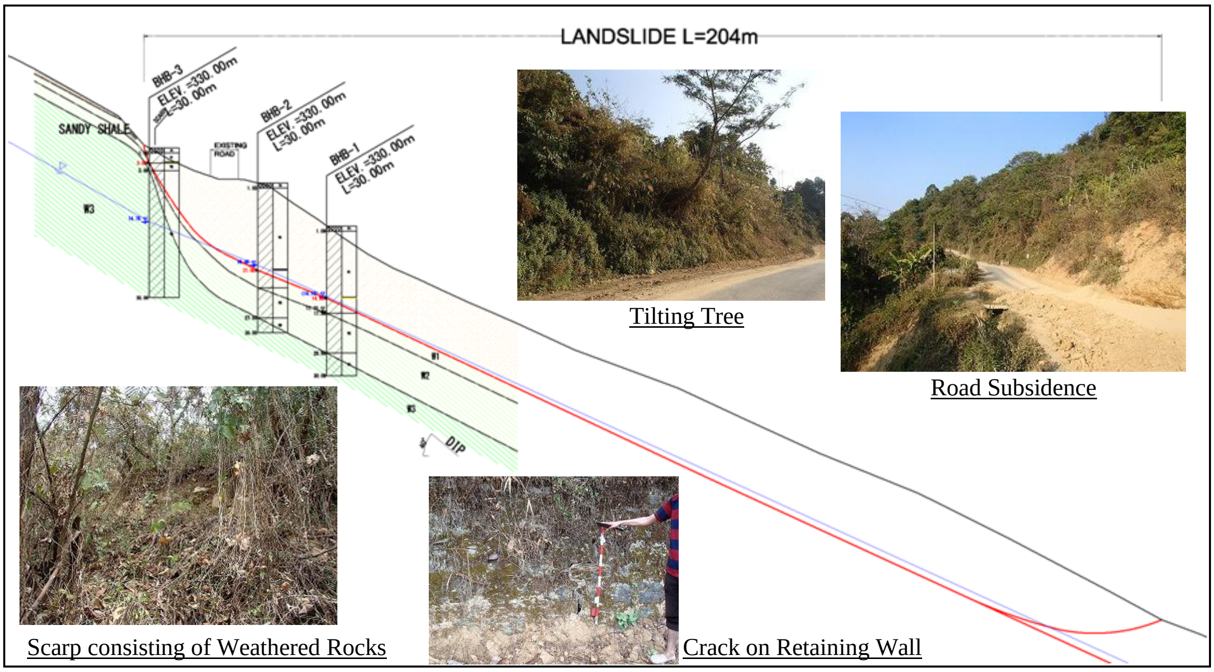


Source: JICA Study Team

Figure 7.1.6 Geological Profile of Landslide A

Landslide B

Landslide B is large mass movement, and has approximate 125m in width, 200 in length, and 15m in depth as shown in Figure 7.1.7. The road is located on the crown of the landslide and has sunk maximum 1.0m by the landslide movement. Small collapses occurred at the both bank of the landslide, and existing retaining walls along the road have been damaged and cracked. Boring survey was conducted around the road for design of countermeasure、and clarified that the landslide doesn’t continue to above the scarp near the road and there is a comparatively hard and intact bed rock layer .under the landslide body. Groundwater is assumed to locate just above the slip plane and rise when rainy season, that triggers the landslide .movement

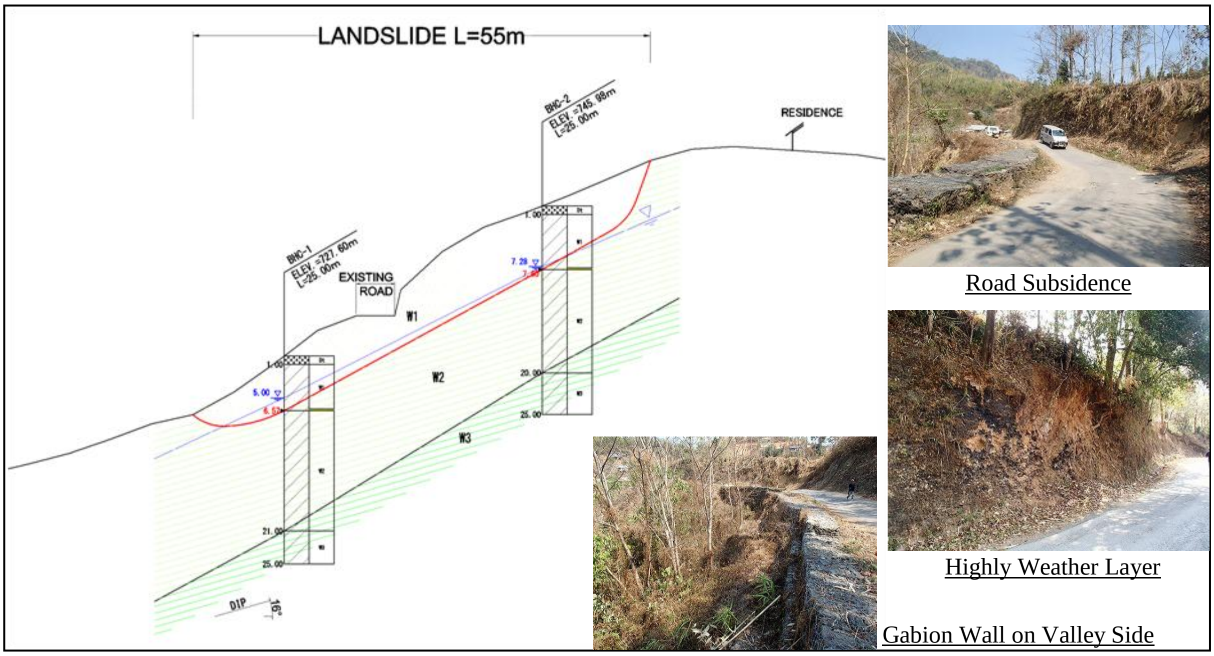


Source: JICA Study Team

Figure 7.1.7 Geological Profile of Landslide B

Landslide C

Landslide C is located near the Dawn village, around 200km from Aizawl. The road has sunk maximum 1.2m and gabion wall with 3m high was built on the valley side of the road for soil retaining. Cut slope on the hill side exposes highly weathered rock layer, which is soften and loosen completely and represents landslide body. The slope above the road is utilized for cultivated field and residential area, and has some steps caused by the landslide movement. As the result of the geological survey, the landslide thickness is assumed to be about 6-7m, and groundwater level is fluctuating just above the slip plane.



Source: JICA Study Team

Figure 7.1.8 Geological Profile of Landslide C

4) Road Alignment Soil Survey

7.1.4 Road Inventory Survey

7.1.4.1 Outline of Road Inventory Survey

JICA Study Team conducted a road inventory survey (herein after referred to as "the inventory survey") from February, 2015 to April, 2015 along national highway of NH-54 in Mizoram state and NH-51 in Megaraya state. The inventory survey aimed to identify the existing road characteristics, problems and issues on the structural and traffic aspects as well as the geological and social conditions of the surrounding area along the target road.

7.1.4.2 Survey Method

(1) Target Road

The JICA Study team conducted the inventory survey along to the following two national highways in Mizoram and Meghalaya state.

- NH-54 : 381 km (Mizoram State)
- NH-51 : 54 km (Meghalaya State)

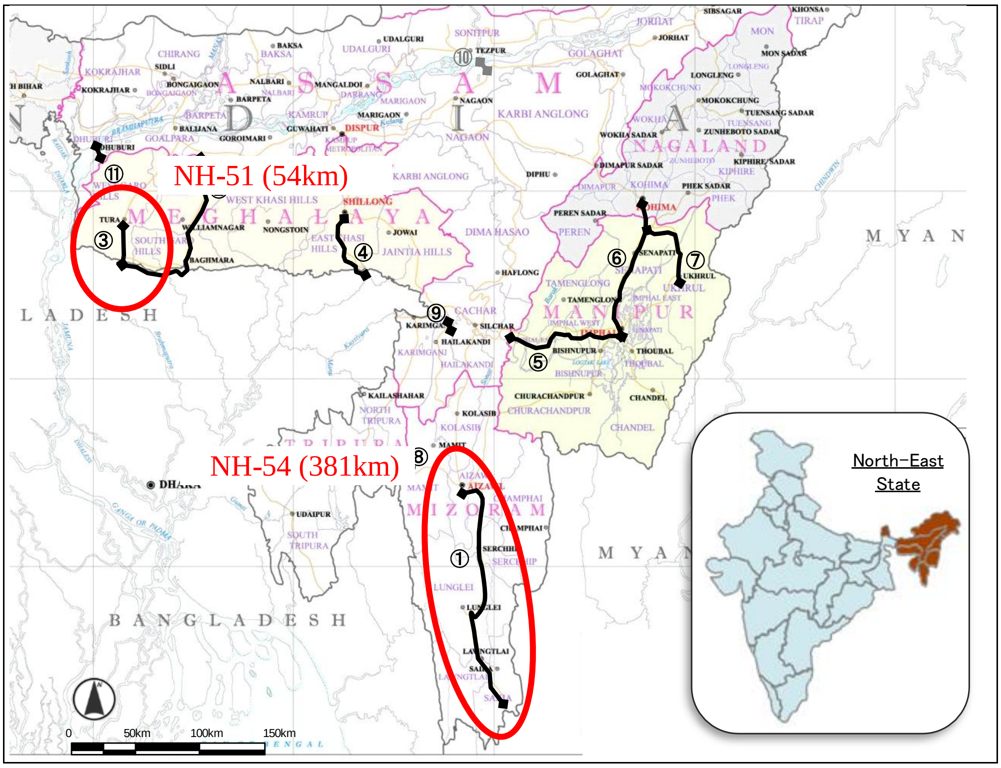


Figure XXX Location Map of NH-54 and NH-51

(2) Measurement Items

1) Road Cross Section Element

The following items were measured by measuring tape and visual observation at every 100 m sections or any locations where the target objects were found out.

- ➢ Topography
- ➢ Land Use
- ➢ Road Width
- ➢ Pavement Condition
- ➢ Side Drain
- ➢ Side Walk

The item of pavement condition is consisting of four categories, "Good", "Fair", "Poor" and

"Bad". Each category was judged in the basis of following criteria

- Good: when the existing road was smooth and had no potholes visible,
- Fair: when existing road was smooth but had few cracks and potholes visible,
- Poor: when existing road had more potholes and surface undulation visible,
- Bad: when severe deterioration including cracking, surface deformation, disintegration and surface defect of the pavement was observed.

The road width was obtained at each 100m interval along target roads and the definition of road width is shown in the following figure.

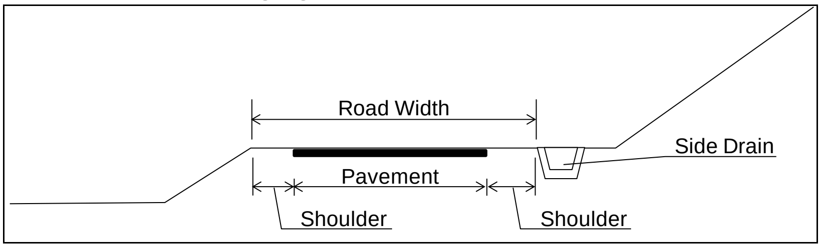


Figure XXX Definition of Road Width

2) Cross Drain and Waterway

The following items were measured by measuring tape and visual observation at any locations where the target objects of cross drain and waterway were found out.

- Cross Drain Structure (Type, Size)
- Condition of Cross Drain Structure
- Waterway (Width)

3) Retaining Wall and Guardrail

The following items were measured by measuring tape and visual observation at any locations where the target objects of retaining wall and guardrail were found out.

- Retaining Wall (Material, Height, Length)
- Guardrail (Material, Height, Length)

4) Social Infrastructure and Religious Object

The following items were recorded based on existing local information collected in advance and visual observation at any locations where the target objects of social infrastructure and religious object were found out. The distance from pavement edge to the objects was measured by measuring tape at each location.

- Social Infrastructure (Object, Distance from Pavement Edge)
- Religious Object (Object, Distance from Pavement Edge)

5) Overhead Utility Line (Side, Distance from Pavement Edge)

The following items were recorded based on existing local information collected in advance and visual observation at any locations where the target objects of overhead utility line were found out. The distance from pavement edge to the objects was measured by measuring tape at each location.

- Electric Distribution Line
- Electric Transmission Line
- Transformer
- Telecommunication Line

6) Underground Utility Line (Side, Distance from Pavement Edge)

The following items were recorded based on existing local information collected in advance, hearing to local resident and visual confirmation at sites along the target routes during this survey period. The distance from pavement edge to the objects was measured by measuring tape at each location.

- ➢ Water Supply Line
- ➢ Optical Fiber Cable Line

7) Bridge (Width, Length)

The size and condition of bridges along the target routes were recorded at any locations where the objects were found out.

7.1.4.3 Summary of Results

(1) Road Cross Section Element

1) Road Width (Pavement & Shoulder)

Figure XXX shows the result of road width inventory data.

- ➢ From Aizawl to Serchhip

  Around 5.5m to 8.0m pavement width which can be said as dual carriage lane was mostly observed between Aizawl to Thingsulthiah. However around 4.0m pavement width which can be judged as intermediate lane (1.5-lane) was recorded after Thingsulthiah to middle between Chhingchhip and Chhiahtlang, even though around 5.5 was found partially before Darlawng for 2 to 3km. After the middle between Chhingchhip and Chhiahtlang to Serchhip, around 5m to 6m pavement width which can be said as dual carriage lane was observed, although partially narrow width like around 4.0m was recorded for about 3km length.

  Sufficient shoulder like around 2m to 5m width was observed in average between Aizawl to Serchhip section.

- ➢ From Serchhip to Hrangchalkawn

  Around 5m to 6m pavement width was observed in some sections where are located near and within each settlement especially. On the other hand, around 4.0m was observed the sections between each settlement in terms of pavement width.

  Around 2m to 3m of shoulder width was observed in each section

- ➢ From Hrangchalkawn to Lawngtlai

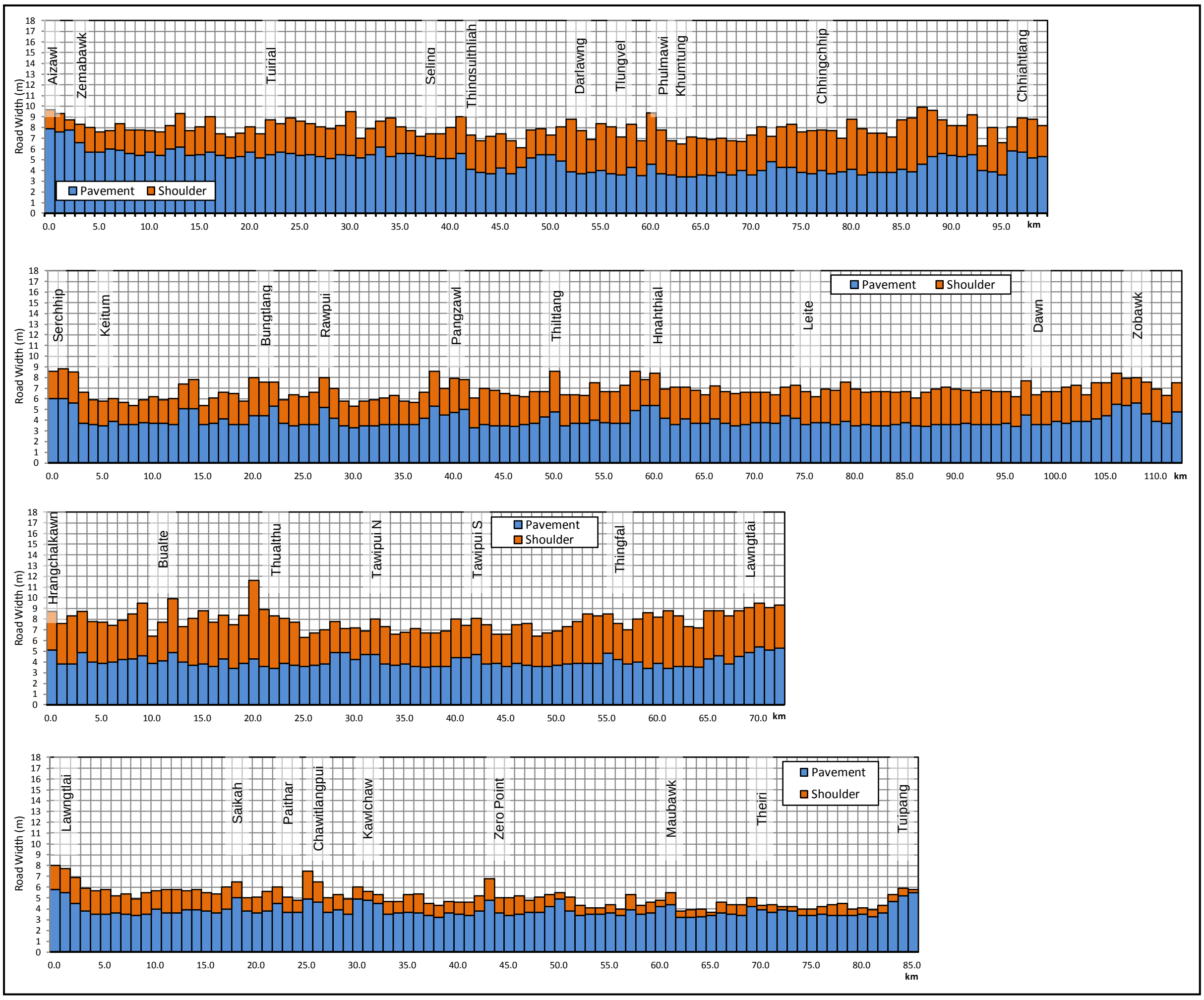
  Except Thualthu, around 5m of pavement width was observed in the sections near and within each settlement. The sections between each settlement had around 4m of pavement width. It is slightly narrow to say dual carriage lane road in this section.

  Sufficient shoulder width from 3m to 5m was mostly observed between Hrangchalkawn and Lawngtlai.

- ➢ From Lawngtlai to Tuipang

  5m to 6m of pavement width in settlement sections was mostly observed. As same as above, around 4.0m of pavement width was recorded in the sections between any settlements.

  Around 2.0m of shoulder width was observed from Lawngtlai to Chawitlangpui, however after the Chawitlangpui, it is relatively narrow shoulder was observed around 1.0m or less.



Source: JICA Study Team

Figure XXX Road Width (Pavement & Shoulder)

2) Others

Figure XXX shows the result of other inventory survey items in road cross section elements.

- Topography

  The sections where one side was hill and the other side was valley occupied in almost whole sections from Aizawl to Tuipang. However several sections where both side were hill terrain was partially observed in several 1km sections between Zemabawk and Tuirial, Thingsulthliah and Darlawng, Khumtung and Chhingchhip, Zobawk and Hrangchalkawn, Tawipui S and Thingfal. Only 2 sections where both side were valley terrain was observed in two 1km sections at Keitum and Rawpui.

- Land Use

  In almost all section from Zamabawk to Chhiahtlang, it was relatively fair or good condition of installed range of side drain and pavement condition, even though land use of rural was observed totally.

  On the other hand, in the section from Bualte to Tuipang, the range of side drain situation as well as pavement condition can be said as poor or bad, regardless the road was passing many existing settlement.

- Pavement Condition

  Bad condition was mostly observed after lawngtlai to Tuipang. One of major cause might be insufficient side drain structure which can prevent the pavement damage from rain fall.

In the sections between Aizawl to after Tuirial, bad condition was observed especially at terrain variation point from hill side to valley side or its' opposite condition.

The condition was relatively good in the section between Keitum to Zobawk rather than the other's sections along NH54.

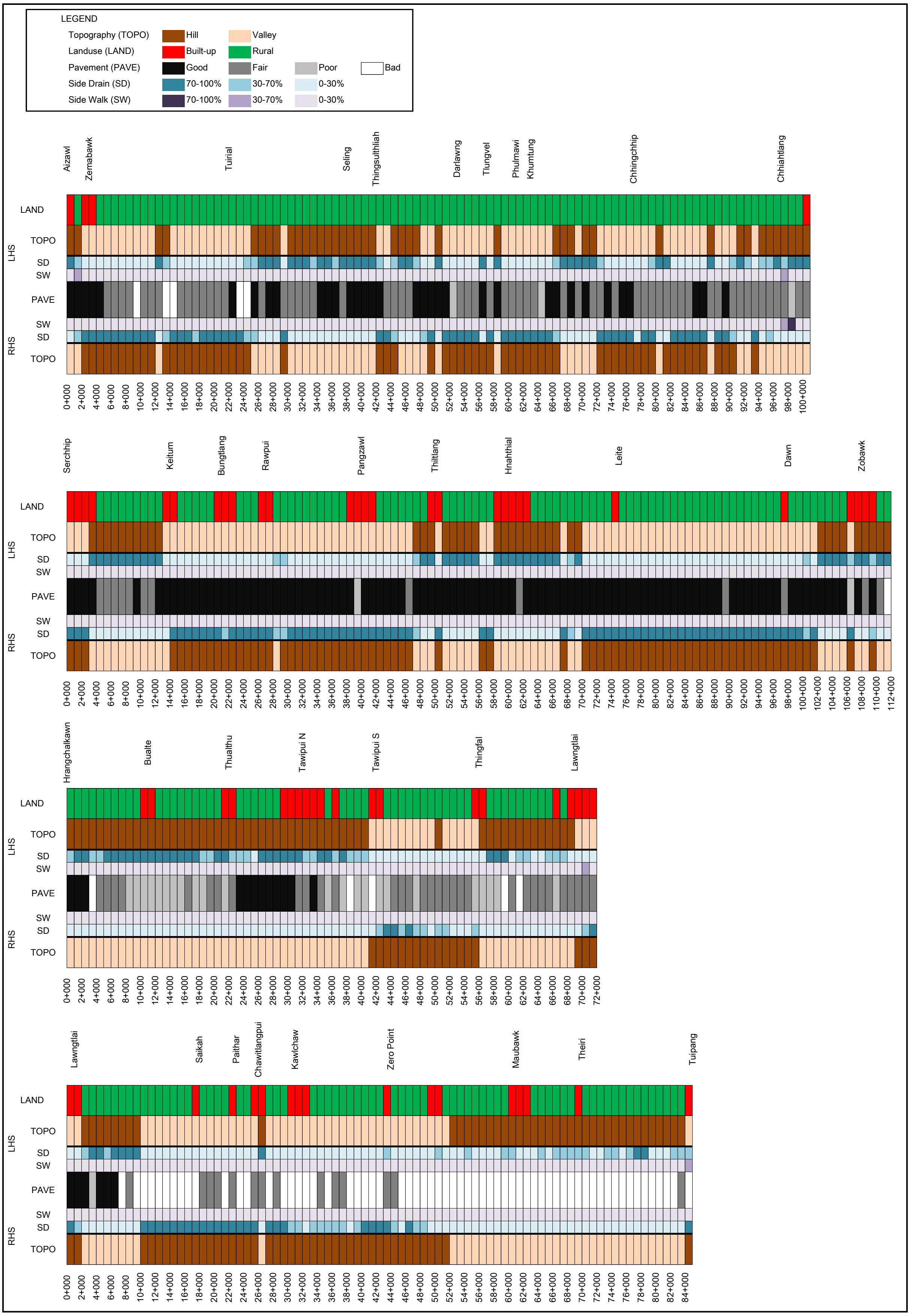
- Side Drain

  The range of installed condition of side drains was more than 30% which likely be said as good or fair in almost all sections from Aizawl to Tawipui S, although 0% to 30% range was recorded in only 1km two sections at Keitum and Tawipui S.

  However low range from 0% to 30% installation which can be said as bad condition was frequently observed after Kawlchaw to Tuipang. This might be one of major cause for deterioration of pavement in this section.

- Side Walk

  In almost all settlement area, only less than 30% occupations having side walk were observed in average. In other words, there were very few side walk along NH54. Only 1km section at Chhiahtlang had side walk in more than 70% range especially and there were no more such kind of settlement in this road who recorded as good rage for side walk.



Source: JICA Study Team

Figure XXX Cross Sectional Elements and Pavement Condition of NH54

(2) Cross Drain

Following table shows the result of cross drain inventory data. The average No. of cross drain was 4.9 No. per km. Hume Pipe type occupied its majority of cross drain the section from Aizawl to Serchhip, however Masonry Slab type occupied its majority in the section after Serchhip to Tuipang.

Table XXX Result of Cross Drain

Route	Section	Section Length (km)	No. of Cross Drain Structure					
			Hume Pipe	Masonry Slab	Other / Unknown	No Structure	TOTAL	Av. No. per km
NH54	Aizawl - Serchhip	101	160	128	5	40	333	3.3
	Serchhip - Hrangchalkawn	112	94	355	2	93	544	4.9
	Hrangchalkawn - Lawngtlai	72	12	305	0	169	486	6.8
	Lawngtlai - Tuipang	85	3	354	0	86	443	5.2
	TOTAL	370	269	1,142	7	388	1,806	4.9

Source: JICA Study Team

(3) Retaining Wall

In almost whole section along NH54, Masonry type was used. The usage of RCC type occupied just less than 5%, 0% and 1% between Aizawl and Serchhip, Serchhip and Lawngtlai, and Lawngtlai and Tuipang respectively.

Table XXX Result of Retaining Wall

Route	Section	Section Length (km)	Area of Retaining Wall (m2)								
			Left			Right			TOTAL		
			Masonry	RCC	TOTAL	Masonry	RCC	TOTAL	Masonry	RCC	TOTAL
NH54	Aizawl - Serchhip	101	5,058.2	104.3	5,162.5	2,761.2	157.8	2,919.0	7,819.4	262.1	8,081.5
	Serchhip - Hrangchalkawn	112	14,383.5	0.0	14,383.5	8,508.7	0.0	8,508.7	22,892.2	0.0	22,892.2
	Hrangchalkawn - Lawngtlai	72	7,567.8	0.0	7,567.8	11,865.1	0.0	11,865.1	19,432.9	0.0	19,432.9
	Lawngtlai - Tuipang	85	9,481.2	54.0	9,535.2	14,552.6	128.0	14,680.6	24,033.8	182.0	24,215.8
	TOTAL	370	36,490.7	158.3	36,649.0	37,687.6	285.8	37,973.4	74,178.2	444.1	74,622.3

Source: JICA Study Team

(4) Guardrail

The guardrails were most densely installed in the section from Lawngtlai to Tuipang. It can be said that safety measure was implemented mostly in terms of guardrail installation in this section. This might be because of existing of many settlements in this section.

On the other hand, the section from Aizawl to Serchhip had lowest density of guardrail installation and the majority of the type was Parapet type and Masonry type.

Table XXX Result of Guardrail

Route	Section	Section Length (km)	Length of Guardrail (m)			
			Masonry	Parapet	Steel	TOTAL
NH54	Aizawl - Serchhip	101	271.9	531.3	0.0	803.2
	Serchhip - Hrangchalkawn	112	3,593.5	66.7	0.0	3,660.2
	Hrangchalkawn - Lawngtlai	72	0.0	46.5	827.1	873.6
	Lawngtlai - Tuipang	85	10.0	6,218.8	380.3	6,609.1
	TOTAL	370	3,875.4	6,863.3	1,207.4	11,946.1

Source: JICA Study Team

(5) Social Infrastructure

The surveyed stretch was totally 370km as shown in following figure. However petrol pump was observed only 4 No. totally. Urinal/Toilet was observed more than 1 No. per 1km except the section from Serchhip to Hrangchalkawn which had the Urinal/Toilet infrastructure at each 1.3 km in average.

Table XXX Result of Social Infrastructure

Route	Section	Section Length (km)	No. of Social Infrastructure					
			School / Orphanage Home	Water pump	Urinal/Toilet	Petrol Pump	Waiting Shed	Others
NH54	Aizawl - Serchhip	101	2	172	105	2	2	13
	Serchhip - Hrangchalkawn	112	6	55	86	1	21	31
	Hrangchalkawn - Lawngtlai	72	0	99	57	1	20	36
	Lawngtlai - Tuipang	85	4	97	37	0	20	51
	TOTAL	370	12	423	285	4	63	131

Source: JICA Study Team

(6) Religious Object

In whole section, Church was mostly observed 1 No. at every 4 to 5km. Total of Memorial Stone, Grave and Monument/Statue was 144 No. This means that 1 No. of those memorial items was recorded within every 2km to 3km. Mosque and Mandir were observed 1 No. and 2 No. only within whole stretch.

Table XXX Result of Religious Object

Route	Section	Section Length (km)	No. of Religious Object					
			Church	Mosque	Mandir	Memorial Stone	Grave	Monument/Statue
NH54	Aizawl - Serchhip	101	20	1	1	0	6	29
	Serchhip - Hrangchalkawn	112	17	0	0	2	2	22
	Hrangchalkawn - Lawngtlai	72	17	0	1	24	0	0
	Lawngtlai - Tuipang	85	22	0	0	25	3	30
	TOTAL	370	76	1	2	51	11	81

Source: JICA Study Team

(7) Public Utilities (Electric Line, Telecommunication Line, Water Supply, Optical Fiber Cable(OFC))

The No. of crossing or close passing utilities' line was counted as shown the table below.

Electric distribution line was mostly found in the section from Serchhip to Tuipang in which 3 to 5 No. of the line in each 1km were observed in average.

Electric transmission line was mostly observed in the section from Aizawl to Serchhip and from Hrangchalkawn to Lawngtlai which respectively had 1 No. of the line at each 2km and 1.4km in average.

Telecommunication line was found most in the section from Serchhip to Hrangchalkawn in which 1 No. of the line was observed at every 1.5km in average.

Water supply line was found most in the section from Serchhip to Hrangchalkawn as well as from Lawngtlai to Tuipang where 1 No. of the line was observed at every 0.5km to 1km approximately in average.

OFC line was mainly observed in the section from Serchhip to Hrangchalkawn which had 5 No. of the line at every 1km in average. Secondary 1 to 2 No. of the line was found in the section from Lawngtlai to Tuipang at every 1km.

Table XXX Result of Public Utilities

Route	Section	Section Length (km)	No. of Neighboring Public Utilities (Location of Crossing / Close Passage)				
			Electric Line		Telecommuni-cation Line	Water Supply	OFC
			Distribution	Transmission			
NH54	Aizawl - Serchhip	101	12	52	5	21	9
	Serchhip - Hrangchalkawn	112	497	15	77	122	537
	Hrangchalkawn - Lawngtlai	72	210	51	15	42	5
	Lawngtlai - Tuipang	85	415	10	15	198	112
	TOTAL	370	1,134	128	112	383	663

Source: JICA Study Team

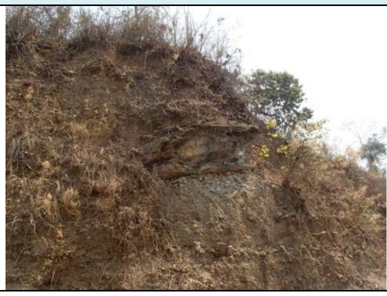
7.1.5 Slope Inventory Survey

The slope inventory survey was conducted for the purpose of topographic measurement, verification of geological and geotechnical condition, and identification of landslide risk. The road stretch was divided into four sections in the slope inventory survey; namely section A from Aizawl to Serchhip, section B from Serchhip to Hrangchlkawn, section C from Hrangchlkawn to Lawgtlai, and Section D from Lawgtlai to Tuipang. Topographic data acquired in the survey supplements the existing topographic survey data conducted in the DPR studies.

1) Geological and Geotechnical Condition

The sandstone and shale of tertiary formation distribute around NH54. The geological and geotechnical condition on each slope along the road was classified according to hardness and weathering as shown in Table 7.1.6 in the slope inventory survey. Taking into consideration spring water and dip slope which often cause landslide occurrence, cut grades with widening are set by each classification.

Table 7.1.6 Soil and Rock Classification

Loose Soil	Dense Soil	
		
Unconsolidated, loose and very soft Fluvial alluvium, colluvium, talus cone	Semi-consolidated and compact Conglomerate and terrace gravel	
Soft Rock	Hard Rock	Very Hard Rock
		
Strongly weathered and very soft. Can Break easily. Many crack, joint and schistosity. Relatively gentle slope	Slightly weathered. Can break by hammer Steep slope	Fresh and Intact Hard to break Very steep slope

Source: JICA Study Team

2) Recommendation of Road Widening Side

In order to minimize effect on landslide by road widening and alignment improvement, hold down the cost of landslide countermeasures, and decrease the maintenance cost after construction, critical slopes which have large mass movement and slope failure has been considered in road design, and road alignment design was conducted taking into consideration the effect to the critical slopes. This can avoid landslide risks which most likely happen by improper cut planned in DPR and reduce the cost of rehabilitation of landslide. In terms of successive road condition and environmental and social consideration, all critical slopes are not always avoided by realignment. Therefore, countermeasures were examined again after road alignment design.

Location of the critical slopes and recommendation of widening side in NH54 are shown in Table 7.1.7 to Table 7.1.10 below, and countermeasures against the unstable slope or landslide after widening on the showed side are also shown in the table. From Sta. 2+330 to Sta.3+580 in Table 7.1.9 is very steep slope section which is changed widening side often and examined in road design separately. The chainage in the tables shows the distance from the start point of each section.

Table 7.1.7 Recommendation of Widening Side (Sec-A)

Sec	LS No.	Landslide Location				Disaster Type	Road Deformation				Recommended Widening Side		
		Slope No.	Start	~	End		Collapse	Sinking	Crack	Bulge	R/L	H/V	Landslide Countermeasure
A	01	009	2 + 555	~	2 + 600	MM	x		x		L	V	Soil retaining wall
A	02	009	2 + 770	~	2 + 800	SF	x		x		L	V	Soil retaining wall
A	03	011	3 + 555	~	3 + 585	MM	x		x		L	V	Rockfall prevention wall
A	04	016	5 + 320	~	5 + 340	MM			x		R	H	Earth removal
A	05	017	5 + 620	~	5 + 650	MM	x		x		L	V	Groundwater drainage
A	06	021	6 + 930	~	7 + 020	MM-p					L	V	Soil retaining wall
A	07	024	7 + 630	~	7 + 860	SF	x				L	V	Soil retaining wall
A	08	025	7 + 980	~	8 + 400	SF	x				L	V	Soil retaining wall
A	09	027	9 + 030	~	9 + 050	MM-p					R	V	Earth removal
A	10	034	12 + 260	~	12 + 340	MM-p			x		R	V	Soil retaining wall
A	11	039	13 + 420	~	13 + 510	MM-p					L	V	Groundwater drainage
A	13	039	13 + 640	~	13 + 680	MM	x		x		L	V	Soil retaining wall
A	14	042	14 + 380	~	14 + 410	MM	x			x	L	V	Soil retaining wall, Groundwater drainage
A	15	051	17 + 710	~	17 + 760	MM	x		x		R	H	Earth removal
A	16	062	20 + 950	~	20 + 990	SF	x		x		L	V	Soil retaining wall
A	17	063	21 + 080	~	21 + 150	MM-p	x		x		L	V	Soil retaining wall
A	18	081	29 + 470	~	29 + 520	SF	x		x		L	V	Soil retaining wall
A	19	085	31 + 150	~	31 + 180	SF			x		R	V	Soil retaining wall
A	20	115	49 + 400	~	49 + 430	MM-p					L	V	Soil retaining wall, Groundwater drainage
A	21	119	52 + 280	~	52 + 310	MM	x		x		L	V	Soil retaining wall, Groundwater drainage
A	22	119	52 + 310	~	52 + 370	MM	x		x		L	V	Soil retaining wall, Groundwater drainage
A	23	119	52 + 370	~	52 + 550	SF	x		x		L	V	Rockfall prevention wall
A	24	119	52 + 570	~	52 + 690	SF	x		x		L	V	Rockfall prevention wall
A	25	124	56 + 100	~	56 + 200	MM	x	x	x		L	H	Anchor
A	26	140	64 + 270	~	64 + 320	MM-p					L	V	- No need
A	27	151	71 + 200	~	71 + 220	MM-p					R	V	Soil retaining wall
A	28	152	71 + 770	~	71 + 830	MM	x	x	x		L	H	Earth removal, Crib work, Rock-bolt
A	29	153	73 + 990	~	74 + 020	MM	x		x		R	H	Earth removal, Soil retaining wall
A	30	178	87 + 470	~	87 + 510	MM-p					R	V	Groundwater drainage
A	31	178	87 + 510	~	87 + 670	MM-p					R	V	Groundwater drainage
A	32	186	91 + 130	~	91 + 150	SF	x		x		R	H	Soil retaining wall

Source: JICA Study Team

Table 7.1.8 Recommendation of Widening Side (Sec-B)

Sec	LS No.	Landslide Location				Disaster Type	Road Deformation				Recommended Widening Side		
		Slope No.	Start	~	End		Collapse	Sinking	Crack	Bulge	R/L	H/V	Landslide Countermeasure
B	01	009	4 + 550	~	4 + 585	MM-p					R	V	Soil retaining wall
B	02	080	36 + 690	~	36 + 760	MM	x			x	L	V	Soil retaining wall
B	03	083	37 + 960	~	38 + 030	MM	x			x	L	V	Renew soil retaining wall
B	04	124	58 + 470	~	58 + 525	MM	x				R	V	Soil retaining wall
B	05	127	60 + 080	~	60 + 150	MM	x			x	L	H	Earth removal、 Soil retaining wall
B	06	133	62 + 860	~	62 + 920	SF	x	x			R	V	Soil retaining wall
B	07	134	62 + 960	~	63 + 030	MM			x	x	R	V	Counterweight fill, Groundwater drainage
B	08	161	74 + 600	~	74 + 630	MM-p					L	V	Soil retaining wall
B	09	174	80 + 230	~	80 + 340	MM			x		L	V	Soil retaining walll, Groundwater drainage
B	10	195	88 + 420	~	88 + 480	MM			x		L	V	Soil retaining walll, Groundwater drainage
B	11	196	89 + 340	~	89 + 430	SF	x				R	H	Soil retaining wall
B	12	198	90 + 040	~	90 + 100	MM			x		L	V	Soil retaining walll
B	13	214	96 + 960	~	97 + 030	MM	x	x			R	H	Groundwater drainage
B	14	216	97 + 660	~	97 + 720	MM	x			x	L	V	Soil retaining walll, Groundwater drainage
B	15	243	108 + 930	~	109 + 015	MM-p					R	V	- No need

Source: JICA Study Team

MM: Mass Movement, MM-p: Inactive mass movement, SF: Slope Failure, RF: Rockfall, DF: Debris Flow

R: Right side, L: Left side, H: Hill side, V: Valley side

Table 7.1.9 Recommendation of Widening Side (Sec-C)

Sec	LS No.	Landslide Location: Slope No.	Start	~	End	Disaster Type	Road Deformation: Collapse	Sinking	Crack	Bulge	Recommended Widening Side: R/L	H/V	Landslide Countermeasure
C	01	006	2 + 330	~	2 + 540	SF	x				R/L	H/V	Cut&Retaining wall, REW
C	02	007	2 + 540	~	2 + 570	SF	x				R/L	H/V	Cut&Retaining wall, REW
C	03	007	2 + 570	~	2 + 700	SF	x				R/L	H/V	Cut&Retaining wall, REW
C	04	008	2 + 700	~	2 + 750	SF	x				R/L	H/V	Cut&Retaining wall, REW
C	05	008	2 + 750	~	2 + 870	SF	x				R/L	H/V	Cut&Retaining wall, REW
C	06	008	2 + 870	~	3 + 010	SF	x				R/L	H/V	Cut&Retaining wall, REW
C	07	008	3 + 010	~	3 + 240	SF	x				R/L	H/V	Cut&Retaining wall, REW
C	08	009	3 + 240	~	3 + 580	SF	x				R/L	H/V	Cut&Retaining wall, REW
C	09	031	11 + 700	~	11 + 800	MM-p					R	V	- No need
C	10	032	11 + 850	~	11 + 950	MM-p					R	V	- No need
C	11	042	15 + 470	~	15 + 520	MM	x		x		R	V	Groundwater drainage
C	12	055	20 + 520	~	20 + 530	DF	x				R	V	Box culvert
C	13	080	31 + 400	~	31 + 450	MM	x		x		R	V	Counterweight fill, Groundwater drainage
C	14	093	37 + 710	~	37 + 720	DF	x				R	V	Box culvert
C	15	097	39 + 000	~	39 + 040	MM-p					R	V	- No need
C	16	097	39 + 200	~	39 + 280	MM-p					R	V	- No need
C	17	133	54 + 730	~	55 + 020	MM		x			L	V	Groundwater drainage
C	18	140	59 + 250	~	60 + 060	SF					R	V	Rockfall prevention wall
C	19	143	60 + 350	~	60 + 400	MM-p					R	V	- No need
C	20	145	61 + 120	~	61 + 410	SF					R	V	Rockfall prevention wall

Source: JICA Study Team

Table 7.1.10 Recommendation of Widening Side (Sec-D)

Sec	LS No.	Landslide Location: Slope No.	Start	~	End	Disaster Type	Road Deformation: Collapse	Sinking	Crack	Bulge	Recommended Widening Side: R/L	H/V	Landslide Countermeasure
D	01	004	2 + 770	~	2 + 880	MM-p					R	V	- No need
D	02	019	9 + 520	~	9 + 740	SF	x				R	V	Rockfall prevention wall
D	03	028	13 + 480	~	13 + 510	MM-p					L	V	- No need
D	04	029	13 + 750	~	13 + 800	MM	x		x		L	V	Soil retaining wall
D	05	030	14 + 100	~	14 + 190	MM-p					L	V	- No need
D	06	037	17 + 650	~	17 + 710	MM-p					L	V	- No need
D	07	040	18 + 920	~	19 + 100	MM-p					L	V	- No need
D	08	048	22 + 010	~	22 + 090	MM		x			L	V	Groundwater drainage
D	09	048	22 + 220	~	22 + 300	MM		x			R	H	Earth removal
D	10	050	23 + 350	~	23 + 420	MM		x			R	H	Anchor
D	11	052	23 + 840	~	23 + 940	MM-p					L	V	Groundwater drainage
D	12	064	29 + 540	~	29 + 790	MM-p					L	V	- No need
D	13	065	29 + 790	~	29 + 870	MM			x	x	L	V	Groundwater drainage
D	14	067	31 + 090	~	31 + 140	MM			x	x	L	V	Soil retaining wall, Groundwater drainage
D	15	071	33 + 060	~	33 + 020	MM-p		x			L	V	- No need
D	16	072	33 + 540	~	33 + 560	MM-p					L	V	- No need
D	17	076	35 + 400	~	35 + 450	MM			x		L	V	Soil retaining wall
D	18	077	35 + 620	~	35 + 705	MM	x		x		R	H	Earth removal
D	19	079	36 + 740	~	36 + 790	MM	x		x		L	V	Soil retaining wall, Rockfall prevention fence
D	20	080	36 + 950	~	36 + 970	SF	x				L	V	Rockfall prevention fence
D	21	087	40 + 150	~	40 + 190	MM	x				L	V	- No need
D	22	087	40 + 610	~	40 + 650	MM		x			L	V	Countermweight fill
D	23	115	53 + 430	~	54 + 320	SF					R	V	Rockfall prevention fence
D	24	118	55 + 120	~	55 + 170	MM		x			L	H	Anchor
D	25	119	55 + 360	~	55 + 480	MM		x			R	V	Anchor
D	26	122	56 + 540	~	56 + 600	MM		x			L	H	Anchor
D	27	139	65 + 350	~	65 + 440	MM-p					R	V	- No need
D	28	141	65 + 830	~	65 + 930	SF					R	V	Soil retaining wall
D	29	141	66 + 060	~	66 + 110	MM-p					R	V	- No need
D	30	147	68 + 980	~	69 + 050	SF					R	V	Soil retaining wall
D	31	151	70 + 540	~	70 + 620	SF	x		x		R	V	Soil retaining wall
D	32	153	71 + 790	~	71 + 860	SF	x		x		R	V	Earth removal, Soil retaining wall

Source: JICA Study Team

MM: Mass Movement, MM-p: Inactive mass movement, SF: Slope Failure, RF: Rockfall, DF: Debris Flow

R: Right side, L: Left side, H: Hill side, V: Valley side

REW: Reinforced Earth Wall

7.2 Preliminary Design

7.2.1 General

(1) Objectives
(2) Background
(3) Project Location
(4) Major Features and Facilities

7.2.2 Review of DPR

(1) Traffic Survey and Traffic Analysis
(2) Design Standards and Design Criteria
(3) Road Alignment Design
(4) Slope Protection Design

Slope protection works planned in the DPRs of each section in NH54 were reviewed. Table 7.2.1 shows the comparison with the DPRs of each section and proposal by this JICA study team.

In the DPRs conducted by several Indian consultants, road widening was planned mostly on hill side with cutting slope, and it resulted in huge volume of cut soil. The large volume of cut soil is not always economical comparing the retaining wall on the valley side due to cost for disposal of soil, construction of temporary access road to the top of the cut slope, and safety measures in construction for high cut slope. Therefore, JICA study team proposed NHIDCL and his consultants that widening should be carried out on both hill and valley in case-by case basis to reduce the cut soil volume and improve economy.

Table 7.2.1 Review of DPR regarding Slope Protection Work

Item	Sec I 0~125 km*	Sec II 125~250 km**	Sec III 250 km~End**	JICA Study Team Proposal***
Widening Side	Mainly hill side	Mainly hill side	Mainly hill side	Plan to widening to both hill and valley side in case by case basis.
Cut Grade Soil Soft Rock Hard Rock	Not defined	 60° 60° 80°	 1:0.5 1:0.25 80-90°	Decide based on classification of rock and soil.
Cut Soil Amount (m3)	Unclear	23.5 million	7.1 million	Reduce by widening on valley side and balance with embankment volume.
Embankment Amount (m3)	Unclear	0.018 million	0.085 million	Will increase with widening on valley side.
Slope Protection	Retaining wall Brest wall	Nil	Retaining wall Gabon wall	Appropriately adopt on landslide risk slope.
Landslide Sites Countermeasure Plan	Not recognized. Nil	Recognized 2 sites Gabion wall Valley revetment (Wooden fence)	Recognized 4 sites Nil	Identify landslide risk sites in inventory survey and plan its countermeasures.

Source: *DPR as of May 2015, **DPRs as of April 2015, ***JICA Study Team

(5) Bridge design

The comments for bridge plan by DPR are as follows.

- The general information for existing bridges are not provided well for all DPR. Such as structural type, span, carriageway width, design load and estimated construction year for each bridge are required.
- In DPR section –I, and section-II, re-construction was proposed only by evaluating damage condition on existing bridge. It doesn't comprehensive evaluation with consideration of carriageway width and design load.
- One of explained bridges in DPR section-II is small slab bridge which similar type is classified as slab culvert in DPR section-III. Hence, it is unsure that bridge condition was evaluated by

same viewpoints in all section among different DPR consultant.

Evaluation of damage condition is subjective matter so that it is difficult to grasp actual condition of existing bridges by only description in DPR. Also, some bridges are judged as sound and not mentioned the statue in DPR section-III.
In such reason, the site investigation to check each bridge condition is required.

In the study, general information of existing bridge such as structural type, span, carriageway width and damaged condition is investigated at site. Also, some important information such as construction year and design load is interviewed to PWD.
The necessity of bridge replacement should be carefully determined with several viewpoints such as carriageway width, design load, and soundness.

Table 7.2.2 Proposal for bridges by DPR (NH54)

	DPR proposal	Comment
NH-54 Section-I	One Major Bridge is explained as exist. No rehabilitation was proposed because major damage is not seen.	DPR explains only a damage condition to evaluate a necessity of replacement of existing bridge.
NH-54 Section-II	One Major Bridge and Three Minor Bridge is explained as exist. Re-construction was proposed for three Minor Bridges.	DPR explains only a damage condition to evaluate a necessity of replacement of existing bridge. (Including one large slab culvert)
NH-54 Section-III	No explanation for bridge.	No explanation even for general information of existing bridges such as number or location.

Source: Based on DPR

(6) Drainage design
The drainage design by DPR was reviewed. The proposed quantity in each type and size of cross drainage structures are summarized in table below. The concrete lined ditch is applied to road side ditch for cut side in all section at most.
The comments for cross drainage design by DPR are as follows.

- It does not enough explain damaged condition and structural features for each existing culverts.
- All existing culverts are proposed to be dismantled and re-constructed to new culverts with 12m width. It does not clarify the reason that existing culvert is not feasible to retain with extension of partial new culvert.
- ・Due the separated section for DPR implementation, culvert type and size does not have uniformity through all section. BOX type is only proposed for all culverts in DPR Section –I and slab culvert is only proposed for all in DPR Section –II. Also, BOX type is mostly proposed in DPR Section – III. (Refer Table)
- In all DPR, the plan doesn't basis for utilization of precast pipe culverts. In general, the pipe culvert is most economical, enable fast construction and easy to certain quality. The pipe culvert should be capable at most location except some location large discharge estimated.
- It is assumed that hydrological analysis was not conducted in DPR. Specially, no any descriptions regarding discharge calculation for DPR section-I and section-II. In DPR section-I, newly added culvert was not proposed at all. In order to decide type and dimension of culvert, the water discharge obtained by hydrological analysis is to be referred.

Table 7.2.3 Proposed culvert by DPR for NH54

	Type	Size	Existing location	Newly added	Sum
NH54 Section - I 8 to 125	BOX culvert	1.0x 1.5	406	0	406
		2.0x 1.0	20	0	20
		2.0x 1.5	6	0	6
		2.0x 2.0	31	0	31
		3.0x 3.0	4	0	4
		4.0x 4.0	0	0	0
		Total	467	0	467
NH54 Section - II 125 to 237.86	Slab culvert	1.5x 1.5	298	72	370
		2.0x 2.0	157	24	181
		3.0x 2.5	4	0	4
		3.5x 2.5	1	1	2
		6.0x 3.0	4	1	5
		Total	464	98	562
NH54 Section - III 431 to 553.6	BOX culvert	1.5x 1.5	394	0	394
		2.0x 2.0	88	0	88
		3.0x 3.0	6	0	6
		6.0x 4.0	1	0	1
	Pipe culvert	ϕ 1.2 x 1	106	90	196
		Total	595	90	685

Note : The number of culverts in bypass section is not included.
Source: Based on DPR

(7) Design Constraint (Accuracy of Design and Map)
(8) RAP Survey
(9) EIA Survey
(10) Project Cost Estimate
(11) Project Implementation

7.2.3 Road Geometric Design

(1) Design Standards
(2) Proposed Design Policy and Design Criteria
(3) Design Control
(4) Horizontal Alignment Design
(5) Vertical Alignment Design
(6) Typical Cross Section

7.2.4 Bridges and Structures Design

(1) General
It is necessary for bridges on NH54 to provide function adapted to current National Highway standard. If the existing bridge is adequate for requirement of current National Highway, it can be retained with or without some repairing works. If the existing bridge is deemed to be inadequate, it should be replaced to new bridge.
The necessity of bridge replacement should be carefully determined with following viewpoints.

- Road width on bridge: The road width for bridges should be enough for National Highway Standard. Although the road width for general road section is planned as 12.0m (3.5mx2 for vehicle lane and 2.5mx2 for side lane), the road width for existing bridge is considered enough if more than 7.5m as referred to IRC:73.

- Design Load: The existing bridge is utilized only if it follows the design load to be applicable for current National Highway Standard. Specially, Live Load is important factor because it directly works to girder. Hence, the application of live load (IRC Class 70R Loading) as mentioned in IRC:6 is confirmed for determination.

- Soundness: The existing bridge is utilized only if the condition is basically soundness without major damages. It is said that the road was originally constructed in around 1970. It means that the existing bridges constructed at origin of the road are aging near to 50 years. The project can be suitable occasion for such old bridges to replace to new bridge.

(2) Existing bridge condition

According to IRC:5, the bridge is defined for a structure of span more than 6m. On the road, several number of RC slab structure with masonry abutments which span is 5m to 7m in approximate does exist. In the study, such structure is classified to large slab culvert. It is explained in chapter of cross-drainage.

Hence, six existing bridges can be recognized in target section of the project. Outline, condition and comment for these existing bridges are summarized in the Table.

Construction year are different between each bridges. For newly constructed bridges, road width and design load are correspond to the National Highway standard. Also, these are no issue in terms of soundness. On the other hand, old bridges provide only narrow width, light design load and has aging deterioration.

Table 7.2.4 Outline and Conditions of existing bridges on NH54

Location	Outline	Condition	Comment
22+670 (At Tuirial)	・Bridge name：Tuirial Bridge ・River name：Tuirial River ・Construction year：1989 ・Structural type：3-span PCBOX girder bridge ・Length & Span：3-pan 1x12+1x47+1x12=71.0m ・Roadway width：7.5m ・Design Load：70R	・No major damages are seen at girder and piers. But pavement is damaged. ・Concrete railing and kerbs are deteriorated. ・The slab at back of abutment at E.P. side is aging deteriorated.	The existing bridge can be retained because; -No major damages are seen. -Roadway width is satisfied. -Design load is satisfied.
74+660 (At Chhingchhip)	・Bridge name：N/A (Temporary Bridge) ・River name：No river ・Construction year：N/A ・Structural type：Steel Truss bridge（Bailey bridge） ・Length：44m ・Roadway width：3.4m ・Design load： 18t（Weight limitation）	・It is a temporary bridge constructed after slope is collapsed at location of old road. The bridge capable only load within 18t and one way traffic.	<u>A new bridge should be constructed instead of temporary bridge because;</u> -The existing bridge is not suitable for permanent use for National Highway.
190+190 (At Maudarh)	・Bridge name：Maudarh Bridge ・River name：Maudarhlui River ・Construction year：1980 ・Structural type：R.C.T-beam ・Length：12m ・Roadway width：4.0m ・Design load：40R	・Girders and piers are aging deteriorated wholly. ・Scouring is seen at the bottom of piers. ・Pavement is damaged. ・Concrete railing and kerbs are quite deteriorated.	<u>The existing bridge should be replaced to a new bridge because;</u> -The bridge has aging deterioration and damages -Shortage of roadway width -Less of design load
193+420 (At before Matbawk)	・Bridge name：Mat Bridge ・River name：Mat River ・Construction year：1992 ・Structural type：PC girder bridge ・Length & Span：3 span 1x16.7+1x45.1+1x31.2=98.0m ・Roadway width：7.5m ・Design load：70R	・No major damages are seen at girder, pier and pavement. ・A part of concrete railing is deteriorated.	The existing bridge can be retained without special repairs because; -No major damages are seen. -Roadway width is satisfied. -Design load is satisfied.
216+450 (At Zobawk)	・Bridge name：Zobawk Bridge ・River name：(Tlawng Hnar) ・Construction year：1980 ・Structural type：RC slab bridge ・Length：7.5m ・Roadway width：5.0m ・Design load：30R	・Girders and piers are aging deteriorated wholly. ・Scouring is seen at the bottom of piers. ・Pavement is damaged. ・Concrete railing and kerbs are quite deteriorated.	<u>The existing bridge should be replaced to a new bridge because;</u> -The bridge has aging deterioration and damages -Shortage of roadway width -Less of design load

503+600 (At Kawichaw)	・Bridge name：Kawlchaw Bridge ・River name：Mat River ・Construction year：2000 ・Structural type：Continuous PCBOX bridge ・Length & Span：3+1 span, total length 285m ・Roadway width：7.5m（2lanes）+1.5mx2（Walkway both side） ・Design load：70R	・No major damages are seen at girder, pier and pavement. ・A part of concrete railing is deteriorated.	The existing bridge can be retained without special repairs because; -No major damages are seen. -Roadway width is satisfied. -Design load is satisfied.

Remarks） The outline data is based on the site measurement, bridge record plate and listening information from Executive Engineers of P.W.D. in District.

Source: JICA Study Team

Hence, it can be proposed to replace to new bridges for following three.

The bridge to be replaced

(a) 74+660 (Steel Truss bridge At Chhing chip)
(b) 190+190 (RC T-beam bridge At Maudarh)
(c) 216+450 (RC slab bridge At Zobawk)

Figure 7.2.1 **Temporary Bridge at Chhingchhip at 74+660**

Figure 7.2.2 **RC T beam Bridge at Maudarh at 190+190**

Figure 7.2.3 **Slab Bridge at Zobawk at 216+450**

(3) Design standard

The design is based on the IRC standard in principal. For detailed design stage, it shall be designed based on IRC standard as far as applicable.

Major codes and typical drawings regarding to bridge design is summarized in table below. Also, the codes for road design are to be referred.

But not limited to;

Table 7.2.5 List of major codes for bridge design

IRC: 5-1998	Standard Specification & Code of practice for Road Bridges. Section – I General Features of Design (Seventh Revision)
IRC: 6-2014	Standard Specification & Code of practice for Road Bridges. Section – II Loads & Stresses (Revised Edition)
IRC: 21-2000	Standard Specification & Code of practice for Road Bridges. Section – III Cement Concrete Plain & Reinforced (Third Revision)
IRC: 24-2010	Standard Specification & Code of practice for Road Bridges, Steel Road Bridges (Limit State Method) (Third Revision)
IRC: 45-1972	Recommendations for Estimating the Resistance of soil below the maximum Scour Level in the Design of Well Foundations of Bridges.
IRC: 73-1980	Geometric Design standards for Rural (Non-Urban) Highways.
IRC: 78-2014	Standard Specification & Code of practice for Road Bridges. Section – VII Foundation & Substructure (Revised Edition)
IRC: 112-2011	Code of Practice or Concrete Road Bridges
MORTH	Standard Plans for 3.0m to 10.0m Span Reinforcement Cement Concrete Solid Slab Structure with and without Footpaths for Highways, 1991
MORTH	Standard Plans for Highway Bridges R.C.C. T-Beam & Slab Superstructure – Span from 10m to 24m with 12m width, 1991

Source: JICA Study Team

The design load condition shall be determined by taking account for the regional and project characteristic. Major load conditions are as follows.

- Live load: IRC Class 70R Loading (Based on IRC:6 Clause201)
- Live load combination: One lane of Class 70R OR Two lanes of ClassA (Based on IRC:6 Clause204.3)
- Impact load: (Based on IRC:6 Clause208)
- Temperature load: +5 to +40 degree (Based on IRC:6 Clause215)
- Seismic load: Zone-V, Important Factor: 1.5 (Based on IRC:6 Clause219)

For other load conditions also be determined with based on IRC standards.

(4) New bridge planning

(a) Major bridge

It is a new bridge plan located at valley point near Chhingchhip town.
A bailey bridge is facilitated to pass over the valley at present. In past, the route was positioned at just on the slope with small radius curve.
By a collapse of the slope on the previous route, the bridge is temporary provided to pass over the slope.

In DPR, the route was proposed to make short-cut in 400m section for the valley point connecting straightly towards to reaching to the road at opposite side of hill with excavation of hill. The proposed route needs large volume of hill excavation and obstacle several numbers of local houses locating at slope. (See Figure)
In JICA study, the route passing over the valley with new bridge is proposed in order to reduce an influence for local environment, to reduce excavation volume of the hill and to improve the alignment smoothness at the section.
The alignment needs small curve if it goes through near to hill slope or bailey bridge. Therefore, the new alignment is proposed to connect straightly more remote two points at valley side. (See Figure)

For the selection of bridge type, appropriate bridge type should be selected with considering the condition of 130m length and valley terrain at the site.
Steel arch type is frequently applied in valley terrain in mountain area. It doesn't require an pier construction at deep valley point by an arch rib built on rigid ground at both slopes.
Manufacture of steel arch member in factory enable to be comparably short construction period. The valley terrain and shape of arch rib is well harmonized and makes good landscape.

As alternative type from PC type bridge, T-type rigid frame bridge which is frequently used to similar scales is compared.
A table for comparison of bridge type is summarized on next page. Because steel arch type is superior to total evaluation, steel arch bridge is proposed.

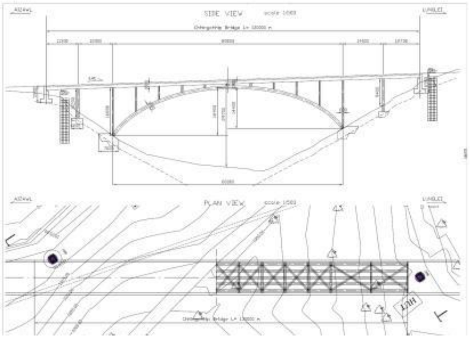
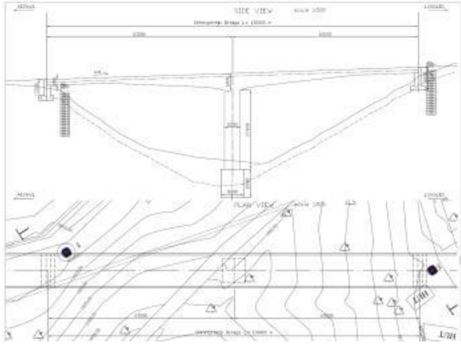
Source: JICA Study Team

Figure 7.2.4 Chhingchhip bridge site (View from E.P. side)

Source: JICA Study Team

Figure 7.2.5 **Route map at around Chhingchhip bridge site**

Table 7.2.6 Comparison of structural type

	Steel arch bridge (Upper-deck type Lohse bridge)	T-type rigid frame bridge (Canti-lever PC BOX bridge)
Layout		
Abstract	Steel arch type is frequently applied in valley terrain in mountain area. Long span is provided by arch effect of rib which supported on rigid ground. It can be built by cable erection method with cable crane facilities and temporary steel tower.	PC Canti-lever type is applied on condition where bent support is un-suitable due to high location. The girder is built by cantilever method with mobile work machine from pier head constructed.
Construction cost ratio	1.00	0.82
	- It is supposed that an oversea's contractor such as Japan is procured. A part of equipment and staff will need to be imported.	- It is well familiar method in India. All material, equipment, staff will be procured from domestic.
Construction period	1.5 year	2 year
	- The sub-structural work can be proceeded during a manufacturing the member of steel arch in factory. Hence. Construction period can be comparably short. -Because site work is less, the construction period is more reliable.	- The canti-lever work is mobilized after the pier head completed. Hence, the construction period takes comparably large. - The concrete work is more influenced by weather condition. It has a risk of huge delay.
Landscape	good	poor
	- The arch bridge is generally considered to be good landscape. The valley terrain and shape of arch rib is well harmonized.	- Due to large dimension of main pier and BOX girder, the bridge looks so artificial and heavy.
Construction condition	good	poor
	-It can be built by cable erection method from existing road side. -Steel member is manufactured in factory so that the it provides well quality control.	- Material and equipment need to be transported to the pier construction point at slope bottom with construction road. - Large concrete work at site in long period need more notification to control quality.
Evaluation	○	-

Source: JICA Study Team

Geographical and Geological condition

- Topographical survey at bridge plan site was conducted. Bridge length will be 130m between two abutments. The height from ground at center is 30m from natural ground in approximate. The elevation difference between two point reaching to existing road is 5m in approximate. Vertical gradient of road on the bridge is 3.4%.
- Geological survey was conducted at two location near to both abutment. For both bore holes, SPT test results over 50 of N-value when it becomes deeper than 3m depth. By observation of gathered core condition, the composition of ground at site is assumed as;
  - Surface : sedimentary soil
  - Till 3m depth : heavily weathered clayey shale rock
  - Deeper than 3m : Weekly weathered clayey shale rock

  It is noted that BH1 at B.P. side indicates more weathered ground condition compared with BH2 at E.P. side.
- Because the weakly weathered rock does locates at comparably shallow depth, all substructure for arch-rib, pier and abutment can be designed as spread foundation. The footing depth should be reached into weakly weathered rock layer.

Outline of bridge plan

- The bridge width is 12m in total based on IRC standard. The sidewalk is not planned on the bridge in reason that walkway can be provided easily by utilizing existing bailey bridge or new path along the slope side.
- Crash barrier needs to be facilitated due to high location bridge.

Design

- Design condition shall be based on current IRC standard. Live load class is to be IRC Class 70R.
- The area of North east region has experienced several large earthquakes in past. The area is categorized Zone-V in seismic zone classification. It requires seismic design based on IRC standard taking account of characteristic of steel arch structure.
- It is an option to add the application of weathering steel, which is known as effective to reduce a total cost of initial cost plus life cycle cost. Japanese manufacturer provides such innovative technology.

Construction

- Member of steel arch will be manufactured in factory and transported to the construction site.
- The steel arch will be erected by the cable erection method with cable crane and temporary steel tower facilitated at the site.

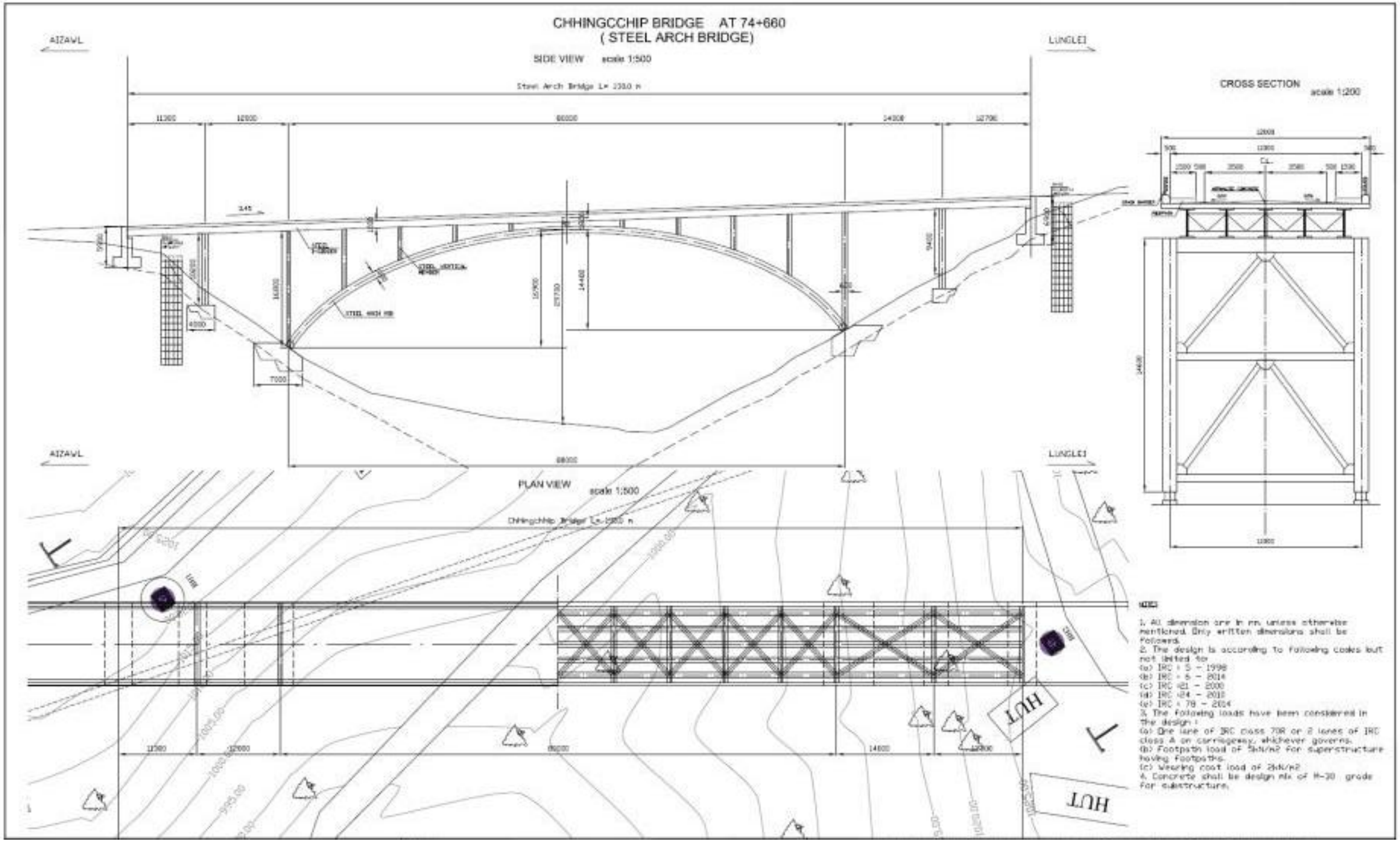


Figure 7.2.6 **Steel Arch Bridge**

(b) Minor bridge

Bridge replacement is proposed for following two Minor bridges.

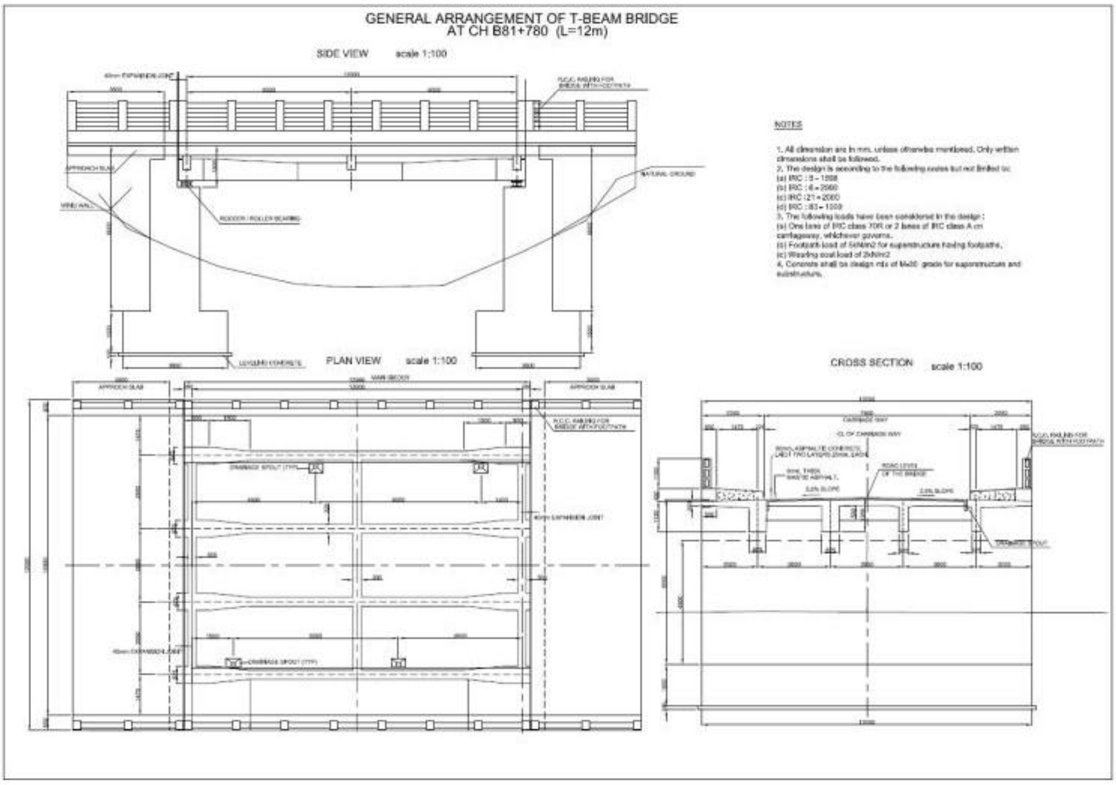
Table 7.2.7 Bridge replacement for NH54

Location	Structural type	Outline
190+190 (At Maudarh)	RC T-beam bridge	Bridge length : L=12.0m, Total width :W=12m (Without footpath) Foundation：Spread foundation
216+450 (At Zobawk)	RC Slab bridge	Bridge length : L=8.0m, Total width : W=12m (Without footpath) Foundation：Spread foundation

Source: JICA Study Team

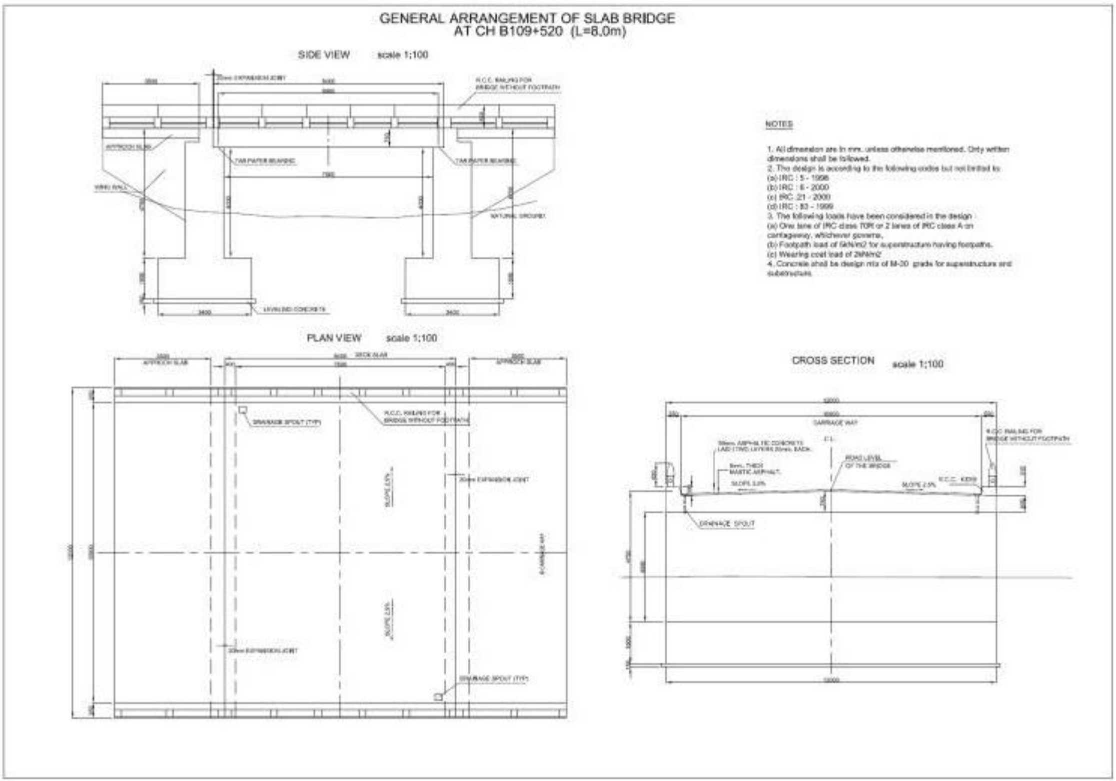
- Both bridge is comparably short span. Hence, IRC typical drawing can be applied. The super-structure is planned based on the IRC typical drawing. Range for RC slab is 6m to 10m and for RC T-beam is 10m to 24m. Hence, structural type for proposed new bridge is RCT-beam and RC slab bridge respectively.
- The bridge width is planned as 12m based on IRC:73. Footpath of 1.5m width is provided at both side.
- No traces of submergence is seen for existing bridge. Hence, the clearance under the girder same to existing bridge is to be provided. The road level is to be decided by approach road level.
- Spread foundation stood with comparably shallow depth is supposed because some rock are appeared above ground surface at around the site.

- Because the bridge is composed from RC and masonry member only, concrete work with mixer at site is supposed. After the demolishment of existing bridge, foundation is constructed. The superstructure concrete will be by cast in-situ on the support.
- Temporary road is required at neighbor for traffic diversion during construction. The construction in dry season is recommended.



Source: JICA Study Team

Figure 7.2.7 **T-beam bridge (L=12m)**



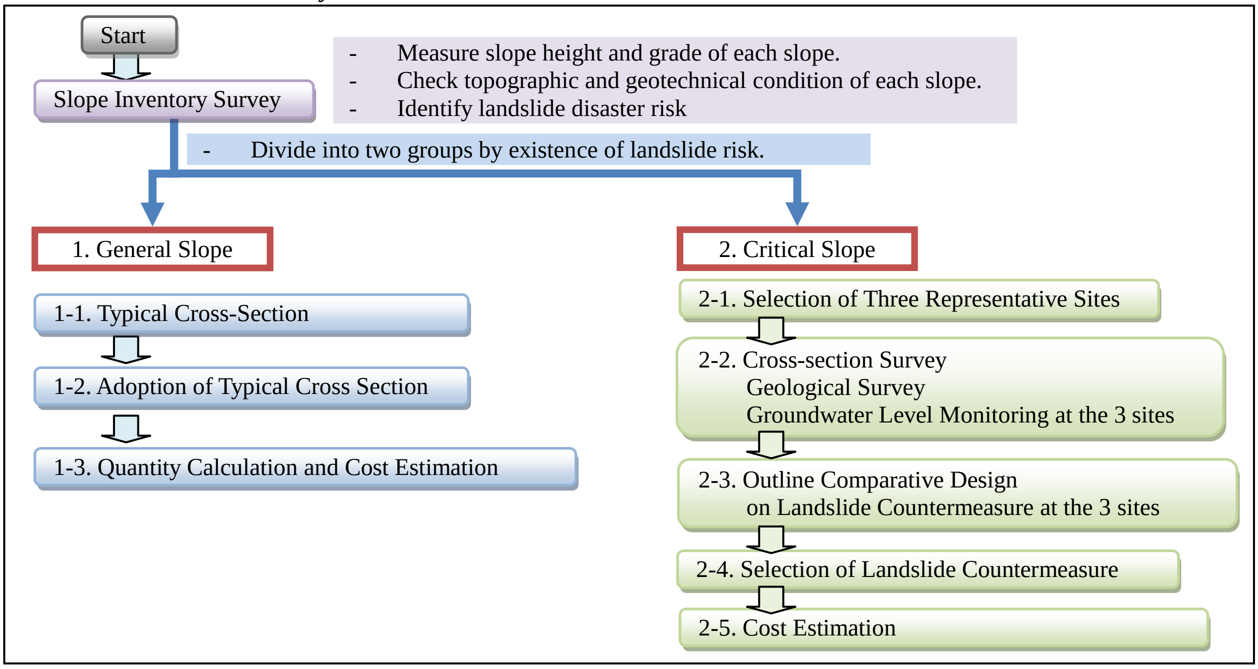
Source: JICA Study Team

Figure 7.2.8 **Slab bridge (L=8m)**

7.2.5 Earth Work / Slope Protection / Land Slide Prevention Design

1) Methodology

Figure 7.2.9 shows flow of the methodology of planning for earth work, slope protection, and landslide prevention works. Based on the slope inventory survey as mentioned above, slopes all along the road were evaluated either critical slope which has existing landslide disaster or risk of large scale mass movement and slope failure or general slope which has less landslide risk. It is necessary for the critical slope to survey geology, geotechnical condition, geography, aquifer, and slide surface in detail, and design countermeasures individually.



Source: JICA Study Team

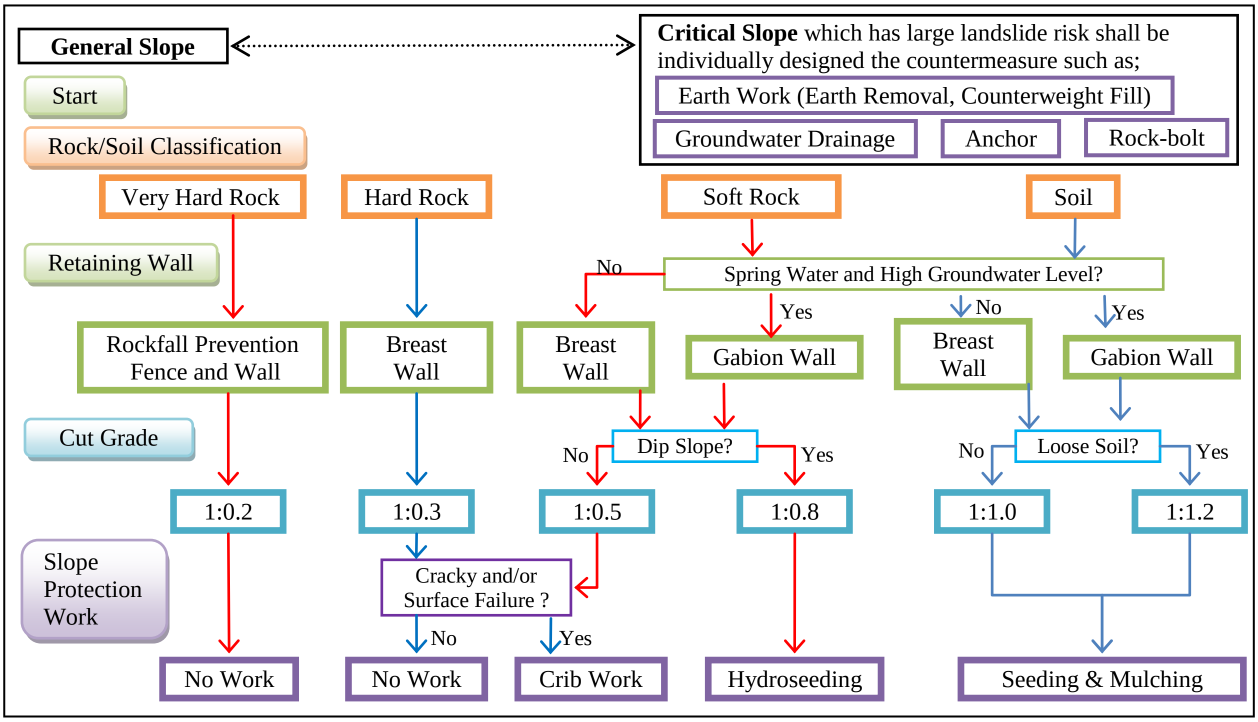
Figure 7.2.9 Flowchart of Plan on Slope Protection Work

2) Proposed Design Policy and Design Criteria

Against the general slopes, slope protection work, retaining wall, and grade of cut/embankment slope shall be planned based on natural condition including geology, geotechnics, and topography of each slope following the design criteria mentioned below. Especially, in order to prevent slope disaster, the design policies are established as below.

- Stable cut slope of soil and soft rock shall be covered with vegetation work.
- Unstable slope and unsuitable slope for vegetation shall be adopted slope protection work.
- Height of one row of cut slope shall be maximum 7m. In case of exceed, a berm with 1.5 wide shall be set between slopes.
- Total height of cut slope shall be maximum 20m basically in terms of environment, construction workability, and disaster prevention.
- To prevent high cut slope, slope shall be cut steeper than stable grade and adopted slope protection work.
- Breast wall shall be built at the toe of slope on hill side to prevent small collapse and to maintain the side drain.
- Slope protection work shall be selected among common construction method in India and Japan.
- Landslide site shall be avoided by road realignment as much as possible.
- If road cannot help planning to pass the landslide area, landslide countermeasure such as groundwater drainage, counterweight fill, earth removal, and anchor work shall be examined for landslide stabilization.

Figure 7.2.10 summarizes the flowchart of selection of retaining wall type, cut grade, and slope protection works for cut slope on hill side. The critical slope which has large landslide with more than 1.0m depth and is expected to give huge damage to the road shall be individually surveyed and designed its countermeasures e.g. earth work including landslide removal and counterweight fill, groundwater drainage, anchor work, and rock-bolt work, etc.



Source: JICA Study Team

Figure 7.2.10 Flowchart of Selection of Slope Protection Work for Cut Slope

3) Design of Earth Work

<u>Cut Slope</u>

Cut grade of slope above the retaining walls along the road shall be decided based on geological and geotechnical condition of slope. Table 7.2.8 presents design criteria of cut grades for each rock and soil classification comparing those in IRC. Because there are many slope failure on the existing cut slope with 1:0.3 consisting of weathered and loosen rock, the soft rock shall be cut with gentler grade than IRC and 1:0.5 to 1:0.8 grades. Harder rock slope can be applied steeper cut grade; namely very hard rock and hard slope shall be cut with 1:0.2 and 1:0.3 respectively. On the other hand, loosen and weakened rock and soil slope shall be carefully cut with gentler cut grades more than 1:0.8.

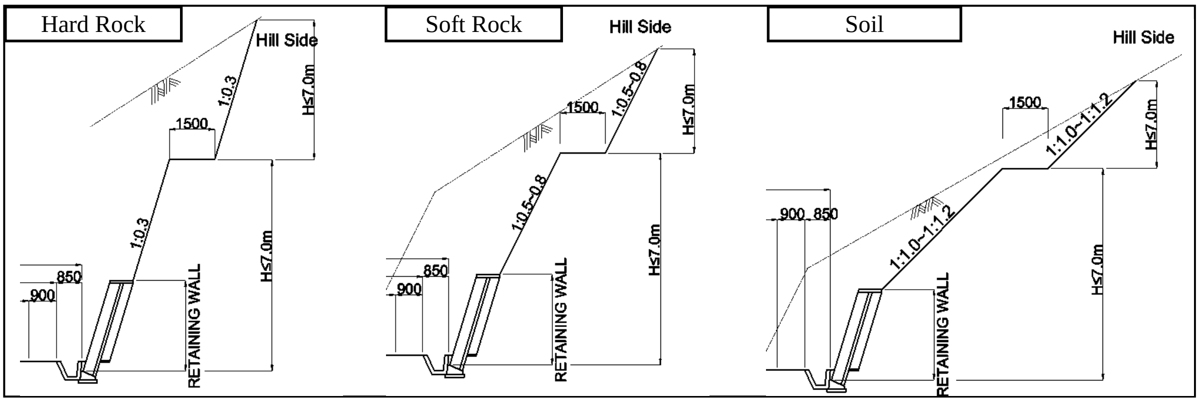
Against rock slope which is cracky and has a risk of rockfall or slope failure, crib work shall be applied for prevention of damage, which can deter surface failure and rockfall with around 10 m3 (less than 3m width and less than 1m depth) on the cut slope. In case that larger landslide is concerned, landslide countermeasure such as anchor and rock-bolt works need to be planned individually in the countermeasure design for the critical slopes.

For prevention of erosion and surface failure and also for landscape improvement, most of cut slope shall be covered by hydroseeding work or seeding and mulching, and will be greened. The thickness of the sprayed hydroseeding shall be varied from 3 to 7 cm depending on the geotechnical condition. The cut slope of soft rock which is cut with 1:0.8 is applied 5cm thick hydroseeding. Seeding and mulching is applied for soil cut slope. As very hard or hard rock slope consists of intact bed rock and is cut with steep grade, the vegetation work including hydroseeding cannot be applied because the plant cannot be expected to grow on such slope.

Table 7.2.8 Design Criteria of Cut Grade and Protection Work

IRC Standard*		JICA Study Team Rock/Soil Classification			Cut Grade	Slope Protection Work
Classification	Cut Grade					
Hard Rock	**80 ~ 90 degree**	Rock	Very Hard		**1:0.2**	No protection work
			Hard	No Risk	**1:0.3**	No protection work
				Landslide Risk		Crib work
Ordinary Soft Rock	**1:0.25 ~ 1:0.125**		Soft	Non-Dip Slope	**1:0.5**	No protection work
				Dip Slope	**1:0.8**	Hydroseeding (t=5 cm)
Ordinary Soil/ Heavy Soil	**1:1.0 ~ 1:0.5**	Soil	Dense Soil		**1:1.0**	Seeding and Mulching
			Loose Soil		**1:1.2**	Seeding and Mulching

*IRC: SP:48:1948 Clause 7.4
Source: JICA Study Team



Source: JICA Study Team

Figure 7.2.11 Typical Cross Section of Cut Slope

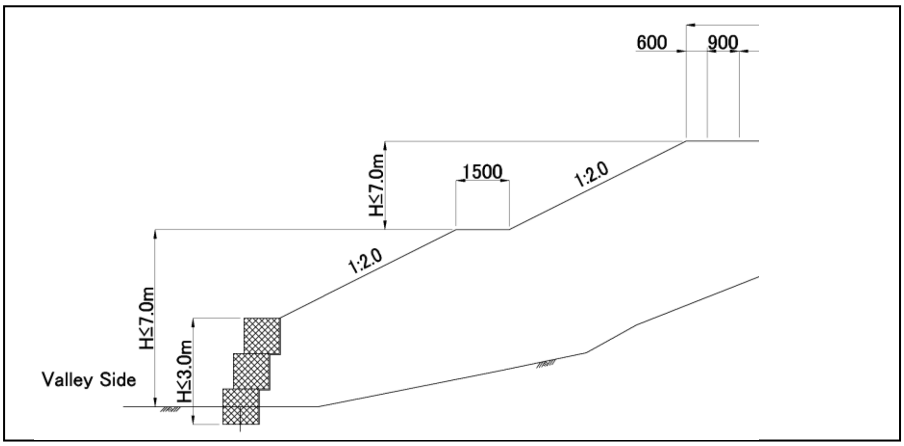
<u>Embankment on the Valley Side</u>

Slope grade of embankment slope is generally decided based on the embankment material and total slope height. Because surplus soil by cutting is expected to utilize as embankment material in this project, the embankment material is composed of gravelly soil derived from sandstone and shale. The slope grade of embankment is proposed as shown in Table 7.2.9. In order to prevent surface failure on the embankment slope, retaining wall such as gabion wall shall be built at the toe of slope. And turfing shall be implemented on the embankment slope for prevention of erosion and landscape improvement.

Table 7.2.9 Design Criteria of Embankment Slope and Slope Protection Work

IRC Standard*		Embankment Material	Height	Grade	Slope Protection Work
Classification	Grade				
Embankment	**1:2.0**	Gravelly Sand derived from Cutting	less than 5 m	**1:1.5**	Turfing
			5 ~ 20 m	**1:2.0**	Turfing

*IRC: 36-1970
Source: JICA Study Team



Source: JICA Study Team

Figure 7.2.12 Typical Cross Section of Embankment Slope

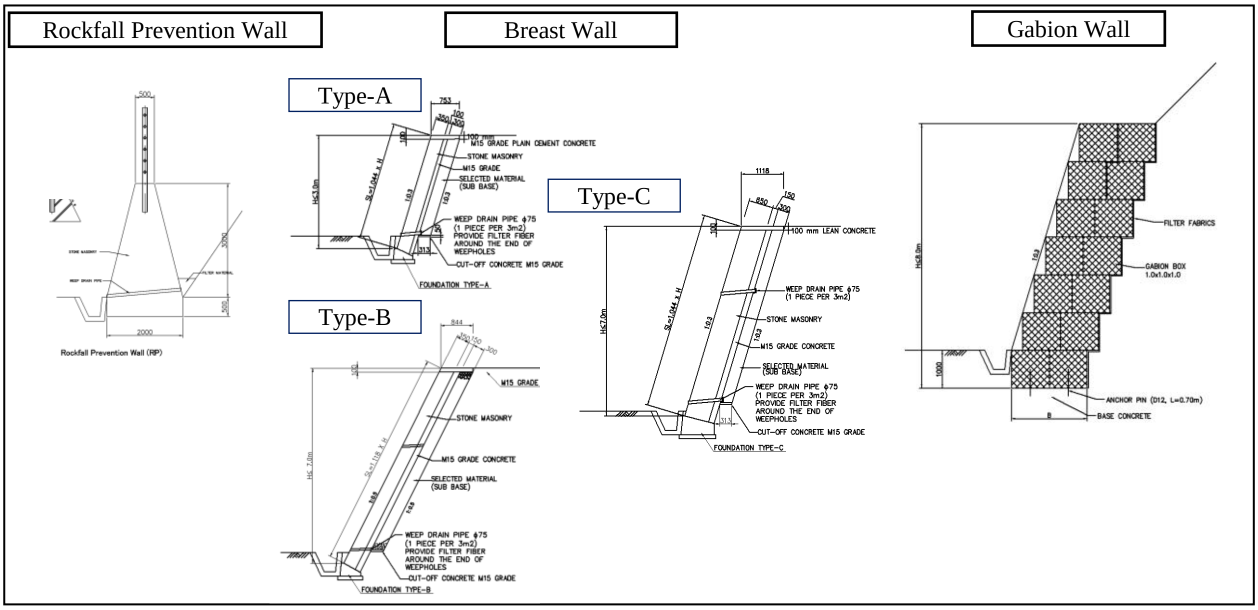
4) Retaining Wall

Retaining walls shall be built on the toe of almost all slopes on hill side along the road in order to prevent the small debris fall on the cut and natural slopes from accumulating in the side drainage, that can result in damage of pavement by the flooding discharged water. Table 7.2.10 shows design criteria of the retaining wall. To reduce cut soil amount, the type of the retaining wall shall be changed by slope topography. Namely, large retaining wall with 65 cm thickness shall be applied for higher slope, and small one with 35 cm thickness shall be applied for other lower slope and soil slope. Gabion wall, which has high permeability, shall be adopted for the slope where spring water was found at the site and groundwater level was assumed to be high. In high and steep slope consisted of very hard rock strata, gravity-type retaining wall with high-intensity rockfall prevention fence shall be built at the toe of cut slope in order to prevent rocks from falling on the road.

Table 7.2.10 Design Criteria of Retaining Wall on Hill Side

Slope Type			Wall Height	Retaining Wall Type (Grade on Front Slope)	
Rock	Very Hard		**Less than 3.0 m**	Rockfall Prevention Wall	1:0.25
	Hard		**Less than 3.0 m**	Breast Wall Type-A	1:0.3
			3.0 ~ 7.0 m	Breast Wall Type-B	1:0.5
			3.0 ~ 7.0 m	Breast Wall Type-C	1:0.3
	Soft		**Less than 3.0 m**	Breast Wall Type-A	1:0.3
			3.0 ~ 7.0 m	Breast Wall Type-B	1:0.5
			3.0 ~ 7.0 m	Breast Wall Type-C	1:0.3
		High Groundwater Level	**Less than 8.0 m**	Gabion Wall	1:0.3~
Soil	Dense Soil		**Less than 3.0 m**	Breast Wall Type-A	1:0.3
			3.0 ~ 7.0 m	Breast Wall Type-B	1:0.5
		High Groundwater Level	**Less than 8.0 m**	Gabion Wall	1:0.3~
	Loose Soil		**Less than 3.0 m**	Breast Wall Type-A	1:0.3
			3.0 ~ 7.0 m	Breast Wall Type-B	1:0.5
		High Groundwater Level	**Less than 8.0 m**	Gabion Wall	1:0.3~

Source: JICA Study Team



Source: JICA Study Team

Figure 7.2.13 Typical Cross Section of Retaining Walls

5) Embankment Structure

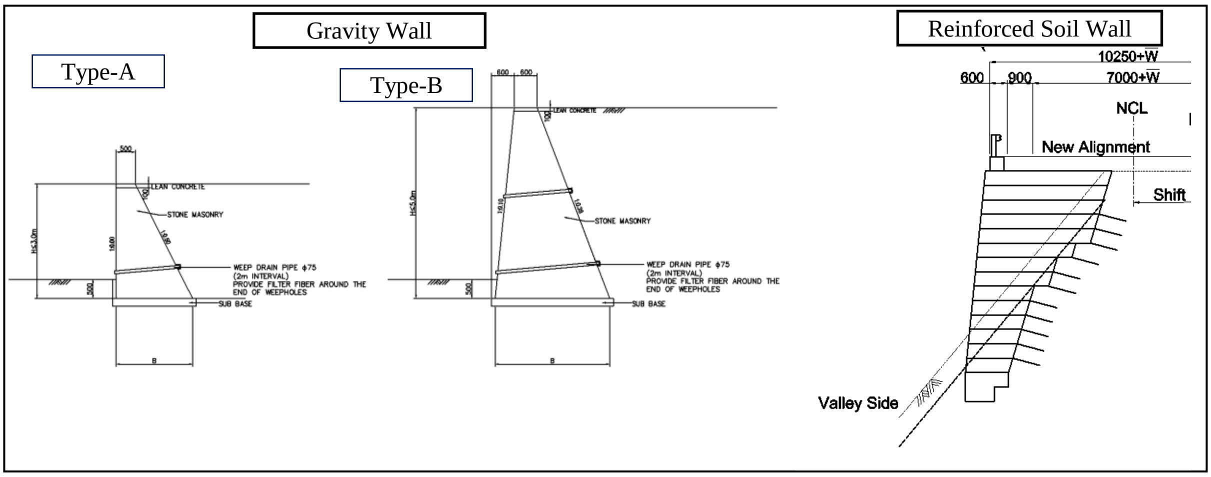
Retaining walls are built in front of the road embankment with the road widening on valley side,. Type of retaining wall should be selected depending on slope topography on valley side. For gentle and low valley slope which is gentler than 30 degree, gravity wall is frequently used for soil retaining. Because the gravity walls which has vertical or very steep grade on front slope need to excavate largely behind the wall in construction, it is necessary to pay attention to ensure the present traffic while construction. Steep and high slope as frequently seen in NH54 need the reinforced earth wall which can be built steep gradient on its front slope and more than 20m in height.

As there is often loose soil dumped in the past road construction on slope of valley side, embedded depth for foundation of the retaining wall shall be 2m on soil slope and 1m on rock slope.

Table 7.2.11 Design Criteria of Embankment Structure

Retaining Wall Type		Height	Grade of Front Slope	Apply to
Gravity Wall	Type-A	less than 3 m	**Vertical**	Gentle and Low Slope
	Type-B	less than 5 m	**1:0.1**	Gentler than 30 degree
Reinforced Earth Wall		5 ~ 20 m	**1:0.1**	High and Steep Slope

Source: JICA Study Team

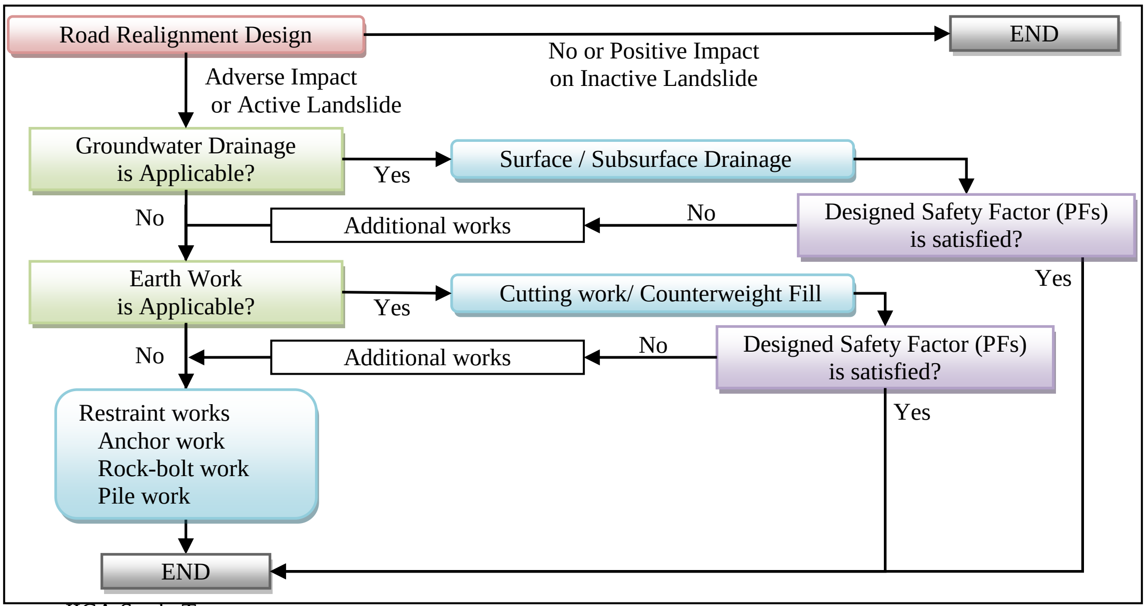


Source: JICA Study Team

Figure 7.2.14 Typical Cross Section of Retaining Walls

6) Landslide Prevention Design

Landslide prevention measure was planned and designed for the critical slopes identified in the slope inventory survey. Figure 7.2.15 shows flowchart of selection of the landslide prevention measures. As mentioned in clause 7.1.5, design of road alignment with widening was carried out taking into consideration location of the critical slopes not to give adverse impact on the landslide movement. Then, if there is no or positive impact on the inactive landslide, any prevention measure is not necessary. However, landslide is active or is concerned to be destabilized by road widening, landslide countermeasure shall be implemented. The landslide prevention measures are mainly divided into three types; namely groundwater drainage work, earth work such as earth removal and counterweight fill, and restraint work including anchor, rock-bolt, and pile work. In general, groundwater drainage work is the cheapest followed by earth work. But they are often constrained by topographical, geotechnical, and geohydrogical condition. On the other hand, restraint work which prevents the landslide movement by force is commonly expensive, but they can be adapted to most of landslide because it can be implemented in limited space. Therefore, groundwater drainage and earth work shall be introduced or combined with other method as much as possible, and reduce the cost of the countermeasures.



Source: JICA Study Team

Figure 7.2.15 Flowchart of Landslide Prevention Measure

Table 7.2.12 Process of Safety Factor by Landslide Prevention Measures

Landslide Site	Groundwater Drainage		Earth Work		Restraint Work	
A	Not Applicable	0.980	Not Applicable	0.980	Anchor Work	1.100
B	Applicable	1.015	Not Applicable	-	Anchor Work	1.100
C	Applicable	1.023	Applicable	1.123	Not Necessary	-

Fs0=0.098, pFs=1.100

Source: JICA Study Team

Against the three representative landslides where boring works were carried out as mentioned in clause 7.1.3, outline design of the landslide prevention measure was conducted. Table 7.2.12 shows the progress of safety factor by planned landslide countermeasures. Because those landslides are unstable and assumed to slide actively during rainy season, initial safety factor in stability analysis was set Fs0=0.980. And designed safety factor aimed pFs=1.10 to raise 12% from initial safety factor.

Groundwater level in landslide A is so low that groundwater drainage work is expected to be not effective. And earth work is not applicable because of limited topographic condition and surrounding houses. Therefore, landslide A shall be adopted anchor work of restraint works.

Landslide B has groundwater level just above the slip plane. Groundwater drainage is applicable, but that cannot satisfy the designed safety factor by itself and additional earth work including earth removal is not applicable because the road is located near the top of the landslide slope. It is necessary to implement anchor work of restraint works to prevent the progression of the road sinking.

Landslide C also assumed to have groundwater level above the slip plane, and earth removal at the top of slope and counterweight fill at the toe of slope can be feasible. Therefore, both groundwater drainage and counterweight fill are so effective that both are planned for landslide stabilization without a restraint work.

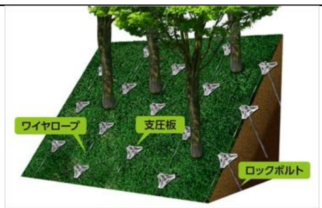
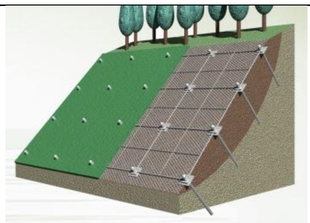
The planned landslide prevention measures are shown in the drawings in Annex of this report.

7) Slope Failure Prevention Measures on Natural Slope

Against slope failures on natural slope above the retaining walls at the toe of slope or the cut slope with stable grade, prevention measure shall be planned in the same manner with landslide prevention measures mentioned above. But because construction will be done on natural slope, not only economy but landscape is also taken into consideration to select a countermeasure.

Table 7.2.13 presents comparison of three countermeasures against the slope failure on natural slope. Two countermeasures, non-frame methods and GF rock-bolt measure which are manufactured by Japanese company are compared to traditional methods, the crib work with rock-bolts. Those two countermeasures have advantage in that it can be forested after construction and improve landscape. But they need to install rock-bolts on whole construction area, so economies of them are worse than the crib work in many cases. Non-frame method can be constructed without deforestation and preserve existing trees in the construction area, and it is more economical than GF rock-bolt method. Therefore, non-frame method shall be adopted against the slope failure on natural slope. And crib works with rock-bolt can be adopted for cut slope where slope failure is concerned.

Table 7.2.13 Comparison of Three Slope Failure Prevention Measures on Natural Slope

Construction Method	Non-frame	GF Rock-bolt & Rope Net	Crib work with Rock-bolts
Photo/ Schematic Image			
Manufacturer	Nippon Steel & Sumikin Metal Products Co., Ltd.	Tokyo Rope MFG Co., Ltd.	-
Environment	Unnecessary to deforest and environmentally-friendly. <good>	Necessary to deforest due to installation of metal mesh. Planting and seeding are available after construction. <fair>	Planting and seeding are available inside frame. Landscape is not better than the other methods. <poor>
Economy	More expensive than crib work with rock-bolts in many cases due to rock-bolt installed in whole construction area. <fair>	Need more materials than the non-frame method and more expensive. <poor>	Unnecessary to install the rock-bolt on whole area and more economical than the other methods in many cases. <good>
JICA Study Team Propose	Adopt only for Natural Slope	Not adopt	Not adopt (Adopt on Cut Slope)

Source: JICA Study Team

7.2.6 Pavement Design

(1) Design Standards and Guidelines

(2) Design Period of Pavement Design

(3) Traffic Condition

(4) Geological Condition

(5) Pavement Design

7.2.7 Drainage Design

(1) General

It is required to facilitate culvert or side ditch on road for drain water surrounding or upstream of road to downstream properly. Specially, hill road is always suffered from large volume of water fallen from mountain slope towards to the road. It is quite important to protect the road by arranging cross drainage appropriately to satisfy the discharge from crossing water.

On the existing NH54, large number of culvert does exist crossing under the road. Because the road improvement includes road widening and alignment modification in most section, appropriate measures for culverts such as demolish/reconstruction or extension of existing is considered to be taken in each location.

However, it is considered that retain of existing culvert with extension measure is not practical for the situation. The reasons are explained below.

- Position shift due to road improvement : The culvert length needs to be extended due to road widening from existing 6-7m to 12m width. Also, the culvert position to be placed is changed because the road center line is shifted by alignment modification. Specially, it can be shifted to valley side at every valley section where the curve radius is modified to be larger by alignment modification. Hence, the extension measure on existing culverts does not much reduce for its work volumes compare with new construction. In addition, it makes the work more complicated.

- Condition of existing culvert : The existing structures constructed at origin of the road are aging near to 50 years. It was confirmed by the investigation that these structures don't provide appropriate durability, structural features and maintenance performance to utilize in improved National Highway.

Moreover, it cannot be ensured that existing culverts are well durable for next several decades. The replacement on one occasion of the road improvement would be much advantage in terms of economy and serviceability of the road more than frequent occasional replacement in near future.
Hence, it is general policy that existing culverts are demolished and is constructed a new one.

The new drainage system is designed by based on hydrological calculation result. Based on obtained location of water crossing and water discharge, dimension and locations for drainage system are determined. For cross drainage structure, appropriate culvert type is selected by taking account of economy, construction workability, and maintenance ability.

(2) Outline and condition of existing culvert

Existing culverts on NH54 can be categorized into four types. Structural outline and condition in each type of culverts are summarized in table.

It is tendency in whole that existing culverts are aging deterioration for RC concrete and masonry. Also, many culverts accumulate soil fully at inside.

Table 7.2.14 Outline and condition of existing culvert

Type	Outline	Condition
Slab culvert	It is the structure of RC slab plate with masonry abutments. Stones are laid at bottom. For some of these an inlet or outlet wall is integrated with retailing wall. Mostly the dimension is 1m to 1.5m type. Some is 5 to 6m type like small bridge. It is assumed that these slab culverts has been retained since original construction of NH-54.	-Concrete exfoliation and exposure of steel bar at back side and edge of slab plate -Shortage of concrete cover at back side of slab plate, as seen exposure steel and coating of mortal -Collapse of slab plate and pavement -Exfoliation of masonry abutment
Slab culvert (Large type)	It is large type of slab culvert which spans 5m to 7m in approximate. The type exists at about 10 locations of NH54.	-For some culvert, concrete exfoliation and exposure of steel bar at edge of slab plate
R.C. Hume pipe	It is the structure of R.C. Hume pipe connecting same pieces. Diameter is ranged as 0.8m to 1.5m in approximate. For some of these an inlet or outlet wall is integrated with retailing wall. It is assumed that these R.C. pipes were installed comparably recent.	-Concrete exfoliation and exposure of steel bar at joint between pipes. -Clacks at surface of concrete
G.C.I. Sheet pipe	It is the structure of Galvanized Corrugated Iron Sheet. Diameter is ranged as 0.6m to 1.5m. A masonry headwall is at inlet or outlet of pipe. Construction year is un-known.	-Deformation and tear of parts -Settlement and collapse of pavement

Source: JICA Study Team

The example of existing culverts at site in each type is shown in Figure .

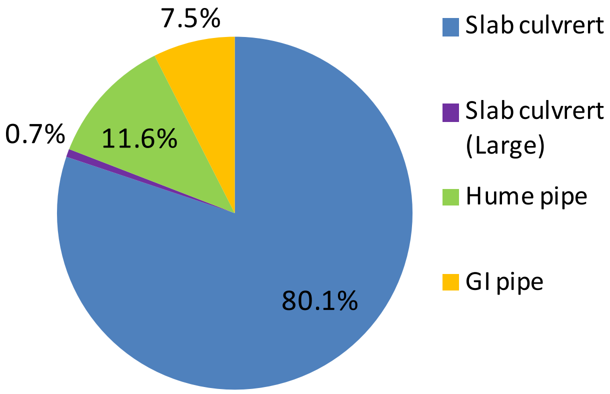
According to the inventory survey result conducted in the study, slab culvert covers approximately 80% on existing culverts in the project range of NH54. The rate of slab culvert is larger as it locates near to Tuipang side.

The rate of structural type of existing culvert is summarized below.

Table 7.2.15 Rate of structural type of existing culvert

Section (DPR border)	Section-I 8-125km		Section-II 125-250km		Section-III 250-380km		Total	
	Nos.	Rate(%)	Nos.	Rate(%)	Nos.	Rate(%)	Nos.	Rate(%)
Slab culvrert	148	47.3%	411	80.4%	543	98.5%	1102	80.1%
Slab culvrert (Large)	0	0.0%	5	1.0%	5	0.9%	10	0.7%
Hume pipe	118	37.7%	39	7.6%	3	0.5%	160	11.6%
GI pipe	47	15.0%	56	11.0%	0	0.0%	103	7.5%
Total	313	100.0%	511	100.0%	551	100.0%	1375	100.0%

Source: JICA Study Team



Source: JICA Study Team

Figure 7.2.16 Rate of structural type of existing culvert

Large type of slab culvert is located at several points on existing road. It should cause large volume of crossing water in rainy season at such location. Hence, the large size of culvert will be planned at the location.

The large slab culvert confirmed by site investigation is summarized in table.

Here, the structure at B90+240 was classified to bridge in DPR. According to PWD, the design live load for the structure is 40R.

Table 7.2.16 Large slab culvert

Cheinage	Opening width (span length)	Road width (Inlet to Outlet)	Averaged height	Condition
At 198+430	6m	10m	4.0m	
At 225+930	7m	6.7m	4.5m	
At 229+480	5m	9.6m	5.0m	Concrete exfoliation and exposure of steel bar at edge of slab plate
At 229+630	6m	6.3m	4.5m	
At 235+260	6m	9.8m	4.5m	Scouring at bottom of masonry wall
At 437+660	6m	7.4m	4.5m	
At 503+870	7m	9.8m	4.5m	
At 506+110	5.5m	7m	4.0m	
At 508+080	6.5m	7m	3.5m	
At 511+190	6.6m	7m	5.0m	

Source: JICA Study Team

By considering structural viewpoint, it is recommendable for all existing culvers to replace to new one in occasion of the road improvement because;

- Slab culvert : improper work for slab concrete, less design load, aging of RC slab and masonry abutment
- Slab culvert (Large type) : Less design load, aging of RC slab and masonry abutment
- R.C. pipe : Un-known of pipe class for existing (NP-2 according to DPR) Soil accumulation issue for small diameter pipes
- G.C.I. Sheet pipe : Structural weakness

(3) Design standard

The design is based on the IRC standard in principal. For detailed design stage, it shall be designed based on IRC standard.

Major codes regarding to drainage design is referred to bridge design. The additional codes and typical drawings for drainage design is as follows.

Table 7.2.17 List of major codes for drainage design

IRC:SP: 13-2004	Guidelines for the Design of Small Bridges and Culverts (First Edition)
IRC: SP:42-2014	Guidelines on Road Drainage (First Edition)
MORTH	Standard Plans for Single, Double and Triple Cell Box Culverts with and without Earth Cushion
IS458 (2013)	Precast Concrete Pipes (with and without Reinforcement)

Source: JICA Study Team

Figure 7.2.17 **An example of existing slab culvert**

Figure 7.2.18 **An example of existing R.C. Hume pipe**

Figure 7.2.19 **An example of existing G.C.I.Sheet pipe**

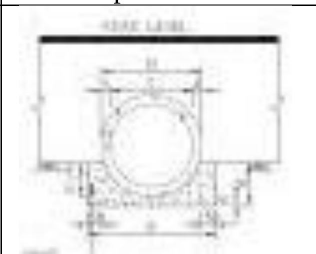
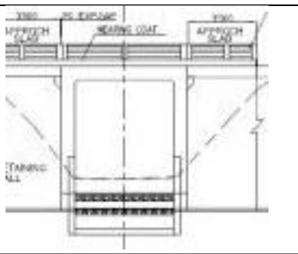
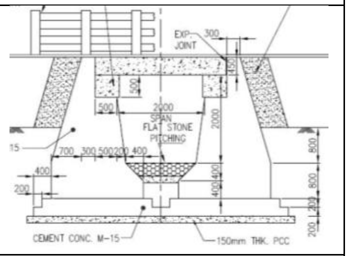
Figure 7.2.20 **An example of existing large slab culvert**

(4) New drainage design

(a) Cross drainage structure

The structural type of cross drainage is classified as pipe culvert, BOX culver and slab culvert.
Pipe culvert is most appropriate structure where the water discharge is comparably small. It has advantage for economy, provision of quality because of precast manufacturing for RC pipes.
BOX culvert is appropriate where the water discharge is more than pipe capacity. Because BOX culvert is composed from all RC structure, it is reliable to keep durability and construction quality more than slab culvert which is composed from slab plate and masonry abutment.
In such reason, BOX culvert was applied to World Bank Road which is neighbor of NH54 constructed few years before.
Each type of culverts is compared in table below.

Table 7.2.18 Comparison for culver type

	Pipe culvert	BOX culvert	Slab culvert
Layout			
Economy	◎	○	△
Construction ability	◎	○	△
Durability	○	○	△
Capacity	○	◎	◎
Comment	To be applied for small discharge point	To be applied for large discharge point	Not applied

Source: JICA Study Team

Hence, pipe culvert is proposed where the water discharge is comparably small. BOX culvert is proposed where the water discharge is comparable large. The size is determined to satisfy the water discharge obtained by hydrological calculation.

The contents of pipe culvert and BOX culvert is explained below.

・Culvert length from inlet to outlet is 12m which is same as the road width in general section. However, it shall be widened to match with widening in curve section.

・BOX culvert is based on the IRC standard drawings. Approach slab is needed for approach part. RC railing is needed at kerb at both side. The inner dimension of BOX culverts is arranged between 2mx2m to 4mx6m to satisfy the discharge in each location. However, the dimension shall also be taken account of topographical condition in each location in detailed design.

・Pipe culvert is type of NP4 based on IRC:13. It is based on the standard of IS458: Precast concrete pipes. The size of diameter 1.2m is planned to arrange to fit to satisfy the capacity for discharge.

・At inlet of the culvert, catch pit is required. For the section of excavation at slope side, the chute is required.

・At outlet of the culvert, gabion is required to protect an erosion by the flowing water at hill slope.

・The headwall is required to retain earth at inlet and outlet. It should be considered with retaining wall at back and forth side.

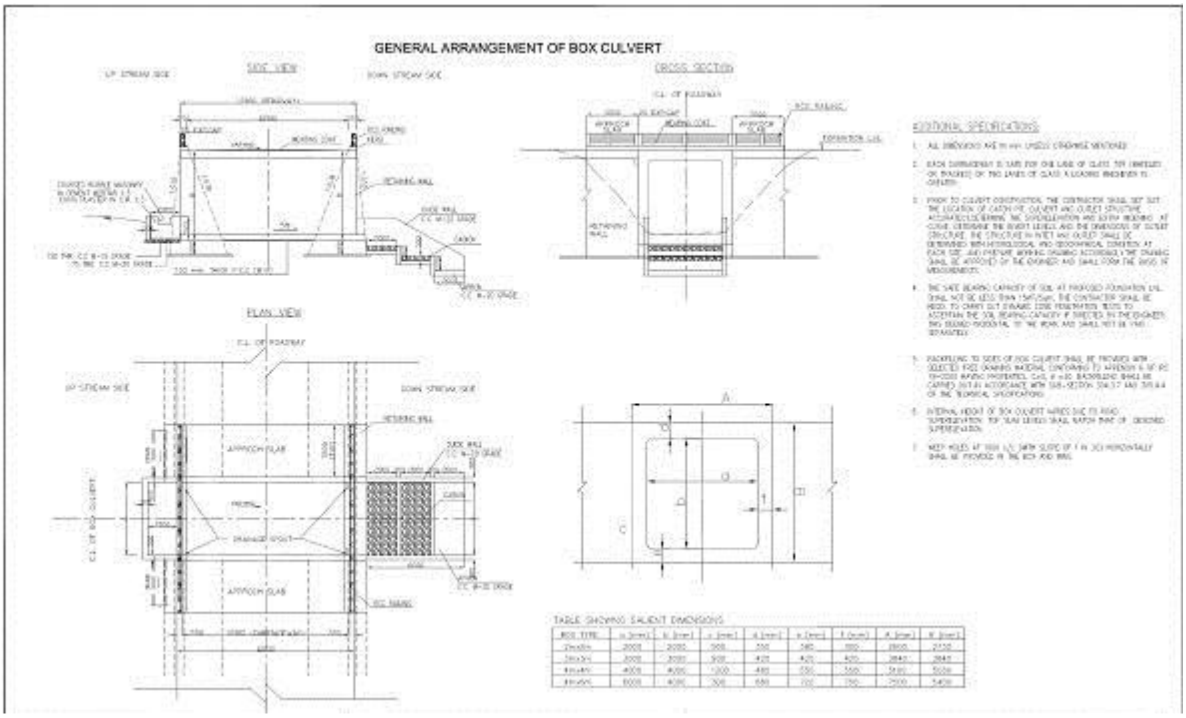
The capacity for each size of culverts is summarized in table below.

Table 7.2.19 Capacity for each size of culverts

	Size	A(m2)	n	i (%)	Capacity (m3)	Applied condition
Pipe culvert	ϕ 1.2m	1.028	0.013	5.0	4.17	Flowing full condition
BOX culvert	2mx2m	4.000	0.033	5.0	15.88	Flowing full condition
	3mx3m	9.000	0.033	5.0	36.19	Flowing full condition
	4mx4m	12.400	0.033	5.0	95.71	Open section with vertical clearance of 0.9m
	4mx6m	18.600	0.033	5.0	166.95	Open section with vertical clearance of 0.9m

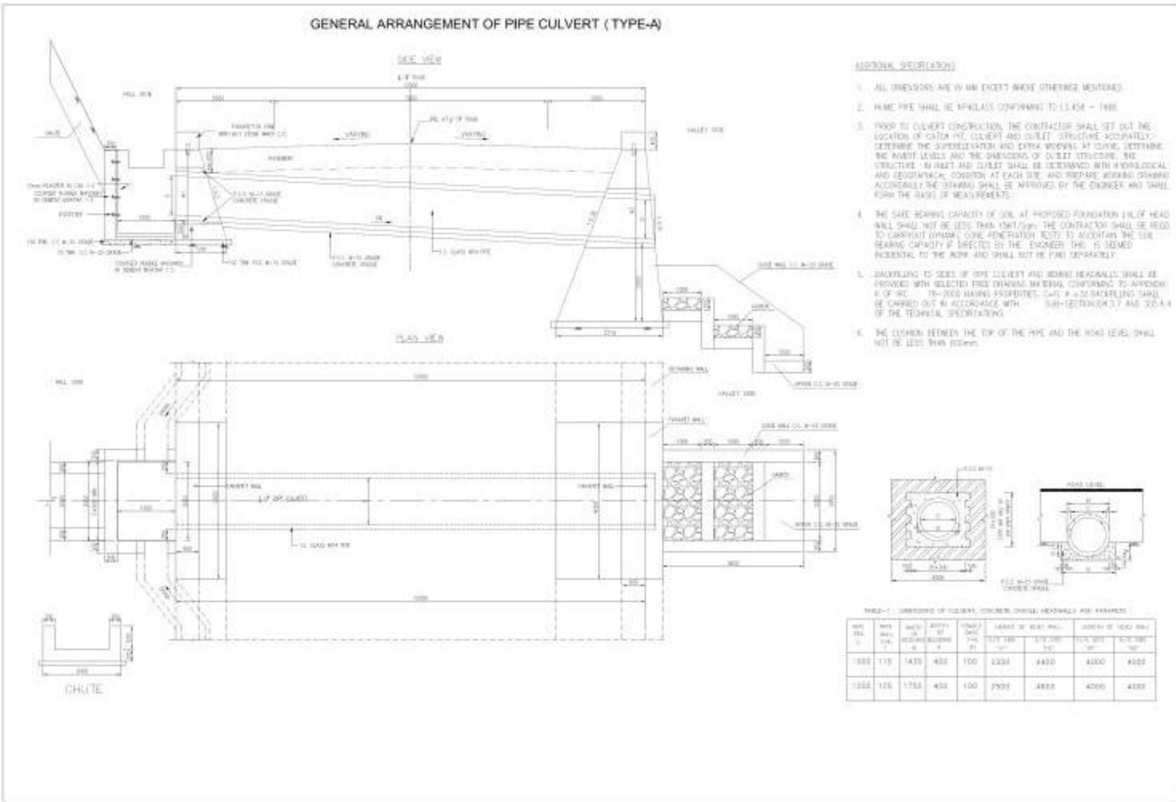
Source: JICA Study Team

General arrangement plan for BOX culvert and Pipe culvert is shown in figure below.



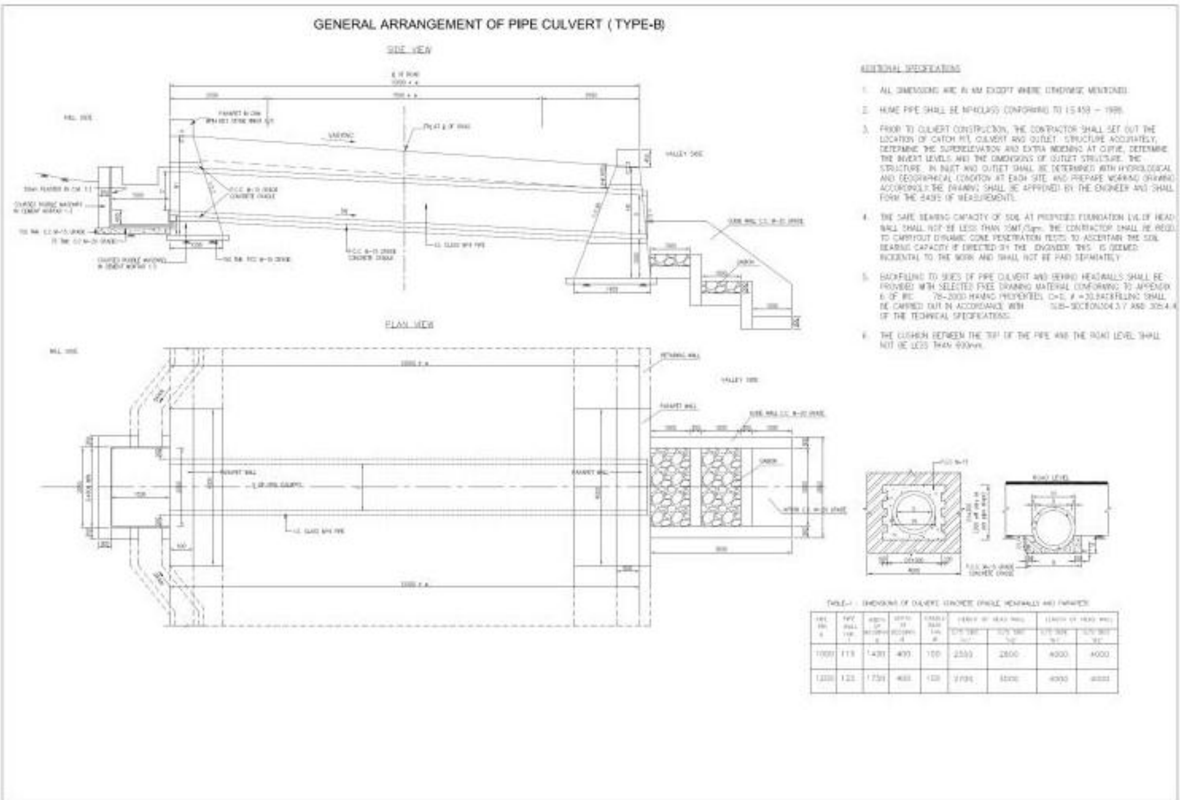
Source: JICA Study Team

Figure 7.2.21 General arrangement plan for BOX culvert



Source: JICA Study Team

Figure 7.2.22 General arrangement plan for pipe culvert (Type-A)

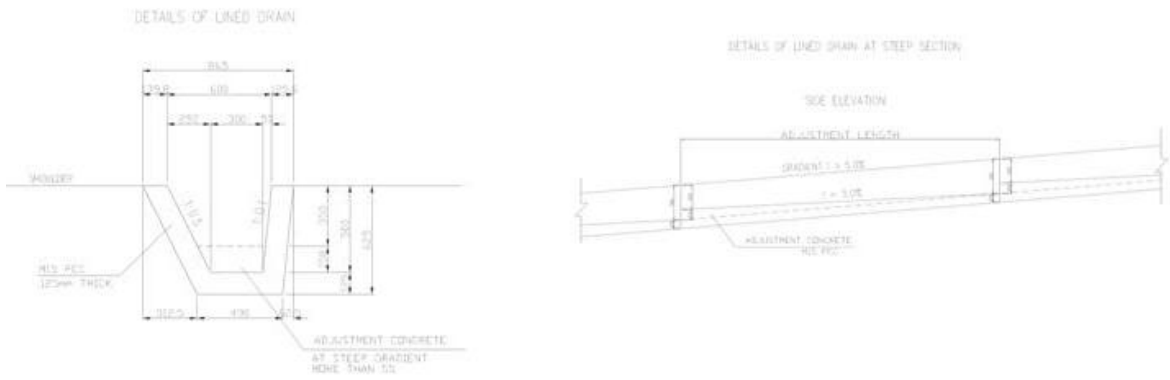


Source: JICA Study Team

Figure 7.2.23 General arrangement plan for pipe culvert (Type-B)

(b) Side ditch structure

The side ditch on road is designed as concrete lined ditch for all section of cut side.
General arrangement plan for side ditch is shown in figure below.



Source: JICA Study Team

Figure 7.2.24 General arrangement plan for side ditch

(c) Drainage arrangement plan

The cross drainage arrangement is planned with following policy.

(i) The cross-drainage which has capable dimension for the estimated discharge is arranged at the location where the crossing water estimated by hydrological map computation.

(ii) The location of existing culvert is high possibility of crossing water flowing. Hence, a pipe culvert 1.2m is planned at all location of existing culvert even the crossing water is not appeared by hydrological map computation.
The existing culvert location is based on topographical surveyed map prepared by DPR.

(iii) Side ditch capacity is not satisfied if an interval between cross-drainages is too long. Hence, a pipe culvert 1.2m is planned to complement the long interval to shorten to 300m in maximum.

The quantity of each culvert for each section is summarized in table below.

Table 7.2.20 Quantity for each culverts

	DPR Section I	DPR Section II	DPR Section III	all NH54
Pipe culvert 1.2m	693	724	675	2092
(TYPE-A)	277	290	270	837
(TYPE-B)	416	434	405	1255
BOX culvert 2x2m	8	22	69	99
BOX culvert 3x3m	2	9	11	22
BOX culvert 4x4m	0	2	7	9
BOX culvert 4x6m	0	3	2	5
Total	703	760	764	2227

Source: JICA Study Team

7.2.8 Traffic Safety Facilities Plan

7.2.8.1 Scope of Traffic Safety Facilities

Traffic safety facilities are to be provided on roads or roadside to secure safety of all road users as well as nearby residents. In this Study, considering road function of rural roads and usage situation of the target roads, facilities listed in Table X are discussed for application to the Project.

Table X Traffic Safety Facilities to be Applied for NH54

No.	Item	Remarks / Related Code
1	Traffic Sign	IRC67-2001, IRC7-1971, IRC-SP-31-1992
2	Road Marking	IRC35-1997, IRC-SP-31-1992, IRC2-1968
3	Road Delineator	IRC79-1981
4	Guard Rail	
5	Street Furniture (Blinker, Road Stud/Cats Eye)	MoRTH's Research Project R-63

Source: JICA Study Team

7.2.8.2 Traffic Safety Facilities proposed in DPR

JICA Study Team received some documents that constitute DPR of the target roads, though they are not necessarily a full set of the documents. Table X summarizes traffic safety facilities that are considered being proposed in DPR.

Table X Traffic Safety Facilities proposed in DPR for NH54

ITEM	NH54-S1	NH54-S2	NH54-S3
Traffic Sign	To be provided in accordance with IRC67. No detailed quantities are available in Report.	To be provided in accordance with IRC67. Detailed quantities are as follows: (i) 90 cm equilateral triangle: 5 (ii) 60 cm equilateral triangle: 9 (iii) 60 cm circular: 12 (iv) 80 mm x 60 mm rectangular: 10 (v) 60 cm x 45 cm rectangular: 20 (vi) 60 cm x 60 cm square: 15	To be provided in accordance with IRC67. Detailed quantities are as follows: (i) 90 cm equilateral triangle: 24 (ii) 60 cm equilateral triangle: 55 (iii) 60 cm circular: 65 (iv) 80 mm x 60 mm rectangular: 50 (v) 60 cm x 45 cm rectangular: 55 (vi) 60 cm x 60 cm square: 60
Road Marking	Edge line marking (yellow continuous, thermoplastic paint) and center line marking (white broken) are to be provided. No detailed quantities are available in Report.	Center line marking (thermoplastic paint) is to be provided. Detailed quantities are as follows: Road Marking: 28,215 sqm (250 sqm/km)	Center line marking (thermoplastic paint) is to be provided. Detailed quantities are as follows: Road Marking: 31,131 sqm (253.92 sqm/km)
Road Delineator	To be provided where necessary. No detailed quantities are available in Report.	To be provided. Detailed quantities are as follows: Road Delineator: 100 (0.89 /km)	No information is available in Report.
Guard Rail	To be provided in built up areas. No detailed quantities are available in Report.	To be provided at bridge approaches and high embankments. Detailed quantities are as follows: Guard Rail: 10,000 metre (88.61 metre/km)	To be provided at bridge approaches. Detailed quantities are as follows: Guard Rail: 6,500 metre (53.02 metre/km)
Street Furniture (Blinker, Road Stud/ Cats Eye)	No information is available in Report.	No information is available in Report.	To be provided. No detailed quantities are available in Report.

Summarized by JICA Study Team

7.2.8.3 Approach for Traffic Safety Facilities Plan

The objectives of preparation of traffic safety facilities plan in this Study are to confirm facilities proposed in DPR and to propose alternative plans where necessary. Furthermore, it will become a part of the basis of the project cost estimate. However, since the documents are available only partially, some information is still missing as shown in Table X.

In this Study, every effort is made to consider facilities in the similar manner as DPR in case where they are clear and reasonable. The quantities are estimated by assuming various conditions. Therefore, it shall be noted that further examination shall be made in the next stage, that is, modification of DPR based on their design basis.

7.2.8.4 Traffic Sign

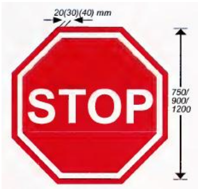
Traffic signs are to be installed to promote road safety and efficiency by providing the orderly movement of all road users in both urban and non-urban areas. Road signs notify road users of regulations and provide warning and guidance needed for safe, uniform and efficient operations.

IRC:67-2012 stipulates three types of traffic signs, namely, 1) Mandatory/Regulatory Signs, 2)

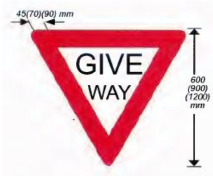
Cautionary/Warning Signs, and 3) Informatory/Guide Signs.

Figure X shows some of typical traffic signs to be installed for the target roads.

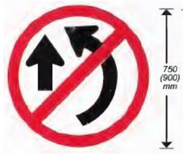
Mandatory/Regulatory Signs



Stop



Give Way



No Overtaking

No Parking

Cautionary/Warning Signs

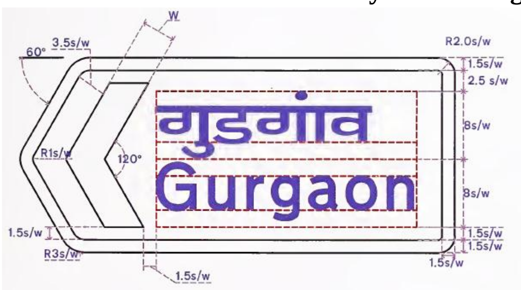
Hair-Pin Bend

Side Road

Narrow Road Ahead

Narrow Bridge Ahead

Informatory/Guide Sings



Flag Type Direction Sign

Toilet

Source: IRC:67-2012 Code of Practice for Road Signs (Third Revision)

Figure X Typical Traffic Signs

The number of traffic signs largely depends on the number and scale of towns/communities the road passes. In this regard, the condition of Section-1 is considered to have a similarity with that of Section-3. Section-1 has Serchhip with population of 21 thousand while Section-3 has Lawngtlai with the almost same population. Thus, it is assumed, in this Study, that the same traffic signs are to be installed in Section-1 as Section-3. In this Study, as a result, traffic signs shown in Table X are considered for the whole target road.

Table X Traffic Signs Estimated for NH54

SOR No.	Item	Unit	Number
8.4	Providing and fixing of retro- reflectorised cautionary, mandatory and informatory sign as per IRC :67 made of encapsulated lens type reflective sheeting vide clause 801.3, fixed over aluminium sheeting, 1.5 mm thick supported on a mild steel angle iron post 75 mm x 75 mm x 6 mm firmly fixed to the ground by means of properly designed foundation with M15 grade cement concrete 45 cm x 45 cm x 60 cm, 60 cm below ground level as per approved drawing		
(i)	90 cm equilateral triangle	Each	53
(ii)	60 cm equilateral triangle	Each	119
(iii)	60 cm circular	Each	142
(iv)	80 mm x 60 mm rectangular	Each	110
(v)	60 cm x 45 cm rectangular	Each	130
(vi)	60 cm x 60 cm square	Each	135

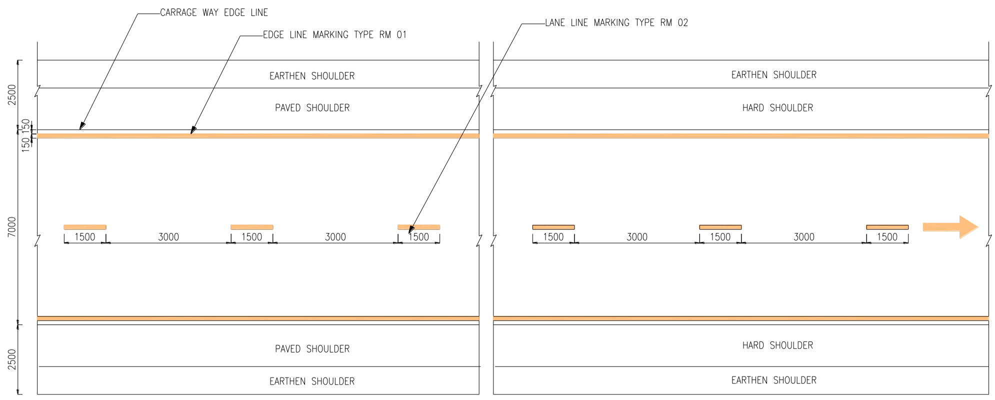
Source: JICA Study Team

7.2.8.5 Road Marking

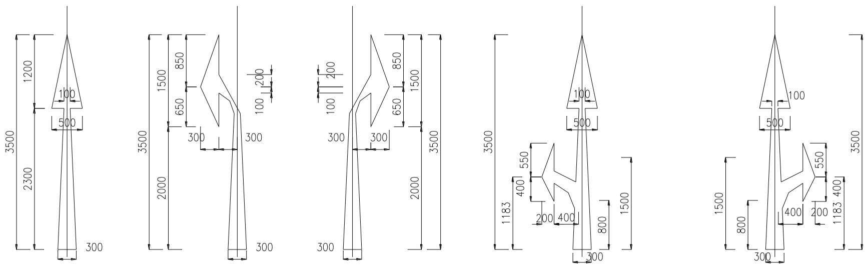
Road markings perform important functions of guiding and controlling traffic on roads. They serve as a psychological barrier and signify the delineation of traffic hazards for safe movement of traffic. Traffic markings also channelize, ensure smooth and orderly flow of traffic. Therefore, suitable road markings shall be provided on roads in accordance with IRC:35-1997.

Figure X shows some of typical road markings to be provided for the target roads.

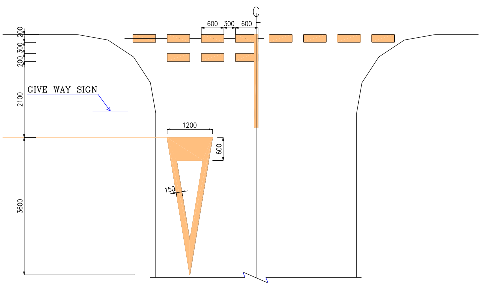
Typical Layout of Road Marking



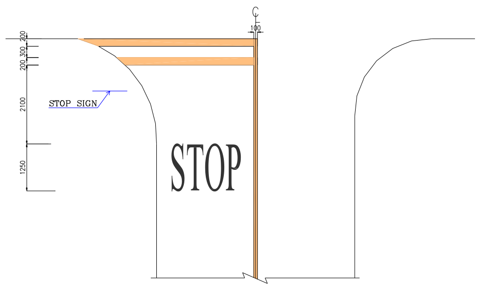
Route Directional Arrows



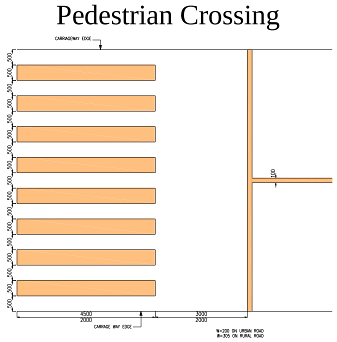
Access Road (Give Way)



Access Road (Stop)



Pedestrian Crossing



Source: Detailed Project Report for National Highway No.54 Section-2

Figure X Typical Road Markings

In this Study, road marking shown in Table X is considered for the whole target road based on unit quantity per kilometer of 250sqm which is adopted in DPR.

Table X Road Markings Estimated for NH54

SOR No.	Item	Unit	Number
8.13	Providing and laying of hot applied thermoplastic compound 2.5 mm thick including reflectorising glass beads @ 250 gms per sqm area, thickness of 2.5 mm is exclusive of surface applied glass beads as per IRC:35 .The finished surface to be level, uniform and free from streaks and holes	sqm	87,298

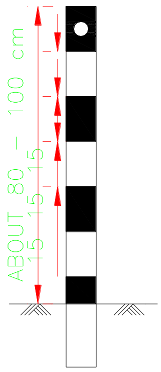
Source: JICA Study Team

7.2.8.6 Road Delineator

Retro-reflective road delineators are to be installed to provide visual assistance for drivers to obtain information on the alignment of the road ahead particularly at night. These are effective at locations involving change in horizontal/vertical geometry and during severe weather condition of heavy rain, fog or snow. IRC:79-1981 stipulates the standards for the post type delineators with retro-reflective units.

Figure X shows typical type of road delineator with circular retro-reflector.

In this Study, road delineators shown in Table X are considered for the whole target road based on unit quantity per kilometer of 0.89 which is derived from DPR.



Source: Detailed Project Report for National Highway No.54 Section-2

Figure X Typical Road Delineator

Table X Road Delineators Estimated for NH54

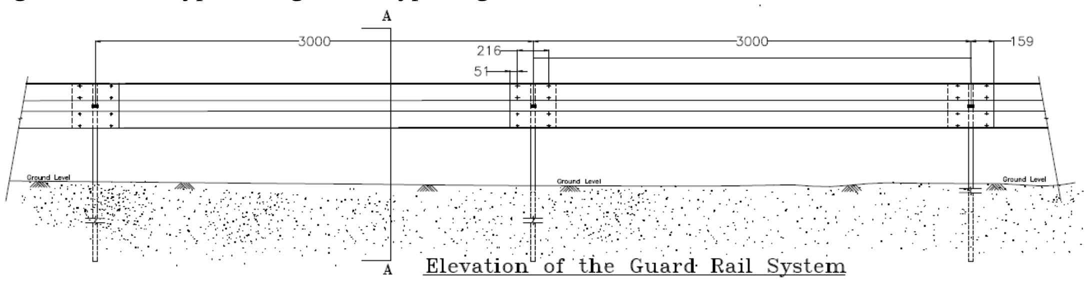
SOR No.	Item	Unit	Number
8.15	Road Delineators (Supplying and installation of delineators (road way indicators, hazard markers, object markers), 80-100 cm high above ground level, painted black and white in 15 cm wide stripes, fitted with 80 x 100 mm rectangular or 75 mm dia circular	each	429

Source: JICA Study Team

7.2.8.7 Guard Rail

DPR adopts single "W" type steel guard rails for selected locations including valley side of curves, high embankment sections, approaches to bridges and built-up areas.

Figure X shows typical single "W" type of guard rail.



Source: Detailed Project Report for National Highway No.54 Section-3

Figure X Typical Guard Rail

In this Study, considering unit quantity per kilometer adopted in DPR, guard rails shown in Table X are considered for the whole target road.

Table X Guard Rails Estimated for NH54

SOR No.	Item	Unit	Number
8.23-A	Type - A, "W" : Metal Beam Crash Barrier (Providing and erecting a "W" metal beam crash barrier comprising of 3 mm thick corrugated sheet metal beam rail, 70 cm above road/ground level, fixed on ISMC series channel vertical post, 150 x 75 x 5 mm spaced 2	metre	27,670

Source: JICA Study Team

7.2.8.8 Street Furniture

Street furniture known as road studs, blinker or cat's eye include equipment installed on road or roadside to assist visibility of road alignment/structures. They are retro-reflective safety devices used in road marking. Generally, it consists of two pairs of reflective glass spheres set into a white rubber dome, mounted in a cast-iron housing. This is the kind that marks the centre of the road, with one pair of devices showing in each direction. A single-ended form has become widely used in other colors at road margins and as lane dividers.

In this Study, considering unit quantity per kilometer adopted in DPR, guard rails shown in Table X are considered for the whole target road.

Table X Street Furniture Estimated for NH54

SOR No.	Item	Unit	Number
8.35	Road Markers/Road Stud with Lense Reflector (Providing and fixing of road stud 100x 100 mm, die cast in aluminium, resistant to corrosive effect of salt and grit, fitted with lense reflectors, installed in concrete or asphaltic surface by drilling hole 30 mm upto a depth of 60 mm and bedded in a suitable bituminous grout or epoxy mortar, all as per BS 873 part 4:1973)	each	38,778

Source: JICA Study Team

7.2.8.9 Locations Requiring Special Consideration

(1) Hair-Pin Bends

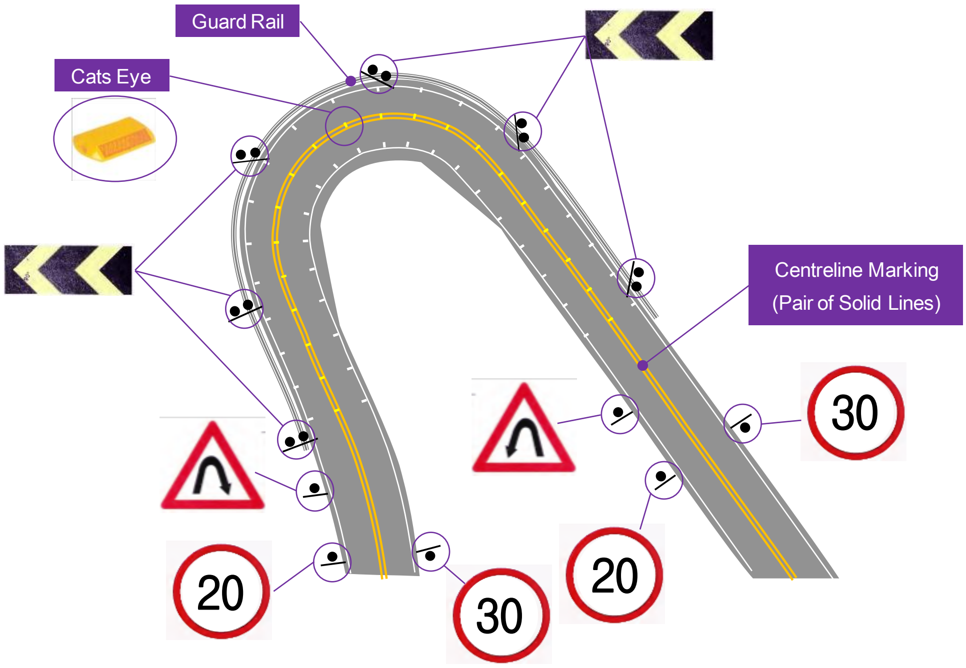
Since the target road is located in mountainous region, hair-pin bends are unavoidable from the viewpoint of cost and environmental impact. Design speed of 20km/h is applied for hair-pin bends, while design speed of 30km/h is adopted in general. Small horizontal curves such as R20m-R25m are used in steep terrain to avoid large-scale earthwork and/or demolition of houses. At those sub-standard sections, securing traffic safety by applying combination of facilities shall be considered.

In hair-pin bends, it is difficult to secure overtaking sight distance and thus, the section shall be designated as no-overtaking section. In order to inform that to drivers, the double centre line with marking of pair of solid lines is applied.

Cats eyes to delineate road alignment are to be installed on the centre line and lane edges so that drivers will be able to identify the direction he should go before entering into the curve.

Furthermore, traffic signs and guard rails shall be properly equipped to avoid hazardous accidents.

Figure X shows an example of combined traffic safety facilities to be installed at hair-pin bends.



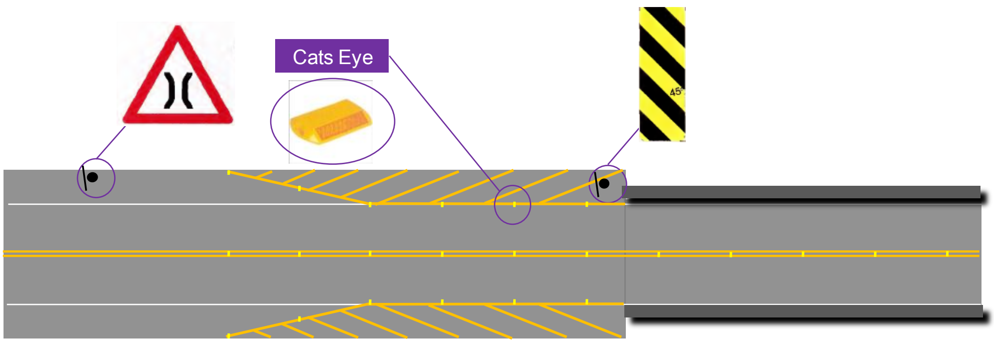
Source: JICA Study Team

Figure X Traffic Safety Facilities to be installed at Hair-Pin Bends

(2) Bridges with Narrow Width

In the locations where the existing bridges are to be utilized with rehabilitation works, carriageway width becomes narrower than that of earthwork sections due to the difference in shoulder width. It is, therefore, proposed to install facilities that notify drivers the decrease in carriageway width and existence of concrete curb.

Figure X shows an example of combined traffic safety facilities to be installed at narrow bridges.



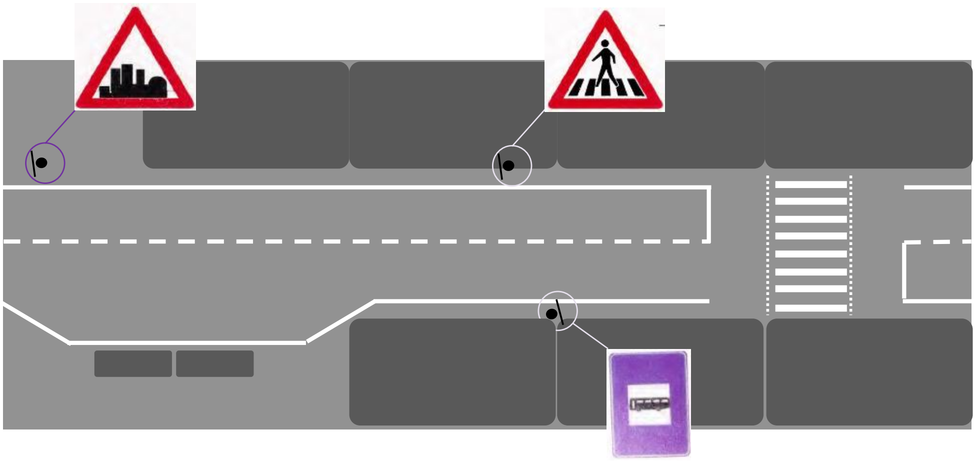
Source: JICA Study Team

Figure X Traffic Safety Facilities to be installed at Narrow Bridges

(3) Built-up Sections

In built-up sections, there are a lot of buildings, shops or houses at roadside as well as pedestrians going along the sidewalk and crossing the road. Furthermore, more kinds of road facilities such as bus stops are necessary than rural sections. Therefore, drivers have to handle much information on roads/traffic and decide their maneuvers in a short time at built-up areas. In order to assist road users in obtaining information, appropriate traffic signs and road markings shall be provided properly.

Figure X shows an example of combined traffic safety facilities to be installed at built-up sections.



Source: JICA Study Team

Figure X Traffic Safety Facilities to be installed at Built-up Sections

7.2.9 Road Appurtenances Plan

7.2.9.1 Scope of Road Appurtenances

Road appurtenances are miscellaneous facilities for road users to take a rest and obtain road-related information as well as for road administrators to maintain their roads efficiently. In this Study, considering road function of rural roads and usage situation of the target roads, facilities listed in Table X are discussed for application to the Project.

Table X Road Appurtenances to be Applied for NH54

No.	Item	Remarks / Related Code
1	Kilometer Stone	IRC8-1980, IRC26-1967
2	Boundary Stone	IRC25
3	Bus Bay	w/Bus Shed, IRC80-1981
4	Road Amenity	Public Toilet, Bazar Shed
5	View Spot	Parking space to be developed at locations with good view

Source: JICA Study Team

7.2.9.2 Road Appurtenances proposed in DPR

Table X summarizes road appurtenances that are considered being proposed in DPR.

Table X Road Appurtenances proposed in DPR for NH54

ITEM	NH54-S1	NH54-S2	NH54-S3
Kilometer Stone	200m, 1km and 5km stones are to be provided in accordance with IRC. No detailed quantities are available in Report.	200m, 1km and 5km stones are to be provided in accordance with IRC. Detailed quantities are as follows: (i) 5th kilometre stone (precast): 22 (ii) Ordinary Kilometer stone (Precast): 91 (iii) Hectometer stone (Precast): 452	200m, 1km and 5km stones are to be provided in accordance with IRC. Detailed quantities are as follows: (i) 5th kilometre stone (precast): 25 (ii) Ordinary Kilometer stone (Precast): 99 (iii) Hectometer stone (Precast): 498
Boundary Stone	To be provided at ROW boundaries. No detailed quantities are available in Report.	To be provided at ROW boundaries. Detailed quantities are as follows: Boundary Stone: 2,260 (20.02 /km)	To be provided at ROW boundaries. Detailed quantities are as follows: Boundary Stone: 1,500 (12.23 /km)
Bus Bay	To be provided at 3 locations: 1) 9+867 Km (Zemabawk), 2) 39+618 Km (Seling), and 3) 95+355 Km (Serchhip).	To be provided at 14 locations.	To be provided. No detailed quantities are available in Report.
Road Amenity	Includes toilets, tea/coffee and snacks bar, drinking water and other articles of emergency. To be provided at 2 locations: 1) Seling, and 2) Serchhip	2 nos of Rest Houses are to be provided	Includes public toilet, public urinal, bus shed and bazar shed. To be provided at 16 locations 1)Tawipui North-2, 2)Tawipui North-1, 3)Tawipui South, 4)Thingfal, 5)Thingka, 6)AOC, 7)Lawngtlai City, 8)Saika, 9)Chawntlangpui, 10)Sihtlangpui, 11)Kawlchaw, 12)Zero Point, 13)Maubawk, 14)Theiva, 15)Theihri, and 16)Tuipang
Truck Lay By	To be provided at 2 locations: 1) 7.00 Km away from Aizawl, and 2) 114+110 Km (Serchhip)	Not to be provided.	No information is available in Report.

Summarized by JICA Study Team

7.2.9.3 Approach for Road Appurtenances Plan

The objectives of preparation of road appurtenances plan in this Study are to confirm facilities proposed in DPR and to propose alternative plans where necessary. Furthermore, it will become a part of the basis of the project cost estimate. However, since the documents are available only partially, some information is still missing as shown in Table X.

In this Study, every effort is made to consider facilities in the similar manner as DPR in case where they are clear and reasonable. The quantities are estimated by assuming various conditions. It is, therefore, noted that further examination shall be made for the modification of DPR based on their design basis.

7.2.9.4 Kilometer Stone

Kilometer stone is one of a series of numbered markers placed along a road or boundary at specific intervals. They are typically located at the side of the road. They are alternatively known as mile stones, mile markers or mileposts. Design of kilometer stones shall be made in accordance with IRC:8-1980.

Table X shows estimated number of kilometer stones for the whole target road.

Table X Kilometer Stones Estimated for NH54

SOR No.	Item	Unit	Number
8.14	Kilo Metre Stone (Reinforced cement concrete M15grade kilometre stone of standard design as per IRC:8-1980, fixing in position including painting and printing etc)		
(i)	5th Kilometre Stone (Precast)	each	69
(ii)	Ordinary Kilometre Stone (Precast)	each	281
(iii)	Hectometer Stone (Precast)	each	1,405

Source: JICA Study Team

7.2.9.5 Boundary Stone

Boundary stones are to be provided to establish the ROW and those shall be incorporated in the as-built drawings for future use. Design of boundary stones shall be made in accordance with IRC:25-1967.

Table X shows estimated number of boundary stones for the whole target road.

Table X Boundary Stones Estimated for NH54

SOR No.	Item	Unit	Number
8.16	Boundary pillar (Reinforced cement concrete M15 grade boundary pillars of standard design as per IRC:25-1967, fixed in position including finishing and lettering but excluding painting)	each	6,035

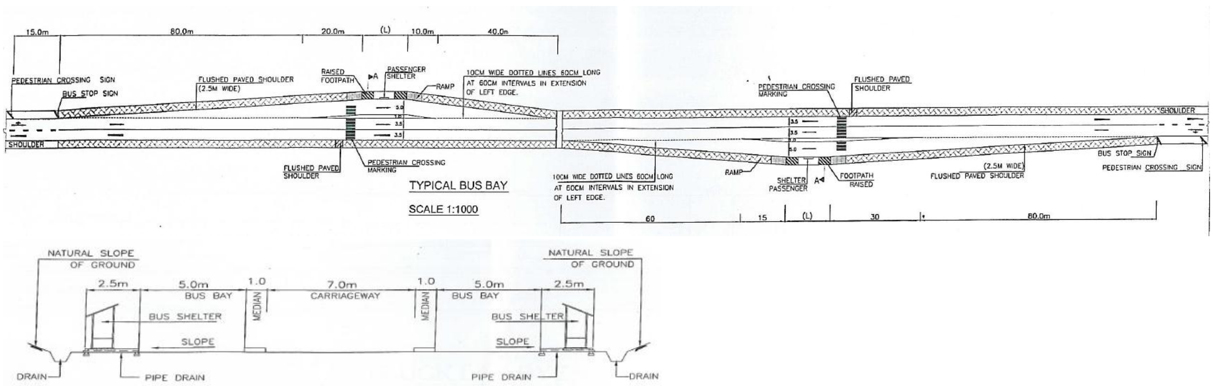
Source: JICA Study Team

7.2.9.6 Bus Bay and Road Amenity

Buses standing indiscriminately on the carriageway to drop or pick-up passengers can seriously affect capacity of the roadway, besides being a source of accidents. It is, therefore, desirable that on all busy non-urban highways, consideration should be given to the construction of bus lay-byes of suitable design at required locations to ensure orderly movement of the through traffic.

Since the target road is part of National Highway with a function of important artery of the region, it is recommended to develop bus bays at appropriate locations.

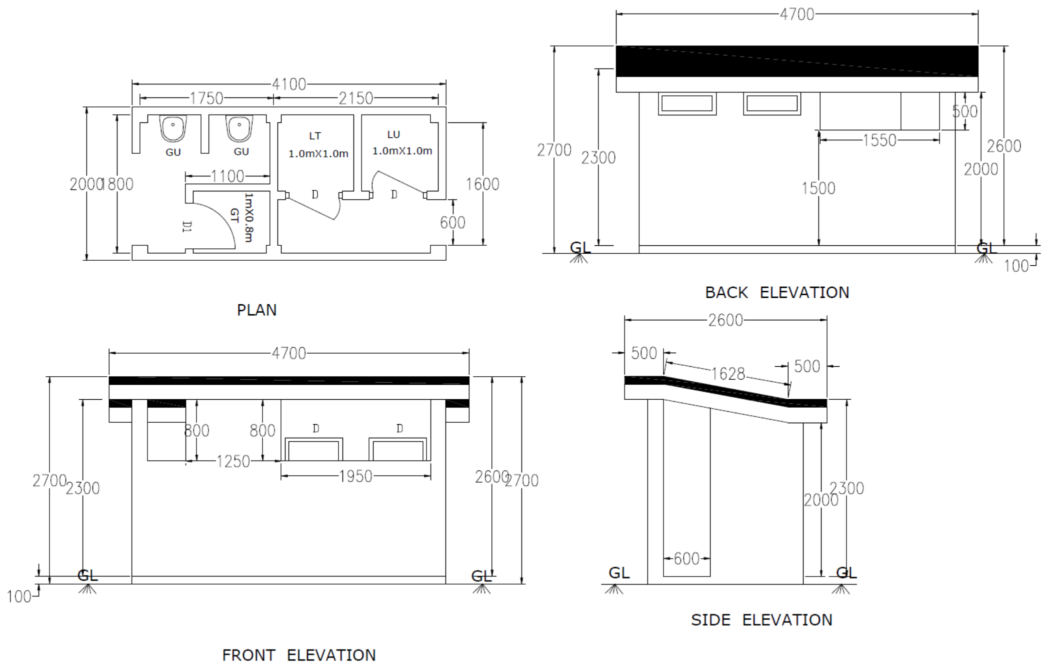
IRC:80-1981 stipulates general requirements for bus bays. DPR has applied the general layout suggested in that standard. This Study also follows the recommendations of IRC and assumes the application of the general plan shown in Figure X.



Source: Detailed Project Report for National Highway No.51

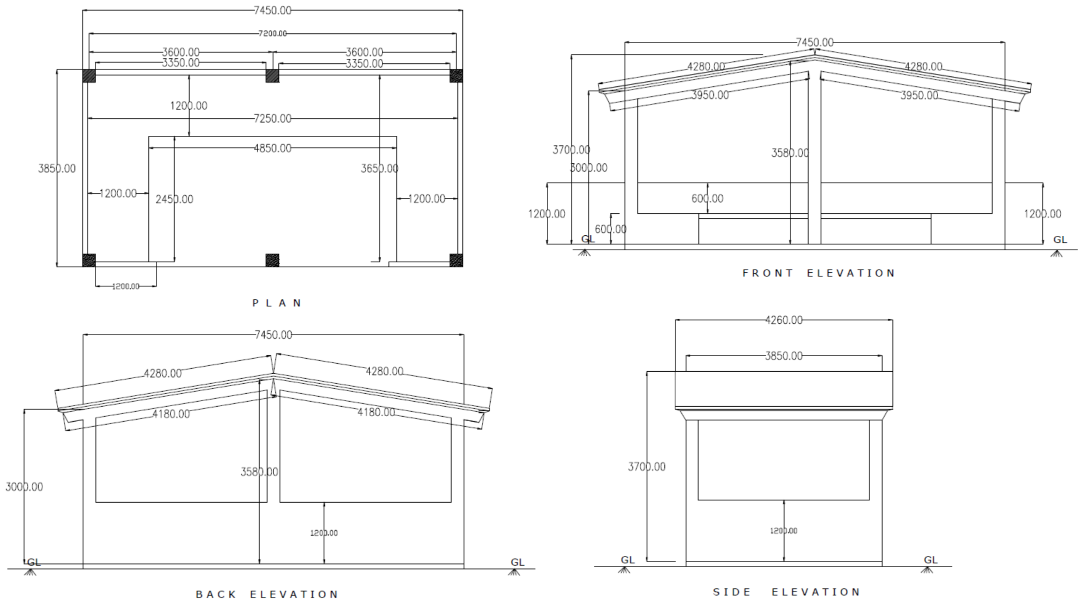
Figure X General Layout for Bus Bays

Road amenities for tourists to use the road comfortably shall be developed at suitable intervals. It is therefore suggested to equip road amenities including public toilets and bazar shed at bus bays. Figures X and X present general view of public toilet and bazar shed proposed in DPR.



Source: Detailed Project Report for National Highway No.54 Section-3

Figure X General View of Public Toilet



Source: Detailed Project Report for National Highway No.54 Section-3

Figure X General View of Bazar Shed

Proposed locations of Bus Bays for NH54 are presented in Table X.

Table X Proposed Bus Bay Locations for NH54

No.	Section	Location	Distance from Aizawl (km)	Section Length (km)	No.	Section	Location	Distance from Aizawl (km)	Section Length (km)
1	1	Aizawl	-		22	2	Dawn	206	16
2	1	Zemabawk	4	4	23	2	Zobawk	219	13
3	1	Tuirial	22	18	24	2	Hrangchalkawn	222	3
4	1	Seling	38	16	25	2	Bualte	231	9
5	1	Thingsulthliah	42	4	26	2	Thualthu	243	12
6	1	Darlawng	53	11	27	3	Tawipui N-II	251	8
7	1	Tlungvel	57	4	28	3	Tawipui N-I	256	5
8	1	Phulmawi	61	4	29	3	Tawipui S	264	8
9	1	Khumtung	63	2	30	3	Thingfal	277	13
10	1	Baktawng	67	4	31	3	Lawngtlai	292	15
11	1	Chhingchhip	77	10	32	3	Saikah	311	19
12	1	Chhiahtlang	97	20	33	3	Paithar	314	3
13	1	Serchhip	107	10	34	3	Chawitlangpui I	316	2
14	2	Keitum	122	15	35	3	Sihtlangpui	319	3
15	2	Bungtlang	130	8	36	3	Kawlchaw	324	5
16	2	Rawpui	135	5	37	3	Zero Point	337	13
17	2	Pangzawl	148	13	38	3	Maubawk	354	17
18	2	Thiltlang	158	10	39	3	Theiva	355	1
19	2	Hnahthial	169	11	40	3	Theiri	363	8
20	2	Leite	182	13	41	3	Tuipang	379	16
21	2	Maudarh	190	8					

Source: JICA Study Team

7.2.9.7 View Point

Along the NH54, there are some places where impressive views of mountains and/or rivers are seen against the background of the wide sky. It is, therefore, recommended to develop parking spaces for such view points along the road for the road users to enjoy natural panoramas and feel refreshed after a long drive. Figure X is example pictures of sceneries taken from NH54.

Source: JICA Study Team

Figure X Example Pictures of Sceneries taken from NH54

Figure X is samples of parking spaces developed along the roads in the mountainous region in Japan.

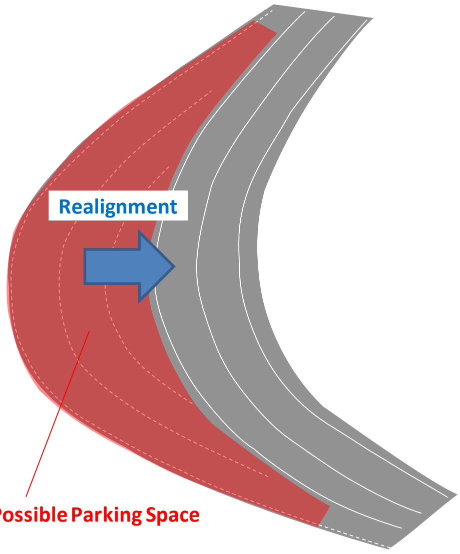
Source: JICA Study Team

Figure X Samples of Parking Spaces along the Roads

Parking spaces for the view point can be developed utilizing flat spaces which are produced by improvement of the horizontal alignment to be made especially in sharp curves as illustrated in Figure X.

The land with the area of around 25sqm would be necessary for a small car to park including the way for movement within the parking space.

JICA Study Team preliminarily estimated that around twenty locations can be utilized as possible parking spaces for view point along NH54. Specific locations and design of the view point shall be further examined in the next stage of the Project.



Source: JICA Study Team

Figure X Possible Land for Parking Space

7.2.10 Preliminary Study of Bypass Route

(1) General

JICA Study Team (herein after referred to as "JST") has preliminarily designed NH-54 longly stretching about 380 km with widening of 12 m width in principle from existing of about 5 m it. Because of its long stretch, the widening might trigger large impact to existing social environment especially in built-up area along the NH-54. Therefore, JST has examined applicability of bypass route for all the 48 built-up settlements identified along the target section of 380 km to mitigate its negative impact.

(2) Procedure for Consideration of Built-up Sections

JST conducted the examination in accordance with following procedure form 1) to 3) to assess the applicability of bypass route for consideration of 48 existing built-up sections.

1) To Assess Social Impact Based On Number of Affected Houses

Number of affected houses built within construction limit of 12m road widening has been counted to assess the social impact for each settlement. Two types of affected houses, "Partially Demolition" and "Totally Demolition" are assumed to distinguish the extent of affected level.

In principle, set-buck option, not resettlement way can be selected if houses are slightly occupying within construction limit, not largely. Therefore, bypass route should be considered more severely where many houses are largely occupying within construction limit. In this concept, JST has examined the scores for respective types in accordance with following rules and assumptions.

- ❖ Partially Demolition
  - When the area of the house encroaching within the construction limit are less than 30% of its total,
  - Settlement where are more than 50 houses categorized in "Partially Demolition" type shall score 5 points,
  - It shall score 1 point in the case where there are 50 or less than 50 houses and more than 25 houses judged as "Partially Demolition" type.
- ❖ Totally Demolition
  - When the area of a house occupying within the construction limit are 30% or more of its total,
  - Settlement where are more than 50 houses categorized in "Totally Demolition" type shall score 10 points,
  - It shall score 5 points in the case where there are 50 or less than 50 houses and more than 25 houses judged as "Totally Demolition" type.

2) To Evaluate Applicability of Bypass Route Based On Population Scale of Settlement

JST has conducted an evaluation of applicability of bypass route in terms of population scale for each settlement. If a settlement is largely urbanized, there might be much generated traffic driving within the settlement and sometime traffic congestion may be occurred due to reduction of road traffic capacity induced by occupation of the generated traffic. In those areas, construction of bypass route can be one of effective solutions to secure the road capacity appropriately for coping with through traffic which have destinations in other areas.

In this concept, JST has examined the scores for population scales in respective settlements in accordance with following rules and assumptions.

- ❖ If a settlement has more than 8,000 population, the settlement shall score 20 points.
- ❖ Similarly, if 8,000 or less than 8,000 and more than 4,000 population, the settlement shall score 10 points.
- ❖ Furthermore, if 4,000 or less than 4,000 and more than 2,000 population, the settlement shall score 5 points.

3) To Examine Geometrical Feasibility of Bypass Route

JST has examined feasibility of bypass route in terms of physical aspect whether the route doesn’t become extremely longer than existing road alignment geometrically or not. In this concept, each settlement has been judged in “Feasible” or “Infeasible”.

(3) Result of Consideration

Below table shows the result of examined scores for all the target settlements in terms of the aspects of number of affected houses, population scale and geometrical feasibility to mitigate the impact of those existing settlements along the designed alignment. The scores have been calculated to clarify the settlements where are recommendable to decide construction of bypass route, not deciding set-back option or any other options.

Table 7.2.XX Result of Bypass Route Consideration

No.	Name[1]	From	To	Section Length (km)	Number of Affected Houses[2]							Population Scale				Total Score	Geometrical Feasibility	Result of Consideration	
					Partial Demolition (PD)	Total Demolition (TD)	Total Affected Houses (TAH)	No. of PD > 50	No. of PD > 25	No. of TD > 50	No. of TD > 25	Population[3]	Population > 8,000	Population > 4,000	Population > 2,000		1: Feasible 0: Infeasible	12m Widening	Bypass with 10m Widening of Existing NH-54
								Score: 5	Score: 1	Score: 10	Score: 5		Score: 20	Score: 10	Score: 5				
1	Aizawl (Zemabawk)	8+000	12+500	4.50	Out of Scope														
2	Bung IB	13+000	14+300	1.30	5	6	11					257			5	5	0	✓	
3	Tuirial	14+600	24+000	9.40	34	35	69		1		5	824			5	10	1	✓	
4	Tuikhurhlu	24+840	31+000	6.16	8	8	16					190			5	5	0	✓	
5	Phaibawk	31+000	34+300	3.30	3	4	7					69			5	5	1	✓	
6	Seling	34+300	38+750	4.45	18	47	65				5	2,289			5	10	0	✓	
7	Thingsul Tlangnuam	39+000	41+150	2.15	30	43	73		1		5	1,587			5	10	1	✓	
8	Thingsulthliah	41+150	46+000	4.85	20	27	47				5	3,402			5	10	1	✓	
9	Darlawng	46+000	53+000	7.00	15	43	58				5	653			5	10	1	✓	
10	Tlungvel	53+000	58+000	5.00	22	41	63				5	2,529			5	10	0	✓	
11	Phulmawi	58+000	60+720	2.72	18	18	36					277			5	5	1	✓	
12	Khumtung	61+000	62+640	1.64	28	33	61		1		5	1,150			5	10	0	✓	
13	Chanin/Baktawng	63+160	67+620	4.46	5	3	8					151			5	5	0	✓	
14	Bukangkawn	68+230	69+840	1.61	2	3	5					151			5	5	1	✓	
15	Chhingchhip	70+420	86+500	16.08	38	38	76		1		5	3,741			5	10	1	✓	
16	Chhiahtlang	86+500	97+260	10.76	17	57	74			10		4,071		10		20	1		✓
17	Serchhip (NT)	97+260	113+650	16.39	78	51	129	5		10		21,158	20			30	1		✓
18	Keitum	113+950	131+100	17.15	11	25	36					2,022			5	5	0	✓	
19	E.Bungtlang	131+420	134+920	3.50	24	71	95			10		1,966			5	15	1	✓	
20	Rawpui	134+920	143+900	8.98	11	40	51				5	835			5	10	1	✓	
21	Pangzawl	143+900	155+230	11.33	28	73	101		1	10		2,428			5	15	0	✓	
22	Thiltlang	155+230	165+650	10.42	8	47	55				5	1,064			5	10	0	✓	
23	Hnahthial (NT)	165+650	176+810	11.16	18	65	83			10		7,187		10		20	1		✓
24	Leite	176+810	189+180	12.37	4	30	34				5	665			5	10	1	✓	
25	Maudarh	189+180	190+990	1.81	1	3	4					62			5	5	1	✓	
26	New Dawn	190+990	207+840	16.85	9	46	55				5	384			5	10	1	✓	
27	Zobawk	208+960	216+320	7.36	4	78	82			10		3,166			5	15	0	✓	
28	Lungpuizawl	216+320	218+200	1.88	0	12	12					774			5	5	1	✓	
29	Hrangchal Kawn (Vawngzawl)	218+200	224+000	5.80	3	19	22					723			5	5	0	✓	
30	Thaizawl	224+000	228+100	4.10	0	30	30				5	378			5	10	1	✓	
31	Bualte	228+100	234+000	5.90	0	23	23					437			5	5	1	✓	
32	Thualthu	234+000	243+200	9.20	0	10	10					604			5	5	1	✓	
33	Tawipui 'N' II	431+000	435+000	4.00	11	23	34					677			5	5	0	✓	
34	Tawipui 'N' I	435+000	441+000	6.00	11	42	53				5	809			5	10	1	✓	
35	Tawipui 'S'	441+000	450+000	9.00	10	33	43				5	1,259			5	10	0	✓	
36	Thingfal	450+000	461+300	11.30	9	24	33					1,365			5	5	0	✓	
37	Thingkah	461+300	469+100	7.80	6	11	17					1,157			5	5	1	✓	
38	Lawngtlai	469+100	488+000	18.90	38	59	97		1	10		20,830	20			30	1		✓
39	Saikah	488+000	495+000	7.00	3	4	7					553			5	5	1	✓	
40	Chawntlangpui	495+000	497+000	2.00	6	11	17					354			5	5	1	✓	
41	Sihtlangpui	497+000	503+000	6.00	11	12	23					630			5	5	1	✓	
42	Kawlchaw 'W'	503+000	503+500	0.50	1	0	1					419			5	5	0	✓	
43	Kawlchaw 'E'	503+700	514+800	11.10	7	9	16					1,071			5	5	0	✓	
44	Zeropoint	514+800	521+000	6.20	7	15	22					759			5	5	0	✓	
45	Maubawk 'L'	521+000	531+500	10.50	8	12	20					599			5	5	1	✓	
46	Theiva	531+500	537+500	6.00	0	14	14					551			5	5	1	✓	
47	Theiri	538+300	544+700	6.40	10	14	24					626			5	5	0	✓	
48	Tuipang	544+700	554+410	9.71	8	34	42				5	1,655			5	10	0	✓	
Total				351.99	608	1346	1954												

*1: Names of settlement have been identified by JST survey collecting through interveiwing local government office and so on. The station of each settlement is assumed by JST.
*2: Number of affected houses has been identified with counting on DPR Topgraphic Drawing prepared by MORTH and PWD of GOI
*3: Population are for the entire village/town beyond the road side.

Based on the examination above, following four settlements have scored more than 20 points and geometrically feasible. Therefore they are recommendable to construct bypass route avoiding densely populated area to mitigate the impact of resettlement as well as to secure sooth traffic coping with through traffic which have destinations to other settlements. Furthermore, in these four sections, JTS recommend to apply an improvement of only 10 m road widening with black top pavement for the time being along the existing NH-54 before completion of the bypass route. This recommendation can make few impacts to avoid resettlement or set-back of existing houses as much as possible.

1) Chhiahtlang
2) Serchhip
3) Hnathial
4) Lawngtlai

(4) Concept of Bypass Route for Four Areas

The concept of bypass route for above recommended four areas are summarized as below respectively.

1) Chhiahtlang Bypass

It is confirmed that there is national park in eastern part of Chhiahtlang. Therefore, JST recommend to follow the bypass route of DPR selected western route from the existing NH-54 to avoid the conservation area of national park. The bypass route is started from STA. 90+100 and ended to STA. 92+300 in section I. However, local residences are observed around the proposed end point area in DPR. Therefore it is recommendable to shift the endpoint to 300m ahead at around STA. 90+600 area to mitigate the impact of local community.

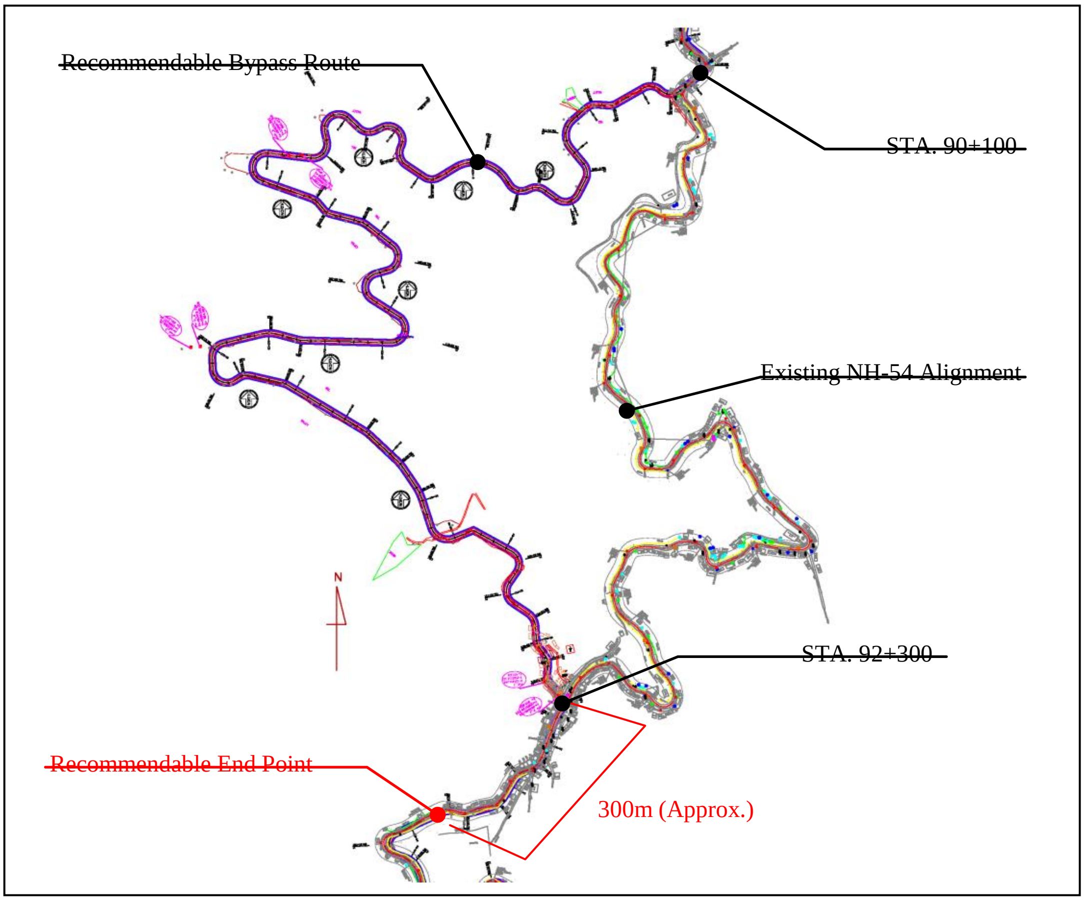


Figure. 7.2.X Recommendable Chhiahtlang Bypass Route

2) Serchhip Bypass

Topographically, it is required to have too long stretch if western route is selected for bypassing Serchhip area. Therefore, the eastern route proposed in DPR is recommendable for Serchhip bypass. The bypass starts from STA. 97+280 and ends to STA. 106+580 in section I. Some residences can be observed in the area nearby the endpoint based on the examination of JST. So it is more applicable to shift the endpoint to 200m ahead for mitigation of local community.

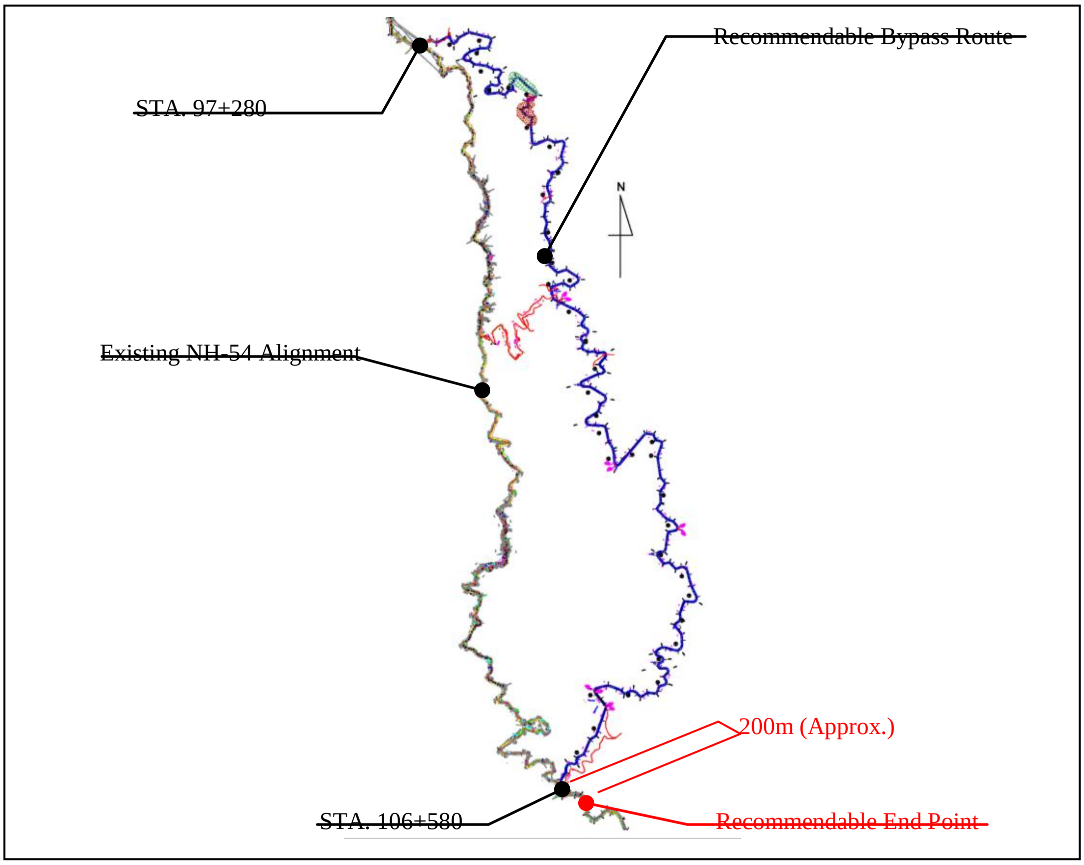


Figure. 7.2.X Recommendable Serchhip Bypass Route

3) Hnathial Bypass

Because it is difficult for the east side of Hnathial area to attract linear alignment due to the steep topography, the western route is reasonable for Hnathial bypass as designed in DPR, but it is recommended to adjust the bypass alignment with consideration of actual topographical condition in western route of DPR. The bypass shall start from STA.167+780 and end to STA. 174+640 in section II.

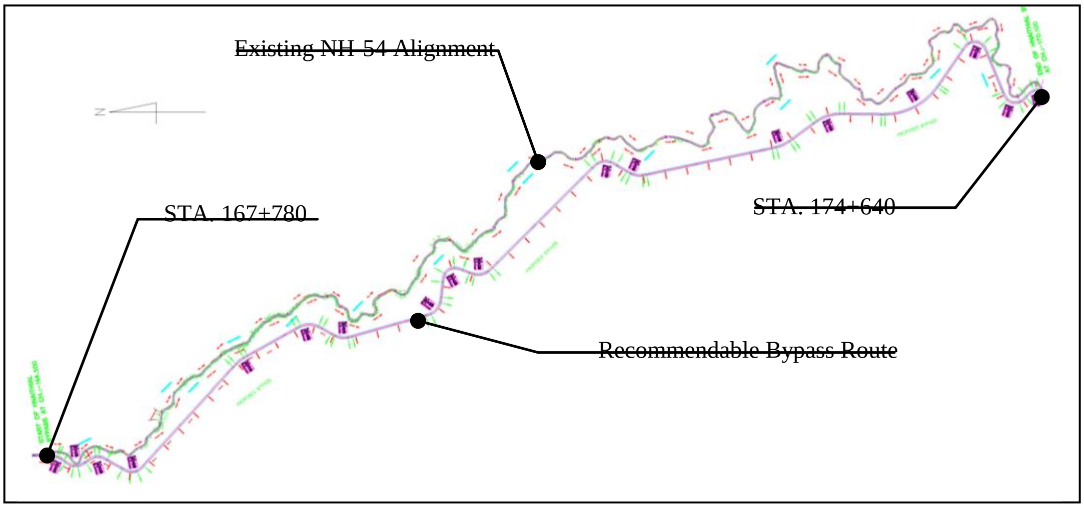


Figure. 7.2.X Recommendable Hnathial Bypass Route

4) Lawngtlai Bypass

In Lawngtlai area, there is another road construction project called as "Kaladan Multi-Modal Transit Transport Project (KMMTTP)" which is under implementation at present and avoiding the route of urbanized area of Lawngtlai. Therefore, it is recommendable to follow the Lawngtlai bypass route consisting of KMMTTP route and the route designed by DPR. The bypass route starts from STA. 471+000 of and ends to STA. 476+000 in section III.

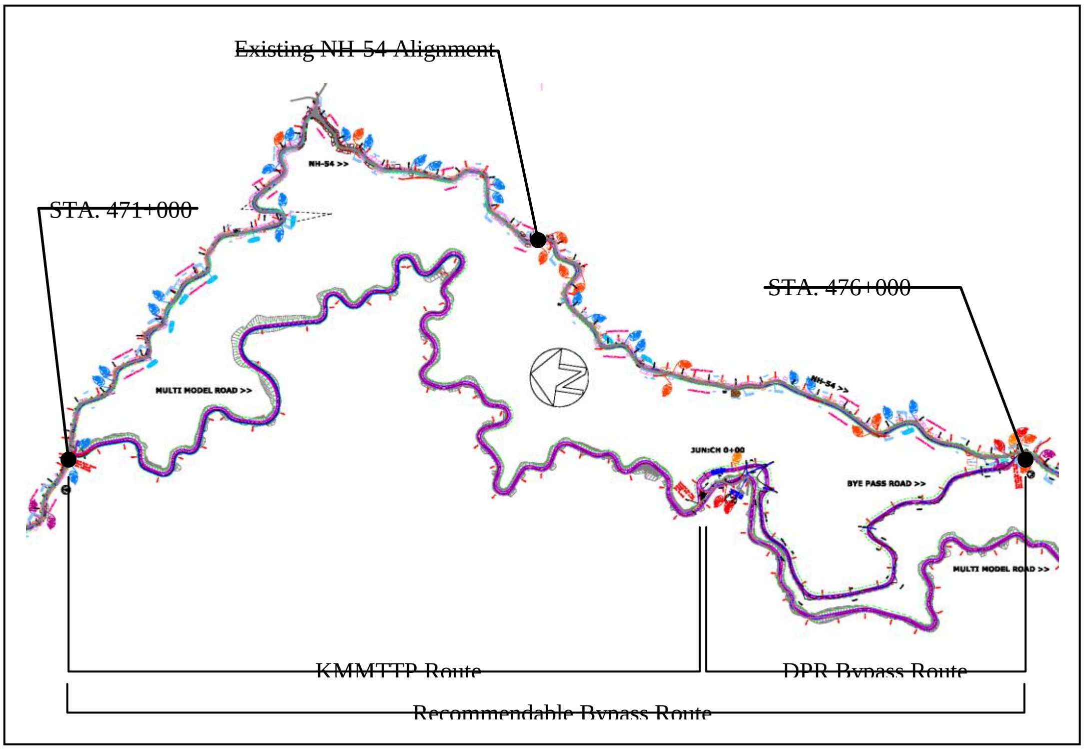


Figure. 7.2.X Recommendable Lawngtlai Bypass Route

7.2.11 Preliminary Study of Spoil Bank

(1) General

Concerning the result of preliminary design of NH-54 of JICA Study Team (Herein after referred to as “JST”), the necessary volume of spoil bank has been calculated as shown below table where Section I, II and III at least require about 2.40, 2.44 and 2.47 million cu.m capacities respectively.

Table 7.2.XX Required Volume for Spoil Bank

Highway No.	Sec.	Item	Unit	Volume of Generated Soil	Coefficient of Compation	Volume of Compacted Soil	Required Volume of Spoil Bank
				Cu.m		Cu.m	Cu.m
NH54	S1	Cut Soil	cu.m	3,442,909	0.9	3,098,618	2,400,495
		Fill Soil	cu.m			698,123	
	S2	Cut Soil	cu.m	3,710,629	0.9	3,339,566	2,437,522
		Fill Soil	cu.m			902,044	
	S3	Cut Soil	cu.m	3,560,596	0.9	3,204,536	2,465,129
		Fill Soil	cu.m			739,407	
	Total						7,303,146

Source: JICA Study Team

(2) Condition of Spoil Bank Selection

JST has examined to identify target locations where seems to have sufficient and required conditions for spoil bank construction. Followings are assumed conditions for suitable locations for that.

- ❖ To find out suitable place at every 5km length along NH-54 with following condition;
  - Ground shape with concavity topography
  - Less ground gradient than 22 degree which is assumed as average angle of spoil bank slope with necessary steps
  - No built-up area
  - No national sanctuary area
- ❖ To be able to construct the spoil bank in less than 30m height

(3) Result of Examination for Spoil Bank Location

In accordance with above assumed conditions, 115 locations in 381 km stretch of NH-54 has been totally identified for spoil bank construction, there are 41, 32 and 42 numbers of spoil bank having about 2.43, 2.90 and 2.51 million cu.m capacities in Section I, II and III respectively. Below table shows the list of that spoil banks with Sta. and capacities.

Table 7.2.XX List of Spoil Banks

Section I

No.	Section	Sta.	Capacity of Spoil Bank
			Cu.m
1	S1 － 1	10+600	75,900
2	S1 － 2	13+200	68,250
3	S1 － 3	15+500	24,553
4	S1 － 4	19+000	167,913
5	S1 － 5	21+700	247,680
6	S1 － 6	25+400	66,640
7	S1 － 7	29+500	50,460
8	S1 － 8	33+600	92,810
9	S1 － 9	36+700	47,266
10	S1 － 10	37+600	203,286
11	S1 － 11	38+400	11,090
12	S1 － 12	39+000	120,000
13	S1 － 13	40+200	38,326
14	S1 － 14	42+100	28,120
15	S1 － 15	44+100	60,060
16	S1 － 16	44+700	26,666
17	S1 － 17	45+600	98,666
18	S1 － 18	46+100	14,186
19	S1 － 19	48+700	53,760
20	S1 － 20	49+400	46,666
21	S1 － 21	50+600	45,013
22	S1 － 22	53+100	8,970
23	S1 － 23	53+600	19,110
24	S1 － 24	59+000	93,620
25	S1 － 25	65+400	73,670
26	S1 － 26	68+900	13,770
27	S1 － 27	73+100	54,370
28	S1 － 28	68+800	84,370
29	S1 － 29	79+600	31,666
30	S1 － 30	81+500	99,750
31	S1 － 31	82+100	43,120
32	S1 － 32	83+300	19,370
33	S1 － 33	83+800	62,500
34	S1 － 34	88+500	18,120
35	S1 － 35	88+900	31,250
36	S1 － 36	90+700	50,000
37	S1 － 37	93+400	23,750
38	S1 － 38	94+300	46,666
39	S1 － 39	97+800	37,500
40	S1 － 40	105+800	17,273
41	S1 － 41	111+000	13,960
Total in Section I			2,430,116

Section II

No.	Section	Sta.	Capacity of Spoil Bank
			Cu.m
42	S2 － 1	127+100	13,120
43	S2 － 2	130+200	230,170
44	S2 － 3	136+600	67,410
45	S2 － 4	137+300	151,870
46	S2 － 5	138+500	196,350
47	S2 － 6	144+800	185,760
48	S2 － 7	145+800	107,660
49	S2 － 8	147+500	25,760
50	S2 － 9	148+400	98,130
51	S2 － 10	150+700	15,680
52	S2 － 11	157+800	57,910
53	S2 － 12	159+800	93,960
54	S2 － 13	167+200	35,133
55	S2 － 14	168+800	114,240
56	S2 － 15	173+700	27,400
57	S2 － 16	176+200	143,060
58	S2 － 17	180+000	56,350
59	S2 － 18	187+000	50,000
60	S2 － 19	190+200	163,800
61	S2 － 20	196+100	130,680
62	S2 － 21	198+400	109,150
63	S2 － 22	207+600	92,500
64	S2 － 23	209+600	123,750
65	S2 － 24	215+000	128,386
66	S2 － 25	216+400	119,000
67	S2 － 26	224+100	18,750
68	S2 － 27	226+000	92,686
69	S2 － 28	229+400	25,000
70	S2 － 29	232+600	53,130
71	S2 － 30	235+300	99,200
72	S2 － 31	238+300	46,410
73	S2 － 32	241+900	25,620
Total in Section II			2,898,025

Section III

No.	Section	Sta.	Capacity of Spoil Bank
			Cu.m
74	S3 － 1	432+400	14,433
75	S3 － 2	433+600	186,373
76	S3 － 3	434+900	100,230
77	S3 － 4	436+000	62,340
78	S3 － 5	437+500	212,850
79	S3 － 6	439+000	52,500
80	S3 － 7	441+100	43,746
81	S3 － 8	441+900	77,960
82	S3 － 9	444+900	15,620
83	S3 － 10	446+400	62,340
84	S3 － 11	452+500	43,500
85	S3 － 12	453+900	36,800
86	S3 － 13	456+700	69,230
87	S3 － 14	457+300	56,250
88	S3 － 15	459+100	56,250
89	S3 － 16	465+200	186,000
90	S3 － 17	470+900	153,120
91	S3 － 18	473+000	56,250
92	S3 － 19	474+600	15,300
93	S3 － 20	482+100	50,000
94	S3 － 21	484+400	59,500
95	S3 － 22	491+500	21,780
96	S3 － 23	492+900	22,000
97	S3 － 24	493+700	31,250
98	S3 － 25	495+900	26,400
99	S3 － 26	497+400	73,780
100	S3 － 27	499+900	49,140
101	S3 － 28	505+400	4,533
102	S3 － 29	514+800	2,520
103	S3 － 30	520+200	13,770
104	S3 － 31	521+600	91,233
105	S3 － 32	523+400	14,166
106	S3 － 33	525+900	23,760
107	S3 － 34	529+100	38,720
108	S3 － 35	543+900	60,000
109	S3 － 36	554+600	46,030
110	S3 － 37	547+600	153,450
111	S3 － 38	550+300	10,970
112	S3 － 39	550+700	40,090
113	S3 － 40	551+500	60,000
114	S3 － 41	552+500	22,130
115	S3 － 42	553+100	93,280
Total in Section III			2,509,594

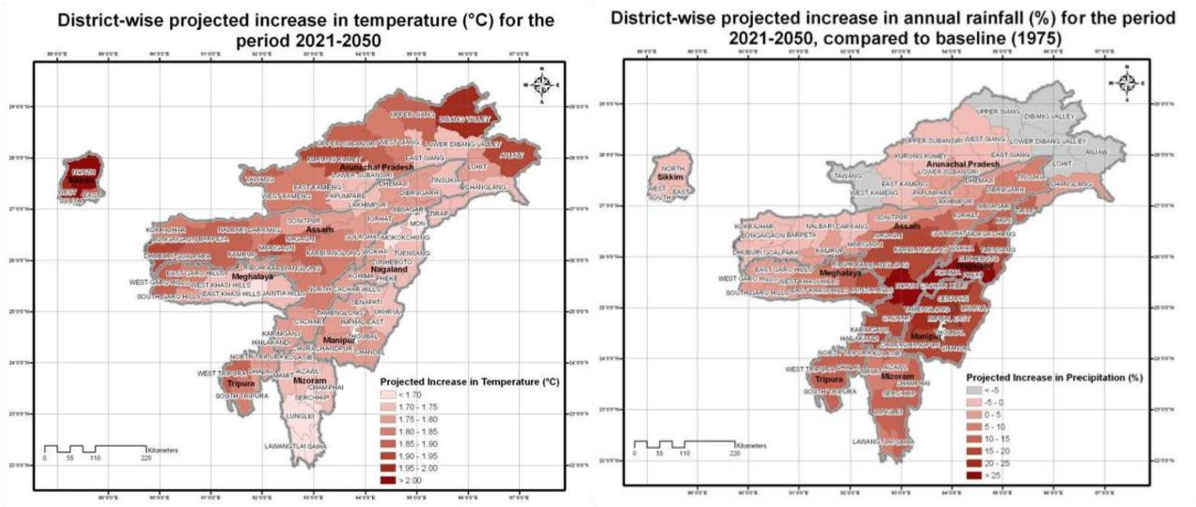
7.3 Consideration of Climate Change Adaption

1) Climate Change Situation in India

Increase of frequency and intensity of rainfall with climate change often causes overflow from road drainage system, shut down by landslide disaster, traffic accident, and frequent traffic controls, which result in economic loss and delay of rehabilitation work for disaster. And due to rising of river level and variation of wind load with increase of frequency and intensity of cyclone, it will be necessary to improve and reinforce the road facilities.

In the North-east state in India, North East Climate Change Adaptation Programme has been carried out by KfW Development Bank and adaptation against the climate change is examined together with Ministry of Development of North-East Region. The Project Document in the programme mentioned the prediction of impact of the climate change in the North-east states as shown below.

- The annual mean maximum temperatures in the North-east states are rising at the rate of 0.11 °C per decade.
- The annual mean temperatures in the states are also increasing at a rate of 0.04 °C per decade.
- The projected temperature increase is high in the central and western parts including NH51 of the states (see Figure 7.3.1 left). And those regions are expected to become warm of about 2 °C by 2030s.
- According to the rainfall data for a period of 1901-2007, the annual mean precipitation has increased by 51 cm in 100years.
- The projected increase in annual rainfall is high in the central and east part of the states (see Figure 7.3.1 right). Especially, rainfall increase in rainy season (June-September) is expected to be significant in the eastern part including Mizoram state.
- Extreme rainfall events of 100-150mm per day and greater than 150 mm are predicted to increase with around 20% and 38% respectively.



Source: North East Climate Change Adaptation Programme

Figure 7.3.1 Projected Increase in Temperature (°C) (left) and Annual Rainfall (%) (right) for the period of 2021-2050

2) Vulnerability to Climate Change

Largest impact of climate change is increase of rainfall intensity in the proceeded road, both NH54 and NH51. As presented in Figure 7.3.1, increase of annual rainfall is predicted 5-15% in NH54 and 5-10% in NH51 for the period of 2021 to 2050. Increase of intensity and frequency of rainfall and groundwater rise and erosion by rainfall cause slope failure and mass movement. Then they damage the road directly and have possibility to decrease road drainage capacity and cause flood damage and destabilization of road structure. The possible impact on the road is shown in Table 7.3.1 below.

Table 7.3.1 Impact on the Road by Climate Change

Factor	Vulnerability
Rainfall Higher rainfall causing flash floods, higher groundwater and moisture content in soil	· Overflow and wash out by flood discharge · Inundation on the road · Decrease of drain capacity by Increase of silt discharge · Occurrence of landslide disaster · Instability of road structure and road embankment failure
Temperature Rising maximum temperature	· Damage on road pavement
Wind (Cyclone) Higher wind speed and load	· Deterioration of bridge safety · Fallen tree and facilities such as electrical pole around road

Source: JICA Study Team

3) Adaption Measure

The design policy of each item mentioned in clause 7.2 takes into consideration adaptation measures to the climate change. They are examined in order to enhance the safety of the road and the road facilities and to limit the extent of damage. Especially, decrease in drainage function was observed in both NH54 and NH51 because of fallen debris from the slope, that has caused heavy damage on the pavement. Therefore, the retaining wall and slope protection work are planned all along the road in this study.

Table 7.3.2 shows adaptation measures for climate change taken into consideration in this road design.

Table 7.3.2 Adaption Measures for Climate Change in NH54

Factor	Design Policy considering Adaptation
Side Slope	· Retaining wall is built all along the road. · Slope protection work is constructed on some weathered and loosen slopes. · Cut slope is covered with vegetation works to prevent erosion and collapse. · Designed Safety factor in landslide stability analysis is set in consideration of high groundwater level. · Countermeasure including restraint works is planned for unstable landslide.
Embankment	· Drain filter is sandwiched in embankment.
Bridge & Drainage System	· Rainfall intensity is carefully determined based on the authorized data : ATLAS of Statewise Generalised ISOPLUVIAL MAPs of Eastern India published by Indian Meteorological Department. The isopluvial value from higher edge of counter range is applied. · The capacity of all structures is determined to be capable for the discharge of 50 years return period.
Pavement	· Super elevation is installed properly. · Pavement material is examined not to rise over 60 °C on the surface.
Road Sign	· Wind load and visibility is taken into consideration.

Source: JICA Study Team

CHAPTER 8 PRELIMINARY DESIGN OF NH51

8.1.1 Meteorological and Hydrological Surveys

(1) General

National Highway shall facilitate drainage system enough and properly to drain out rainy water fallen at road surface and flown from mountain upstream. Specially, hill road is suffered from large volume of crossing water flown from mountain slope. It is essential to protect the improved highway from such rainy water by appropriate arrangement of drainage facilities.

The hydrological study based on meteorological and topographical condition at project area is conducted.

(2) Meteorological condition

The cold weather commences from December and comes to an end in the month of February. The hot weather commences from month of May & soon after this the rainy season commences and continues till the end of September. The climate in the cold weather is pleasant. The days are bright and warm and the sun is not too hot. As soon as the sun sets the temperature falls and heat of day yields place to a sharp bracing cold. The maximum temperature recorded is 340 C at Tura.

In addition, the rainfall intensity has being increased in the North-east state of India due to climate changes in recent as explained in Chapter8.3

(3) Topographical condition

Meghalaya has mountainous/rolling terrain. Tura is a valley located at the foothills of the Tura Hills and right below the Tura Peak. Elevation of Tura is 350m in approximate. It is the district capital of the West Garo Hills district. It is filled with small rivulets and green valleys all around. Dalu is the end of National Highway 51 and National Highway 62, elevated at 20m, which is 33 km North-east of Tura in Meghalaya.

In the project area of NH51 between Tura to Dalu, the project route passes several rivers and its tributaries, including following Rivers.

- Ganol River
- Rongkhon River
- Rongnabak River
- Mason River
- Jintal River
- Debok River

(4) Hydrological study

a) Methodology

The hydrological study is conducted with referred on IRC:SP:13 “Guidelines for the design of small bridges and culverts” and IRC:SP42 “Guidelines of road drainage”, which is well used technical standard for hydrological study in Indian highway design.

The analysis is conducted based on Rational Formulae for peak-off from catchment. The size of the flood are determined by factors such as rainfall intensity, distribution in time and space, duration, catchment area, shape, slope and permeability of the soil and vegetable cover.

Ratinal Formulae

$Q = 0.028 \times C \times I \times A$

C : Runoff coefficient

I : Critical intensity of rainfall (cm/hr), $I = F/T \times ((T+1)/(tc+1))$

F : Rainfall intensity (mm/hr)

T : Duration of storm (hrs)

tc : Time of concentration (hrs)

A : Catchment area (hectares)

b) Return period

The return period is described on IRC:SP42 as follows.

-For side drain for N.H. : 25 years (at valley points)

-For cross-drainage for N.H. : 25 years (up to 2m span) / : 50 years (2 to 6m span)

It is also suggested on IRC:SP42 that to assure the discharge not only for design flood but also for check flood in order to protect an area from prolonged inundation when a flood rarer that the design flood hits the area. A check flood is a flood having next higher commonly followed recurrence interval.

The project highway locates at highly hill, the water flood may causes high risk of fatal accidental. Also increase of rainfall intensity in recent years, an application of 50 years for all drainage is not overestimate.

Therefore, the structural dimension of all drainage is determined to be capable for the discharge of 50 years return period.

c) Rainfall Intensity

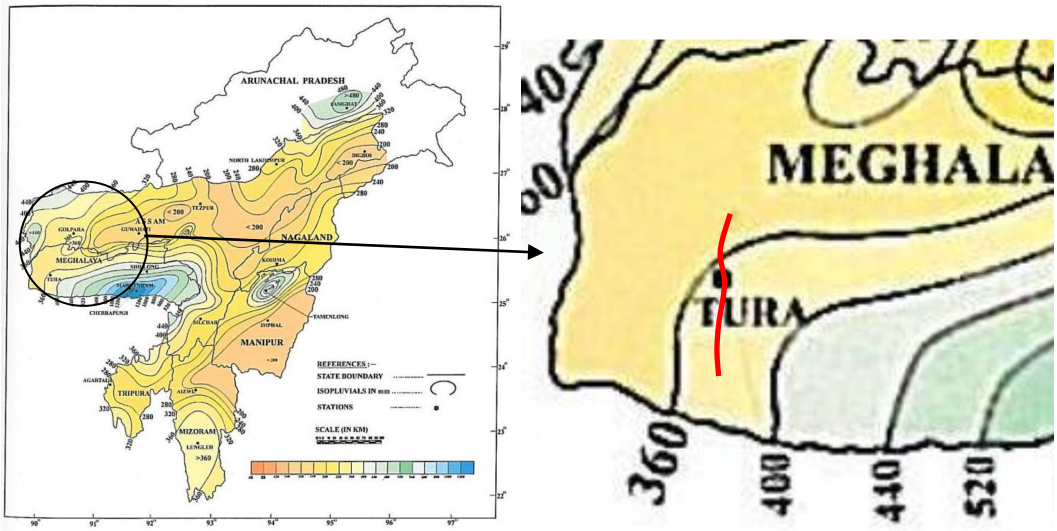
The rainfall intensity is based on the ATLAS of Statewise Generalised ISOPLUVIAL MAPs of Eastern India (Part-II), published by India Meteorological Department, Government of India. Location of project site is identified on the isopluvial map. The isopluvial map with the project location is shown in Figure below. It is sectioned by range of rainfall intensity which value is read from higher edge of counter value.

Rainfall intensity for each sections in NH51 us shown in Table below.

Table 7.3.1 Rainfall intensity for each section in NH51

City From	City To	50Years- 24hours Rainfall intensity
B.P. of project section (near90k)	E.P. of project section (near148k)	400mm/hr

Source: JICA Study Team



Source: ATLAS of Statewise Generalised ISOPLUVIAL (Return Period) Maps of Eastern India (Part – II)

Figure 7.3.1 Isopluvial map with project location for NH51 (For 50years)

d) Runoff coefficient

The guidance of runoff-coefficient is described on IRC:SP:13.

The topographical condition at project area on NH51 is mostly rocky mountainous to steep terrain.

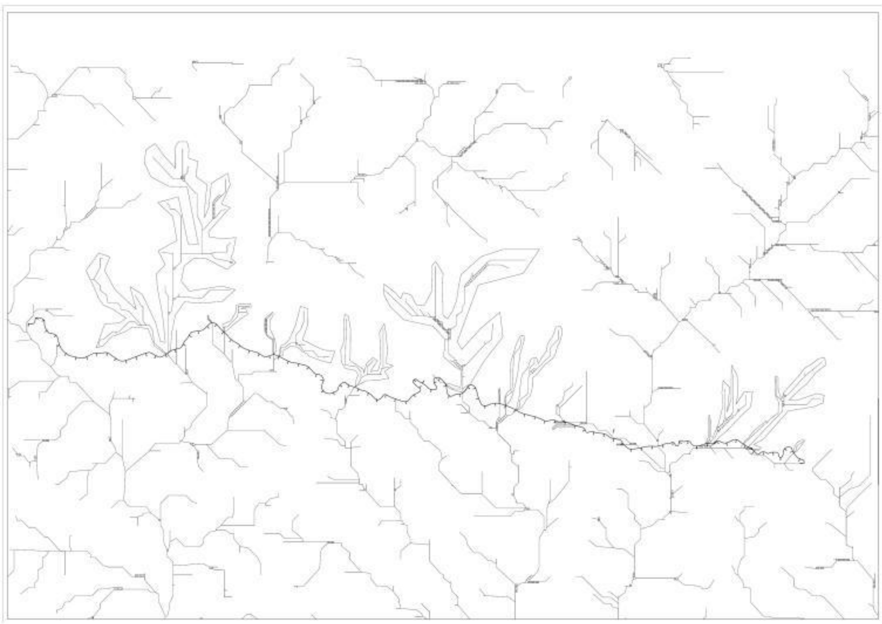
Hence, Runoff coefficient C: 0.8 is applied. (Rock, steep but wooded)

e) Catchment parameters

Catchment parameters such as catchment area, length of tributary and difference of elevation along the project highway is obtained by computation with satellite data and GIS software.

- Satellite data : CatoSat I
- Software : Arc GIS 10.1 & Erdas

An example of catchment area map obtained by computation for NH51 is shown in Figure below.



Source: JICA Study Team

Figure 7.3.2 An example of hydrological area map obtained by computation for NH51

(4) Discharge result

By hydrological study, discharge results for water crossing point with catchment area are obtained.

The discharge summary for large discharge (Q>4m3/s) is summarized in table below.

For all discharge result including small catchment area is estimated.

It is noted that cross-drainage is planned not only for the location where crossing water is appeared on the hydrological computation but also the location of existing cross-drainage. Also at some location to complement between long intervals. It is explained in chapter of Drainage Design.

Table 7.3.2 Discharge summary for large discharge (NH51)

Cheinage (Project Alignment)	Catchment Area (m2)	Length of Tributry (m)	Difference of elevation (m)	Discharge Q50 (m3/s)	Remark
86+570	898,275	1,832	68	76.34	Existing culvert location
87+885	80,401	474	16	8.38	Existing culvert location
88+850	102,637	17	8	10.23	
90+395	569,853	101	10	54.31	Existing culvert location
91+020	38,628	561	257	4.37	
91+120	79,986	782	216	9.08	
93+080	76,662	782	216	8.77	Existing culvert location
93+490	145,099	923	336	15.08	Existing culvert location
138+150	970,671	1,718	50	91.32	Existing culvert location
139+225	52,495	427	14	6.55	
139+910	402,207	1,204	41	38.84	Existing culvert location
141+560	700,998	1,239	40	66.42	

Source: JICA Study Team

8.1.2 Topographic Survey

(1) General (Objectives, Methodology)

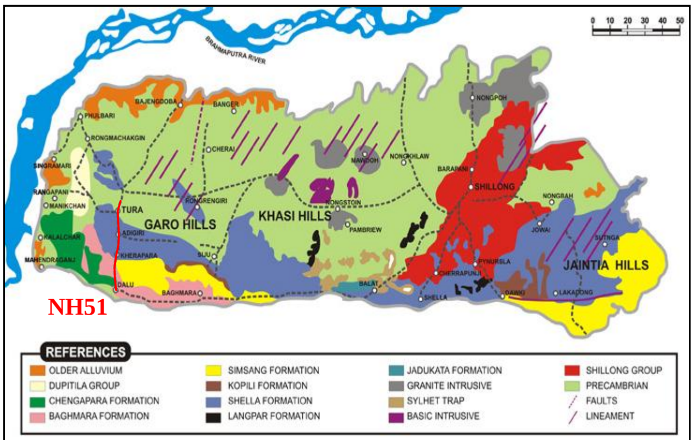
(2) Location of Survey Works

8.1.3 Geological Survey

1) General

Similarly to NH54, JICA study team conducted slope inventory survey and road alignment soil survey for design of slope protection work and pavement respectively in NH51.

Meghalaya state where NH51 runs is located within the Shillong Massif Plateau lying in the south of the Brahmaputra valley geomorphologically. Meghalaya is one of the wettest place in India with average annual rainfall as high as around 12,000 mm. The western part of the plateau, where the Garo Hills with lower elevations are located, has high temperature for most of a year.



Source: Department of Mining and Geology, Meghalaya

Figure 7.3.3 Geological Map of Meghalaya

Figure 7.3.3 presents the geological map of the Meghalaya state. Although the Shillong Massif plateau is geologically composed various formations from Precambrian complex to the recent alluvium, tertiary to quaternary deposits distribute in the west part of the plateau where NH51 runs. The tertiary formation is composed of Shella and Baghmara formations which are mainly consisted of clayey and sandy shale and sandstone sandwiching limestone and conglomerate. Southern part of NH51, near the boarder of Bangladesh, fluvial alluvium overlies on the tertiary rocks. That unconsolidated soil is vulnerable for erosion and collapse, that causes slope failure and road subsidence.

The result of the slope inventory survey is mentioned in clause 8.1.5 below.

(2) Road Alignment Soil Survey

8.1.4 Road Inventory Survey

8.1.4.1 Outline of Road Inventory Survey

JICA Study Team conducted a road inventory survey (herein after referred to as “the inventory survey”) from February, 2015 to April, 2015 along national highway of NH-54 in Mizoram state and NH-51 in Megaraya state. The inventory survey aimed to identify the existing road characteristics, problems and issues on the structural and traffic aspects as well as the geological and social conditions of the surrounding area along the target road.

8.1.4.2 Survey Method

(1) Target Road

The JICA Study team conducted the inventory survey along to the following two national highways in Mizoram and Meghalaya state.

- NH-54 : 381 km (Mizoram State)
- NH-51 : 54 km (Meghalaya State)

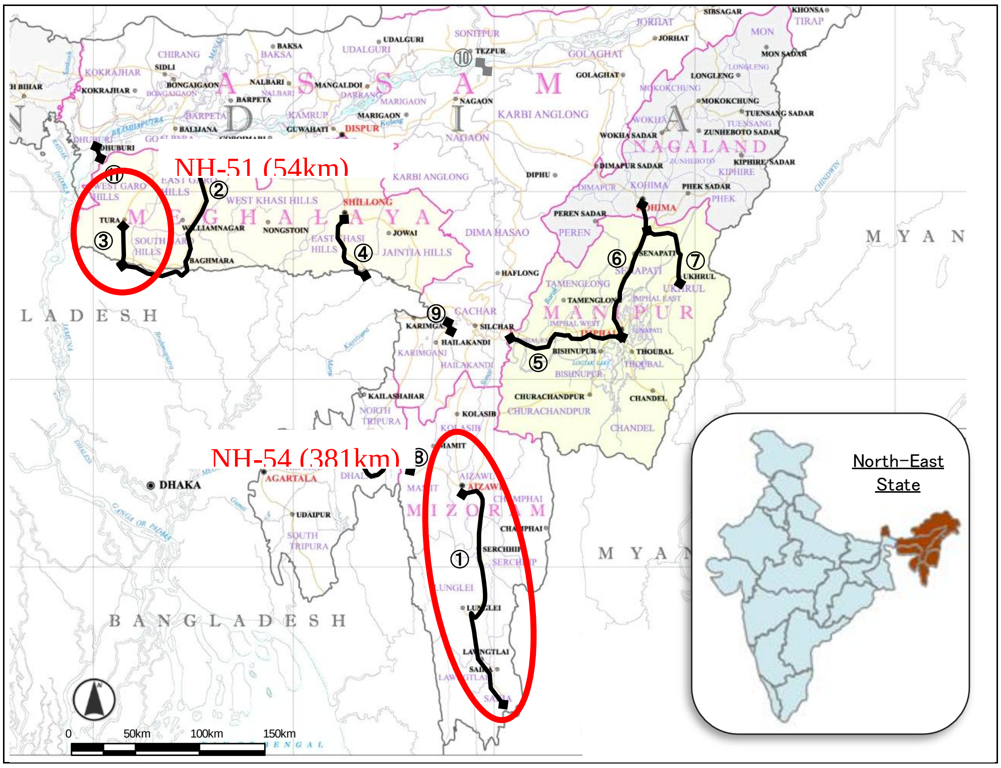


Figure XXX Location Map of NH-54 and NH-51

(2) Measurement Items

1) Road Cross Section Element

The following items were measured by measuring tape and visual observation at every 100 m sections or any locations where the target objects were found out.

- Topography
- Residence Condition
- Road Width
- Pavement Condition
- Side Drain
- Side Walk

The item of pavement condition is consisting of four categories, “Good”, “Fair”, “Poor” and “Bad”. Each category was judged in the basis of following criteria

- Good: when the existing road was smooth and had no potholes visible,
- Fair: when existing road was smooth but had few cracks and potholes visible,
- Poor: when existing road had more potholes and surface undulation visible,

- Bad: when severe deterioration including cracking, surface deformation, disintegration and surface defect of the pavement was observed.

The road width was obtained at each 100m interval along target roads and the definition of road width is shown in the following figure.

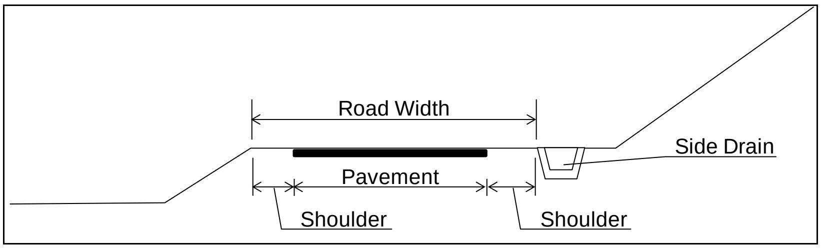


Figure XXX Definition of Road Width

2) Cross Drain and Waterway

The following items were measured by measuring tape and visual observation at any locations where the target objects of cross drain and waterway were found out.

- Cross Drain Structure (Type, Size)
- Condition of Cross Drain Structure
- Waterway (Width)

3) Retaining Wall and Guardrail

The following items were measured by measuring tape and visual observation at any locations where the target objects of retaining wall and guardrail were found out.

- Retaining Wall (Material, Height, Length)
- Guardrail (Material, Height, Length)

4) Social Infrastructure and Religious Object

The following items were recorded based on existing local information collected in advance and visual observation at any locations where the target objects of social infrastructure and religious object were found out. The distance from pavement edge to the objects was measured by measuring tape at each location.

- Social Infrastructure (Object, Distance from Pavement Edge)
- Religious Object (Object, Distance from Pavement Edge)

5) Overhead Utility Line (Side, Distance from Pavement Edge)

The following items were recorded based on existing local information collected in advance and visual observation at any locations where the target objects of overhead utility line were found out. The distance from pavement edge to the objects was measured by measuring tape at each location.

- Electric Distribution Line
- Electric Transmission Line
- Transformer
- Telecommunication Line

6) Underground Utility Line (Side, Distance from Pavement Edge)

The following items were recorded based on existing local information collected in advance, hearing to local resident and visual confirmation at sites along the target routes during this survey period. The distance from pavement edge to the objects was measured by measuring tape at each location.

- Water Supply Line
- Optical Fiber Cable Line

7) Bridge (Width, Length)

The size and condition of bridges along the target routes were recorded at any locations where the objects were found out.

8.1.4.3 Summary of Results

(1) Road Cross Section Element

1) Road Width (Pavement & Shoulder)

Figure XXX shows the result of road width inventory survey.

- Rongram to Tura

  In this section, it is relatively narrow shoulder like around 1.0m was observed compared with after Tura to Barengapara. It can be mostly said as dual carriage lane in this section where 5.0m to 6.5m pavement width was observed totally.

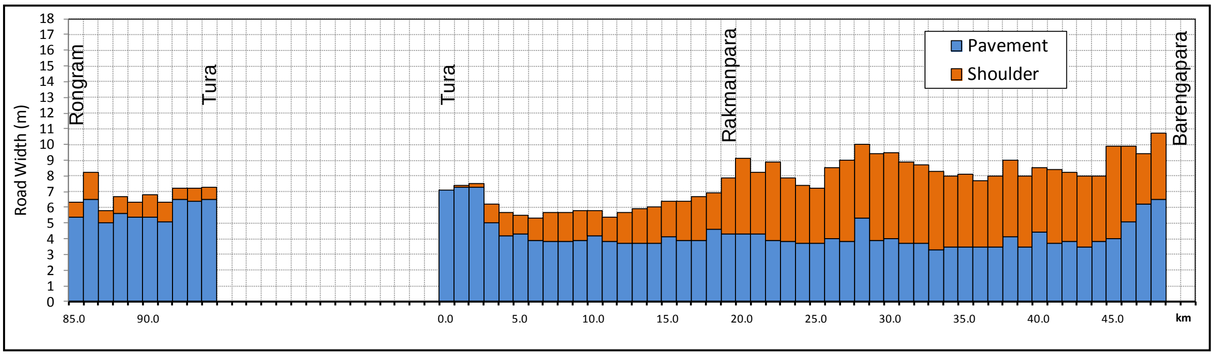
- Tura to Rakmanpara

  Around 7m pavement width was recorded in 3km after Tura, however around 4.0m of pavement width was observed in this section in average. Therefore it is slightly narrow to say dual carriage lane in this section.

  The shoulder width gradually was increasing after Tura to Rakmanpara from less than 1.0m to 5.0m. So it is relatively more enough passing space than usual intermediate lane after Tura section.

- Rakmanpara to Barengapara

  In this section, it can likely be dual carriage lane because of sufficient shoulder width recorded from 5.0m to 6.0m in average in spite of narrow pavement width observed around 4.0m. Just 2km to 3km nearby Barengapara was recorded as around 5.0m pavement width with sufficient shoulder, so that this section can be said as dual carriage lane.



Source: JICA Study Team

Figure XXX Road Width (Pavement & Shoulder)

2) Others

- Topography

  The sections where one side was hill and the other side was valley occupied in almost whole sections from Rongram to Barengapara. However several sections where both side were hill terrain was partially observed in 3km stretch from Rongram to Tura. The sections where both side were valley terrain was observed in 5km stretch from Tura to Rakmanpara and also 5km stretch nearby Barengapara area.

- Land Use

The stretch from Rongram to Tura was continuously observed as built-up area. On the other hand, 2km and 3km built-up area in Bakmanpara and Barengapara were found after Tura.

- Pavement Condition

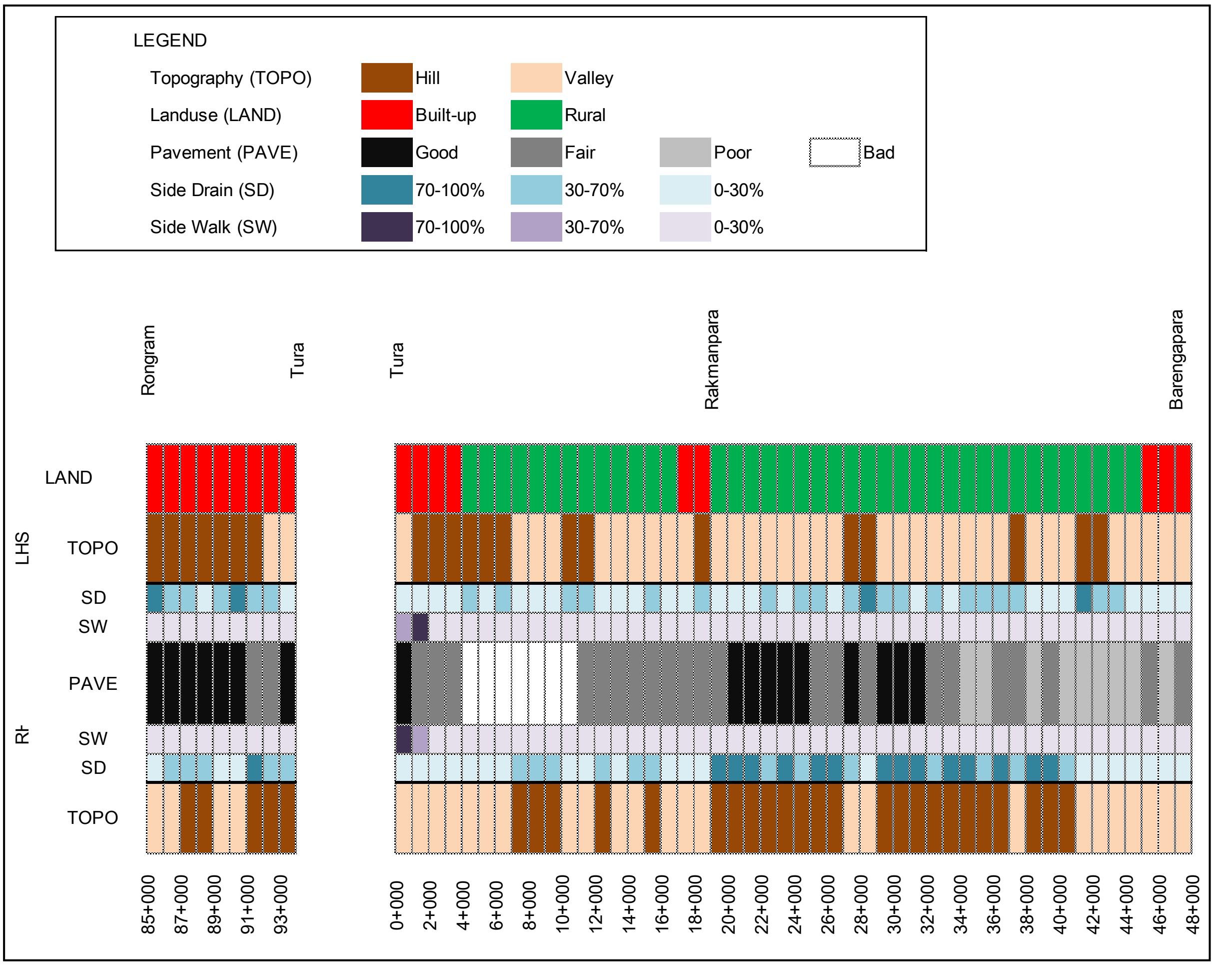
In 7km stretch between Tura to Rakmanpara, the pavement condition was continuously judged as Bad. In the section from Rakmanpara to Barengapara, poor condition was observed for 9km length totally especially nearby Barengapara side.

- Side Drain

Poor range having only less than 30% side drain in both side of the road cross section was observed in 8km stretch from Tura to Rakmanpara and 4km stretch nearby Barengapara area.

- Side Walk

Good range having 70% to 100% side walk infrastructure was observed in 2km stretch nearby Tura area only. Poor range having less than 30% was observed in the other whole sections.



Source: JICA Study Team

Figure XXX Cross Sectional Elements and Pavement Condition of NH51

(2) Cross Drain

In whole section, 4 to 5 No. of cross drain was observed at every 1km in average. Hume pipe type occupied about 82% and 59% of existing cross drain in the section from Bakmanpara to Barengapara and from Rongram to Rakmanpara.

Table XXX Result of Cross Drain

Route	Section	Section Length (km)	No. of Cross Drain Structure					
			Hume Pipe	Masonry Slab	Other / Unknown	No Structure	TOTAL	Av. No. per km
NH51	Rakmanpara - Barengapara	28.9	102	22	7	7	138	4.8
	Rongram-Tura-Rakmanpara	28.8	65	46	13	10	134	4.7
	TOTAL	57.7	167	68	20	17	272	4.7

Source: JICA Study Team

(3) Retaining Wall

RCC type was not observed in whole section. In other words, all of retaining wall type was

Masonry type in accordance with following table.

Table XXX Result of Retaining Wall

Route	Section	Section Length (km)	Area of Retaining Wall (m2)								
			Left			Right			TOTAL		
			Masonry	RCC	TOTAL	Masonry	RCC	TOTAL	Masonry	RCC	TOTAL
NH51	Rakmanpara - Barengapara	28.9	1,997.3	0.0	1,997.3	1,469.0	0.0	1,469.0	3,466.3	0.0	3,466.3
	Rongram-Tura-Rakmanpara	28.8	4,799.5	0.0	4,799.5	3,271.5	0.0	3,271.5	8,071.1	0.0	8,071.1
	TOTAL	57.7	6,796.8	0.0	6,796.8	4,740.5	0.0	4,740.5	11,537.3	0.0	11,537.3

Source: JICA Study Team

(4) Guardrail

In the section from Rakmanpara to Barengapara, steel type of guardrail was mostly observed. On the other hand, Masonry type was mostly was found in the section from Rongram to Rakmanpara having no steel type.

Table XXX Result of Guardrail

Route	Section	Section Length (km)	Length of Guardrail (m)			
			Masonry	Parapet	Steel	TOTAL
NH51	Rakmanpara - Barengapara	28.9	5.8	0.0	223.7	229.5
	Rongram-Tura-Rakmanpara	28.8	1,448.4	419.2	0.0	1,867.6
	TOTAL	57.7	1,454.2	419.2	223.7	2,097.1

Source: JICA Study Team

(5) Social Infrastructure

School/Orphanage Home was found approximately by 1 No. per 4km to 5km in the section from Rongram to Rakmanpara. Waiting Shed was observed at every 1km to 2km section approximately in whole stretch.

Table XXX Result of Social Infrastructure

Route	Section	Section Length (km)	No. of Social Infrastructure					
			School / Orphanage Home	Water pump	Urinal/Toilet	Petrol Pump	Waiting Shed	Others
NH51	Rakmanpara - Barengapara	28.9	0	2	1	1	20	6
	Rongram-Tura-Rakmanpara	28.8	7	2	0	1	13	0
	TOTAL	57.7	7	4	1	2	33	6

Source: JICA Study Team

(6) Religious Object

Few objects were observed in terms of all types of religious object through this whole section. To stretch a point, Church and Mosque were found at every 5km to 6km and about 10km respectively in average for whole section.

Table XXX Result of Religious Object

Route	Section	Section Length (km)	No. of Religious Object					
			Church	Mosque	Mandir	Memorial Stone	Grave	Monument/Statue
NH51	Rakmanpara - Barengapara	28.9	3	0	0	0	0	1
	Rongram-Tura-Rakmanpara	28.8	7	4	0	0	0	3
	TOTAL	57.7	10	4	0	0	0	4

Source: JICA Study Team

(7) Public Utilities (Electric Line, Telecommunication Line, Water Supply, Optical Fiber Cable(OFC))

The No. of crossing or close passing utilities' line was counted as shown the table below.

Electric distribution line was found approximately at every 3km and 4km in the section from Rakmanpara to Barengapara and Rongram to Rakmanpara respectively in average.

Electric transmission line was observed approximately at every 3km to 4km in whole section in average.

Telecommunication line was found at every 4km approximately in whole section.

Water supply line was densely found at every 0.5km approximately in whole section in average.

OFC line was mostly and densely observed in the section from Rongram to Rakmanpara at every 0.5km approximately in average.

Table XXX Result of Public Utilities

Route	Section	Section Length (km)	No. of Neighboring Public Utilities (Location of Crossing / Close Passage)				
			Electric Line		Telecommuni-cation Line	Water Supply	OFC
			Distribution	Transmission			
NH51	Rakmanpara - Barengapara	28.9	84	9	10	35	3
	Rongram-Tura-Rakmanpara	28.8	124	9	4	79	57
	TOTAL	57.7	208	18	14	114	60

Source: JICA Study Team

8.1.5 Slope Inventory Survey

The slope inventory survey was conducted for the purpose to implement topographic measurement, verification of geological and geotechnical condition, and identification of landslide risks as well as NH54.

Table 7.3.3 shows critical slopes identified in the survey and recommendation of widening side in NH51. Many subsidence parts were frequently found on NH51, that is caused by poor subsurface soil and drainage system. For the subsidence portions, subsurface drainage shall be build for improvement of drainage regardless of widening side.

Table 7.3.3 Recommendation of Widening Side (NH51)

Sec	LS No.	Landslide Location				Disaster Type	Road Deformation				Recommended Widening Side		
		Slope No.	Start	~	End		Collapse	Sinking	Crack	Bulge	R/L	H/V	Landslide Countermeasure
NH-51	01	221	93 + 400	~	93 + 420	SF	x				L	V	Soil retaining wall
	02	014	4 + 480	~	4 + 540	SF	x				R	V	Soil retaining wall
	03	015	4 + 540	~	4 + 580	SF					R	V	Soil retaining wall
	04	030	10 + 181	~	10 + 219	SF	x		x	x	L	H	Earth removal
	05	046	15 + 440	~	15 + 480	SF	x	x			-	-	Subsurface drainage
	06	055	18 + 520	~	18 + 560	SB		x			-	-	Subsurface drainage
	07	057	19 + 430	~	19 + 470	SB		x			-	-	Subsurface drainage
	08	058	19 + 700	~	19 + 720	SB		x			-	-	Subsurface drainage
	09	059	20 + 000	~	20 + 020	SB		x			-	-	Subsurface drainage
	10	060	20 + 240	~	20 + 280	SB		x			-	-	Subsurface drainage
	11	060	20 + 480	~	20 + 520	SB		x			-	-	Subsurface drainage
	12	061	20 + 640	~	20 + 660	SB		x			-	-	Subsurface drainage
	13	061	20 + 850	~	20 + 870	MM		x	x		R	V	Road realignment
	14	062	21 + 020	~	21 + 060	SB		x			-	-	Subsurface drainage
	15	062	21 + 200	~	21 + 250	SB		x			-	-	Subsurface drainage
	16	063	21 + 360	~	21 + 600	SB		x			-	-	Subsurface drainage
	17	064	21 + 660	~	21 + 720	SB		x			-	-	Subsurface drainage
	18	069	23 + 700	~	23 + 780	SB		x			-	-	Subsurface drainage
	19	070	23 + 940	~	24 + 010	MM-p		x			R	H	- No need
	20	070	24 + 120	~	24 + 220	SB		x			-	-	Subsurface drainage
	21	071	24 + 420	~	24 + 480	SB		x			-	-	Subsurface drainage
	22	074	25 + 680	~	25 + 700	MM		x			L	V	Soil retaining wall
	23	091	32 + 020	~	32 + 040	MM		x			L	V	Retaining wall

Source: JICA Study Team

MM: Mass Movement, MM-p: Inactive mass movement, SF: Slope Failure, SB: Subsidence

R: Right side, L: Left side, H: Hill side, V: Valley side

8.2 Preliminary Design

8.2.1 General

(1) Objectives

(2) Background

(3) Project Location

(4) Major Features and Facilities

8.2.2 Review of DPR

(1) Traffic Survey and Traffic Analysis

(2) Design Standards and Design Criteria

(3) Road Alignment Design

(4) Slope Protection Design

Slope protection works planned in the DPR of NH51 were reviewed. Table 8.2.1 shows the comparison with the DPRs of each section and proposal by this JICA study team.

Similarly to the DPRs in NH54, road widening was planned mostly on hill side with cutting slope and it resulted in very huge volume of the cut soil comparing to embankment volume. JICA study team proposed NHIDCL and his consultant that widening should be applied on both hill and valley in case-by case basis to reduce the cut soil volume and plan landslide prevention measure against sediment disaster risk sites and road subsidence area sites as well as NH54.

Table 8.2.1 Review of DPR regarding Slope Protection Work

Item	DPR*	Proposal **
Widening Side	Hill side only	Plan to widen on both hill and valley side in case by case basis.
Cut Grade	1:0,.6	Decide based on classification of rock and soil.
Cut Soil Volume (m3)	1.45 million	Reduce by widening on valley side and balance with embankment volume.
Embankment Volume (m3)	0.13 million	Will increase with widening on valley side.
Slope Protection	Retaining wall Brest wall	Appropriately adopt on landslide risk slope.
Landslide Sites Countermeasure Plan	Not recognized. Nil	Identify landslide risk sites in inventory survey and plan its countermeasures.

Source: *DPR as of May 2015, **JICA Study Team

(5) Bridge design

The comments for bridge plan by DPR are as follows.

- The general information for existing bridges are not provided well. Such as structural type, span, carriageway width, design load and estimated construction year for each bridge are required.
- Re-construction was proposed for one Minor bridge and rehabilitation was proposed for eleven Bridges. However, damage condition and the contents of rehabilitation are not explained.

Therefore, the site investigation to check each bridge condition is required.

In the study, general information of existing bridge such as structural type, span, carriageway width and damaged condition is investigated at site. Also, some important information such as construction year and design load is interviewed to PWD.

The necessity of bridge replacement should be carefully determined with several viewpoints such as carriageway width, design load, and soundness.

Table 8.2.2 Proposal for bridges by DPR (NH51)

	DPR proposal	Comment
NH-51	One Major Bridge and Eleven Minor Bridge is explained as exist. Re-construction was proposed for one Minor Bridge and Rehabilitation was proposed for eleven Bridges.	Shortage for general information such as structural type or carriageway width. No explanation for damage condition and the contents of rehabilitation.

Source: Based on DPR

(6) Drainage design

The drainage design by DPR was reviewed. The proposed quantity in each type and size of cross drainage structures are summarized in table below. The concrete lined ditch is applied to road side ditch for cut side in all section at most.

The comments for cross drainage design by DPR are as follows.

- It does not enough explain damaged condition and structural features for each existing culverts.
- All existing culverts are proposed to be dismantled and re-constructed to new culverts with 12m width. It does not clarify the reason that existing culvert is not feasible to retain with extension of partial new culvert.
- It is assumed that hydrological analysis was not conducted in DPR. No any descriptions regarding discharge calculation in DPR. Newly added culvert was not proposed at all. In order to decide type and dimension of culvert, the water discharge obtained by hydrological analysis is to be referred.

Table 8.2.3 Proposed culvert by DPR for NH51

	Type	Size	Existing location	Newly added	Sum
NH51 85 to 95 101 to 145	Slab culvert	1.0x 1.0	1	0	1
		1.0x 1.5	28	0	28
		1.5x 2.0	1	0	1
		2.0x 1.0	8	0	8
		2.0x 2.0	2	0	2
		2.5x 2.5	3	0	3
	BOX culvert	1.0x 2.0	3	0	3
	Pipe	ϕ 1.2 x 1	162	0	162
		ϕ 1.2 x 2	19	0	19
		Total	227	0	227

Note : The number of culverts in bypass section is not included.

Source: Based on DPR

(7) Design Constraint (Accuracy of Design and Map)

(8) RAP Survey

(9) EIA Survey

(10) Project Cost Estimate

(11) Project Implementation

8.2.3 Road Geometric Design

(1) Design Standards

(2) Proposed Design Policy and Design Criteria

(3) Design Control

(4) Horizontal Alignment Design

(5) Vertical Alignment Design

(6) Typical Cross Section

8.2.4 Bridges and Structures Design

(1) General

It is necessary for bridges on NH51 to provide function adapted to current National Highway standard. If the existing bridge is adequate for requirement of current National Highway, it can be retained with or without some repairing works. If the existing bridge is deemed to be inadequate, it should be replaced to new bridge.

The necessity of bridge replacement should be carefully determined with following viewpoints.

- Road width on bridge: The road width for bridges should be enough for National Highway Standard. Although the road width for general road section is planned as 12.0m (3.5mx2 for vehicle lane and 2.5mx2 for side lane), the road width for existing bridge is considered enough if more than 7.5m as referred to IRC:73.

- Design Load: The existing bridge is utilized only if it follows the design load to be applicable for current National Highway Standard. Specially, Live Load is important factor because it directly works to girder. Hence, the application of live load (IRC Class 70R Loading) as mentioned in IRC:6 is confirmed for determination.

- Soundness: The existing bridge is utilized only if the condition is basically soundness without major damages. It is said that the road was originally constructed in around 1970. It means that the existing bridges constructed at origin of the road are aging near to 50 years. The project can be suitable occasion for such old bridges to replace to new bridge.

(2) Existing bridge condition

Fourteen existing bridge is identified in project area of NH51. Outline, condition and comment for these existing bridges are summarized in Table.

Construction year are different between each bridge. Carriageway width 7.5m is roughly provided in all bridge. Aging deterioration is seen for all bridges except few new bridges.

According to information obtained from PWD in Tura, IRC ClassA Loading is applied to all existing bridges On the other hand, both of IRC class 70R Loading and ClassA loading need to be verified on current National Highway Standard. (It is called IRC class 70R Loading simply.)

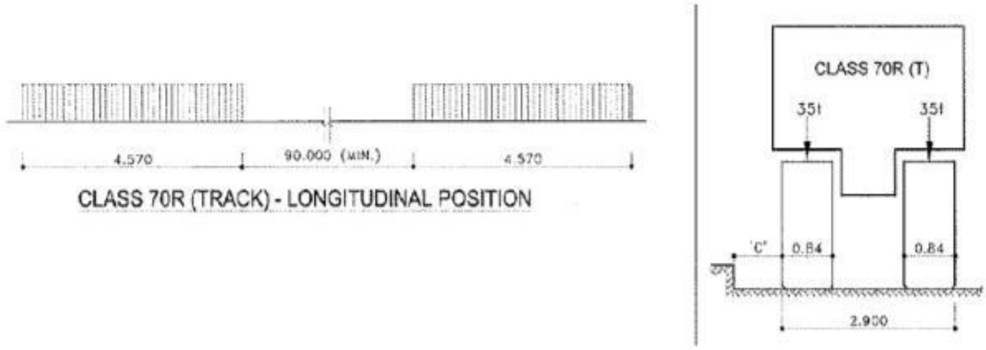
Because axle intervals and weight between two live load models are different, Class A load may become lighter design condition in case of some bridge length.

Here, total amount of axle load for both live load model loaded at simple supported beam is compared. Class A Load become lighter than 70R loading in case one span of girder less than 15m. It means that the bridge less than 15m cannot meet condition for 70R loading and it seems to be shortage of design load.

Table 8.2.4 Comparison of total axle load between IRC models on simple supported girder

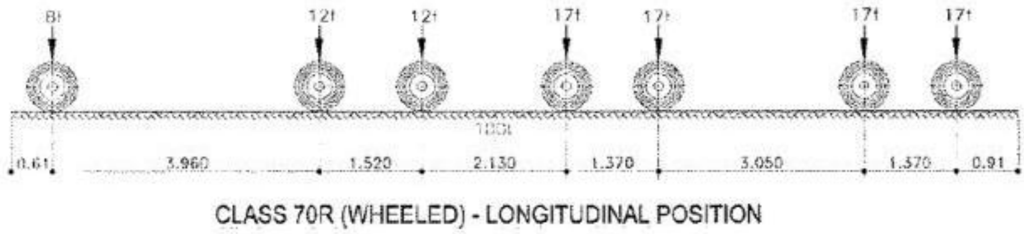
Bridge Length	Live load total		
	70R (Tracked Vehicle)	70R (Wheeled Vehicle)	Class-A
Lanes	One lane load	One lane load	Two lane loads
L=5m	70t	46t	51.0t
L=10m	70t	92t	70.0t
L=12.5m	70t	92t	78.2t
L=15m	70t	100t	100t
L=20m	70t	100t	110.8t
L=30m	70t	100t	110.8t

Source: JICA Study Team



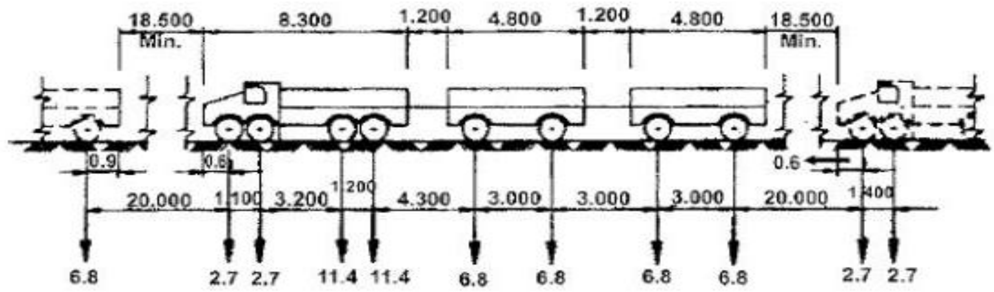
Source: IRC:6

Figure 8.2.1 **Wheel arrangement for 70R (Tracked) Vehicle**



Source: IRC:6

Figure 8.2.2 **Wheel arrangement for 70R (Wheeled) Vehicle**



Source: IRC:6

Figure 8.2.3 **Class A Train of Vehicles**

Table 8.2.5 Outline and Conditions of existing bridges on NH51

Location	Outlines	Condition	Comment
86+310	・Bridge name：Ganol Bridge ・River name：Ganol River ・Construction year：2002 ・Structural type ：4-span RC girder ・Length & Span：4-span 98.9m ・Roadway width：7.5m +sidewalk at both side ・Bridge overall width : 12m ・Design load：Class A	・No major damages are seen at girder, pier, abutment pavement and railing.	The existing bridge can be retained without special repairs because; -No major damages are seen. -Roadway width is satisfied. -Design load is satisfied.
90+077	・Bridge name：Dapu Bridge ・River name：Dapu Stream ・Construction year：1994 ・Structural type：RC slab ・Length & Span：1 x 12.8m ・Roadway width：7.5m ・Bridge overall width : 8.5m ・Design load：Class A	・Girders and abutments are aging deteriorated wholly.	The super-structure of existing bridge should be replaced to new one because; -Less of design load for existing girder
91+385	・Bridge name：Jongme Bridge ・River name：Jongme stream ・Construction year：1985 ・Structural type：RC slab ・Length & Span：1 x 8.8m ・Roadway width：7.5m ・Bridge overall width : 11m +sidewalk at both side ・Design load：Class A	・Girders and abutments are aging deteriorated wholly.	The super-structure of existing bridge should be replaced to new one because; -Less of design load for existing girder
92+442	・Bridge name：Rongkhon Bridge(N) ・River name：Rongkhon River ・Construction year：2003 ・Structural type：RC girder ・Length & Span：1 x 37.0m ・Roadway width：7.5m + sidewalk at both side ・Bridge overall width : 12m ・Design load：Class A	・No major damages are seen at girder, pier, abutment pavement and railing.	The existing bridge can be retained without special repairs because; -No major damages are seen. -Roadway width is satisfied. -Design load is satisfied.
92+532	・Bridge name：Rongkhon Bridge(S) ・River name：Rongkhon River ・Construction year：2003 ・Structural type：RC girder ・Length & Span：1 x 17.1m ・Roadway width：7.5m + sidewalk at both side ・Bridge overall width : 12m ・Design load：Class A	・No major damages are seen at girder, pier, abutment pavement and railing.	The existing bridge can be retained without special repairs because; -No major damages are seen. -Roadway width is satisfied. -Design load is satisfied.

103+240	・Bridge name：Deran Bridge ・River name：Deran Stream ・Construction year：1990 ・Structural type：RC slab ・Length & Span：1 x 11.5m ・Roadway width：7.5m ・Bridge overall width : 8.5m ・Design load：Class A	・Girders and abutments are aging deteriorated wholly. ・Concrete exfoliation and exposure of steel bar is seen at girder side.	The super-structure of existing bridge should be replaced to new one because; -Less of design load for existing girder
107+335	・Bridge name：Rongnabak Bridge ・River name：Rongnabak River ・Construction year：1990 ・Structural type：RC girder ・Length & Span：1 x 25.8m ・Roadway width：7.5m ・Bridge overall width : 8.5m ・Design load：Class A	・Girders and abutments are aging deteriorated wholly.	The existing bridge can be retained without special repairs because; -No major damages are seen. -Roadway width is satisfied. -Design load is satisfied.
136+990	・Bridge name：Mason Bridge ・River name：Mason River ・Construction year：1993 ・Structural type：RC girder ・Length & Span：1 x 25.3m ・Roadway width：7.5m ・Bridge overall width : 8.5m ・Design load：Class A	・Girders and abutments are aging deteriorated wholly.	The existing bridge can be retained without special repairs because; -No major damages are seen. -Roadway width is satisfied. -Design load is satisfied.
137+825	・Bridge name：Jintal Bridge ・River name：Jintal River ・Construction year：1996 ・Structural type：3-span RC slab ・Length & Span：9.0m+17.4m+9.0m =35.4m ・Roadway width：7.5m ・Bridge overall width : 8.5m ・Design load：Class A	・Change of color on concrete at girder side for center span due to drain water. ・Girders at side span are aging deteriorated wholly. ・Pavement is little settled at approach part.	For side span, the super -structure of existing bridge should be replaced to new one because; -Less of design load for existing girder
140+690	・Bridge name：- ・River name：- ・Construction year：N/A ・Structural type： RC slab ・Length & Span：1 x 6.0m ・Roadway width：4.0m ・Bridge overall width : 5m ・Design load：Class A	・Girders and abutments are aging deteriorated wholly. ・Concrete railing is quite deteriorated.	The super-structure of existing bridge should be replaced to new one because; -Shortage of carriageway width -Less of design load for existing girder
140+990	・Bridge name：Debok Bridge ・River name：Debok River ・Construction year：1990 ・Structural type：3-span RC slab ・Length & Span：3x9.7m =29.0m ・Roadway width：7.5m ・Bridge overall width : 8.5m ・Design load：Class A	・Girders, piers and abutments are aging deteriorated wholly.	The super-structure of existing bridge should be replaced to new one because; -Less of design load for existing girder

141+928	・Bridge name：- ・River name：- ・Construction year：1991 ・Structural type： RC slab ・Length & Span：1 x 7.5m ・Roadway width：7.5m ・Bridge overall width : 8.5m ・Design load：Class A	・Girders and abutments are aging deteriorated wholly. ・Exposure of steel bar is seen at girder side.	The super-structure of existing bridge should be replaced to new one because; -Less of design load for exiting girder

Note）The outline data is based on the site measurement and listening information from Executive Engineer of P.W.D. in Tura District.

Source: JICA Study Team

Hence, it can be proposed to re-construction of One bridge and replacement of super-structure for Seven bridges as below.

The bridge to be re-constructed ・・・1 location

(a) 140+690 (RC slab L=6.0m)

The bridge to be replacement of super-structure ・・・6location

(b) 90+077 (RC slab L=12.8m)

(c) 91+385 (RC slab L=8.8m)

(d) 103+240 (RC slab L=11.5m)

(e) 137+825 (Side span of 3-span RC slab Side span 2nos x 9.0m)

(f) 140+990 (3-span RC slab L : 3x9.7m)

(g) 141+928 (RC slab L=7.5m)

Table 8.2.6 Existing bridges to be replaced or rehabilitated

At 140+690	
At 90+077	
At 91+385	

At 103+240	
At 137+825	
At 140+990	

<table><tr><td>At 141+928</td><td></td></tr></table>

Source: JICA Study Team

(3) Design standard

The design is based on the IRC standard in principal. For detailed design stage, it shall be designed based on IRC standard as far as applicable.

Major codes and typical drawings regarding to bridge design is summarized in table below. Also, the codes for road design are to be referred.

But not limited to;

Table 8.2.7 List of major codes for bridge design

IRC: 5-1998	Standard Specification & Code of practice for Road Bridges. Section – I General Features of Design (Seventh Revision)
IRC: 6-2014	Standard Specification & Code of practice for Road Bridges. Section – II Loads & Stresses (Revised Edition)
IRC: 21-2000	Standard Specification & Code of practice for Road Bridges. Section – III Cement Concrete Plain & Reinforced (Third Revision)
IRC: 24-2010	Standard Specification & Code of practice for Road Bridges, Steel Road Bridges (Limit State Method) (Third Revision)
IRC: 45-1972	Recommendations for Estimating the Resistance of soil below the maximum Scour Level in the Design of Well Foundations of Bridges.
IRC: 73-1980	Geometric Design standards for Rural (Non-Urban) Highways.
IRC: 78-2014	Standard Specification & Code of practice for Road Bridges. Section – VII Foundation & Substructure (Revised Edition)
IRC: 112-2011	Code of Practice or Concrete Road Bridges
MORTH	Standard Plans for 3.0m to 10.0m Span Reinforcement Cement Concrete Solid Slab Structure with and without Footpaths for Highways, 1991
MORTH	Standard Plans for Highway Bridges R.C.C. T-Beam & Slab Superstructure – Span from 10m to 24m with 12m width, 1991

Source: JICA Study Team

The design load condition shall be determined by taking account for the regional and project characteristic. Major load conditions are as follows.

- Live load: IRC Class 70R Loading (Based on IRC:6 Clause201)
- Live load combination: One lane of Class 70R OR Two lanes of ClassA (Based on IRC:6 Clause204.3)
- Impact load: (Based on IRC:6 Clause208)
- Temperature load: +5 to +40 degree (Based on IRC:6 Clause215)
- Seismic load: Zone-V, Important Factor: 1.5 (Based on IRC:6 Clause219)

For other load conditions also be determined with based on IRC standards.

(4) Bridge design

(a) Bridge replacement for Minor bridge

Bridge replacement is proposed for following one Minor bridge.

Table 8.2.8 Bridge replacement for NH51

Location	Structural type	Outline
140+690	RC slab bridge	Bridge length：L=6.0m Total width：W=12m (Without footpath) Foundation：Spread foundation

Source: JICA Study Team

- The bridge is comparably short span. Hence, IRC typical drawing can be applied. The super-structure is planned based on the IRC typical drawing. Range for RC slab is 6m to 10m. Hence, structural type for proposed new bridge is RC slab bridge.
- The bridge width is planned as 12m based on IRC:73. Footpath is not provided because the proposed bridge is quite short length and existing bridge doesn't provide footpath.
- No traces of submergence is seen for existing bridge. Hence, the clearance under the girder same to existing bridge is to be provided. The road level is to be decided by approach road level.
- Based on information for existing bridge, spread foundation is supposed as same as the existing.

- Because the bridge is composed from RC and masonry member only, concrete work with mixer at site is supposed. After the demolishment of existing bridge, foundation is constructed. The superstructure concrete will be by cast in-situ on the support.
- Temporary road is required at neighbor for traffic diversion during construction. The construction in dry season is recommended.

(b) Bridge replacement for Minor bridge

Replacement of super-structures is proposed for following seven Minor bridge.

Table 8.2.9 Replacement of super-structures for NH51

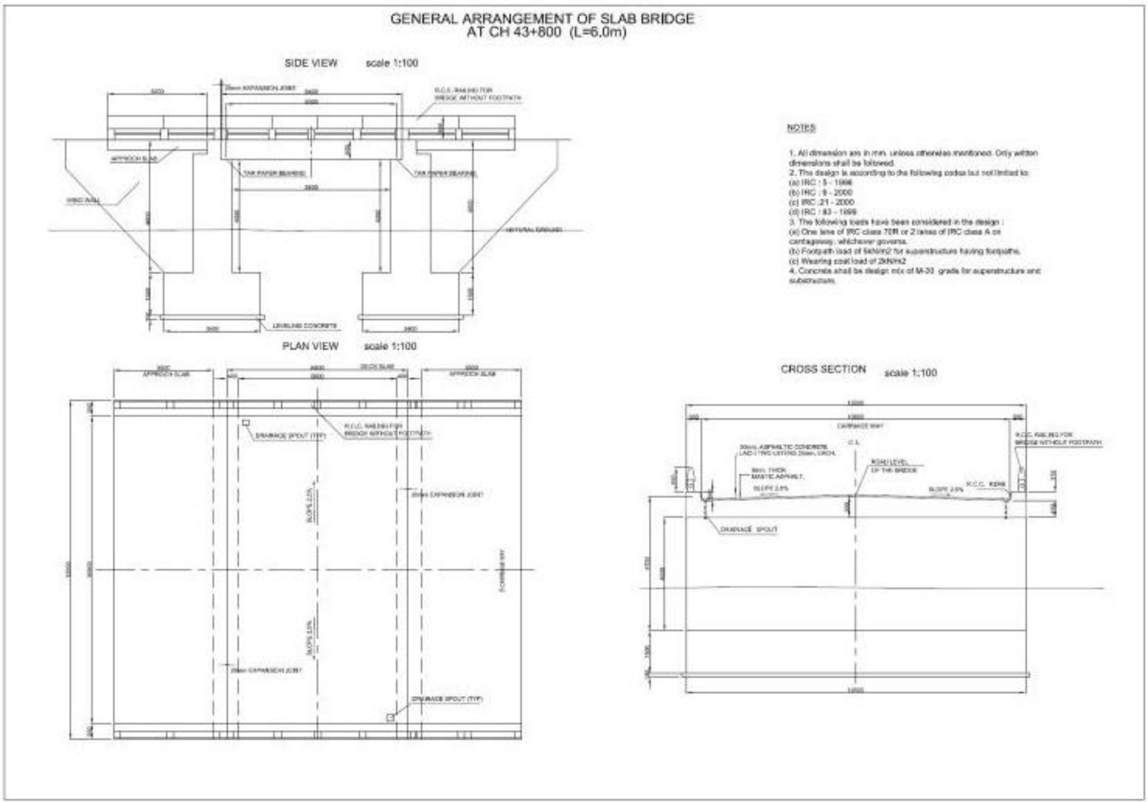
Structural type	Bridge width	Location and length for replacement

RC slab bridge	With footpath (width :11m)	91+385（L=8.8m）
RC slab bridge	Without footpath (width :8.5m)	137+825（L : 9.0m x2 spans at side） 140+990（L : 9.7m x3 spans） 141+928（L=7.5m）
RC T-beam bridge	With footpath (width :12m)	90+077（L=12.8m） 103+240（L=11.5m）

Source: JICA Study Team

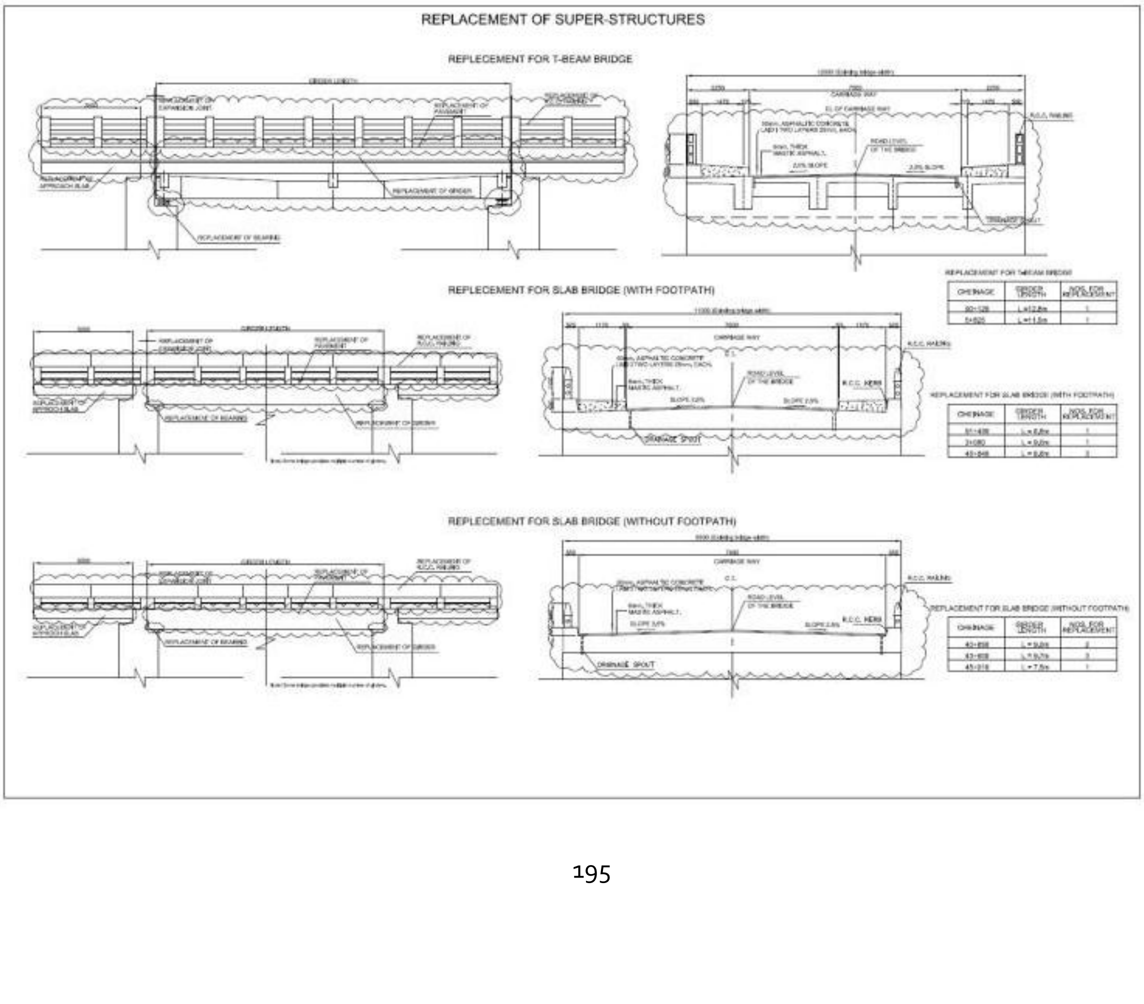
- All is comparably short span. Hence, IRC typical drawing can be applied. The super-structure is planned based on the IRC typical drawing. Range for RC slab is 6m to 10m and for RC T-beam is 10m to 24m. Hence, the type of super-structures for replacement is RCT-beam or RC slab girder type.
- The bridge width is determined by taking account of girder type and a size of sub-structure for the existing bridge.

- Because the bridge is composed from RC and masonry member only, concrete work with mixer at site is supposed. After the demolishment of existing bridge, foundation is constructed. The superstructure concrete will be by cast in-situ on the support.
- Temporary road is required at neighbor for traffic diversion during construction. The construction in dry season is recommended.



Source: JICA Study Team

Figure 8.2.4 **Slab bridge (L=6m)**



Source: JICA Study Team

Figure 8.2.5 Replacement of super-structures

8.2.5 Earth Work / Slope Protection / Land Slide Prevention Design

JICA study team use the same design standard of earth work, slope protection, and landslide prevention measure for NH51 as NH54 .mentioned in clause 7.2.5.

Slope along NH51 is covered by very loose quaternary alluvium. It is concerned that slope failure and erosion have frequently occurred on cut slope along NH51. Therefore, such loose soil slope shall be cut with 1:1.2 gentler than IRC standard for landslide prevention as shown in Table 8.2.10. The cut slope shall be greened by seeding and mulching consisting of jute netting including seeds which cover all over the slope and prevent erosion by rain water.

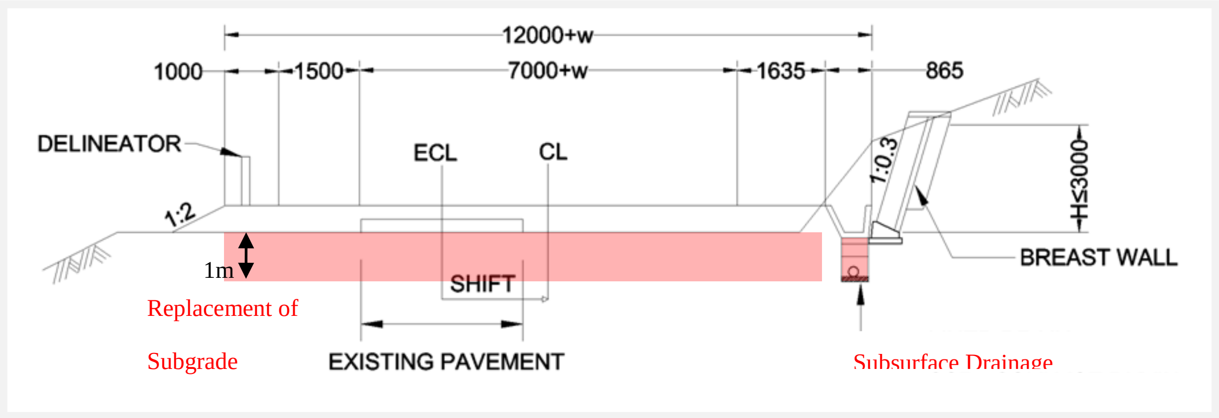
Table 8.2.10 Design Criteria of Cut Slope and Slope Protection Work

IRC Standard*		JICA Study Team Rock/Soil Classification		Cut Grade	Slope Protection Work
Classification	Cut Grade				
Ordinary Soil/ Heavy Soil	**1:1.0 ~ 1:0.5**	Soil	Dense Soil	**1:1.0**	Seeding and Mulching
			Loose Soil	**1:1.2**	Seeding and Mulching

*IRC: SP:48:1948 Clause 7.4

Source: JICA Study Team

JICA study team identified a lot of road subsidence sites in the slope inventory survey, which was assumed to occur due to consolidation of loosen subsurface soil and high groundwater level except for embankment sliding. Therefore, replacement of subgrade with 1.0m thick and subsurface drainage are planned as countermeasures of sinking as shown in Figure 8.2.6.



Source: JICA Study Team

Figure 8.2.6 Typical Cross Section of Countermeasure for Sinking

8.2.6 Pavement Design

(1) Design Standards and Guidelines

(2) Design Period of Pavement Design

(3) Traffic Condition

(4) Geological Condition

(5) Pavement Design

8.2.7 Drainage Design

(1) General

It is required to facilitate culvert or side ditch on road for drain water surrounding or upstream of road to downstream properly. Specially, hill road is always suffered from large volume of water fallen from mountain slope towards to the road. It is quite important to protect the road by arranging cross drainage appropriately to satisfy the discharge from crossing water.

On the existing NH51, large number of culvert does exist crossing under the road. Because the road improvement includes road widening and alignment modification in most section, appropriate measures for culverts such as demolish/reconstruction or extension of existing is considered to be taken in each location.

However, it is considered that retain of existing culvert with extension measure is not practical for the situation. The reasons are explained below.

- Position shift due to road improvement : The culvert length needs to be extended due to road widening from existing 6-7m to 12m width. Also, the culvert position to be placed is changed because the road center line is shifted by alignment modification. Specially, it can be shifted to valley side at every valley section where the curve radius is modified to be larger by alignment modification. Hence, the extension measure on existing culverts does not much reduce for its work volumes compare with new construction. In addition, it makes the work more complicated.

- Condition of existing culvert : The existing structures constructed at origin of the road are aging near to 50 years. It was confirmed by the investigation that these structures don’t provide appropriate durability, structural features and maintenance performance to utilize in improved National Highway.

Moreover, it cannot be ensured that existing culverts are well durable for next several decades. The replacement on one occasion of the road improvement would be much advantage in terms of economy and serviceability of the road more than frequent occasional replacement in near future.
Hence, it is general policy that existing culverts are demolished and is constructed a new one.

The new drainage system is designed by based on hydrological calculation result. Based on obtained location of water crossing and water discharge, dimension and locations for drainage system are determined. For cross drainage structure, appropriate culvert type is selected by taking account of economy, construction workability, and maintenance ability.

(2) Outline and condition of existing culvert
Existing culverts on NH51 can be categorized into four types. Structural outline and condition in each type of culverts are summarized in table.
It is tendency in whole that existing culverts are aging deterioration for RC concrete and masonry. Also, many culverts accumulate soil fully at inside.

Table 8.2.11 Outline and condition of existing culvert

Type	Outline	Condition
Slab culvert	It is the structure of RC slab plate with masonry abutments. Stones are laid at bottom. For some of these an inlet or outlet wall is integrated with retailing wall. Some structure is type of narrow inner width. It is assumed that these slab culverts has been retained since original construction of NH-51.	-Concrete exfoliation and exposure of steel bar at back side and edge of slab plate -Shortage of concrete cover at back side of slab plate, as seen exposure steel and coating of mortal -Collapse of slab plate and pavement -Exfoliation of masonry abutment
R.C. Hume pipe	It is the structure of R.C. Hume pipe connecting same pieces. Diameter is ranged as 0.8m to 1.5m in approximate. For some of these an inlet or outlet wall is integrated with retailing wall. It is assumed that these R.C. pipes were installed comparably recent.	-Concrete exfoliation and exposure of steel bar at joint between pipes. -Clacks at surface of concrete
R.C. Hume pipe (Double)	It is the structure of R.C. Hume pipe which two low of pipes lined.	Same as above

Source: JICA Study Team

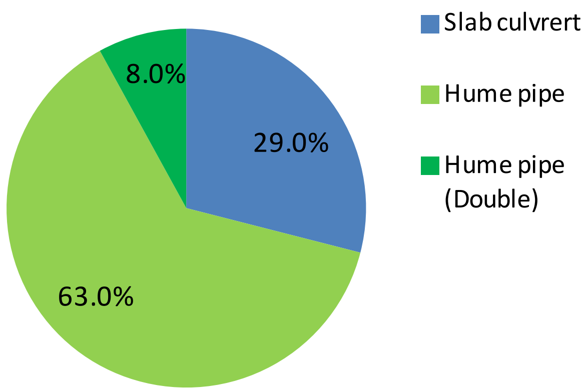
The example of existing culverts at site in each type is shown in Figure .

According to the inventory survey result conducted in the study, Hume pipe culvert covers approximately 70% on existing culverts in the project range of NH51. According to DPR, these Hume pipes are NP2 or NP3 type.
The rate of structural type of existing culvert is summarized below.

Table 8.2.12 Rate of structural type of existing culvert

Section	Section-A 85-95km		Section-B 110-148km		Total	
	Nos.	Rate(%)	Nos.	Rate(%)	Nos.	Rate(%)
Slab culvrert	12	41.4%	57	27.3%	69	29.0%
Hume pipe	17	58.6%	133	63.6%	150	63.0%
Hume pipe (Double)	0	0.0%	19	9.1%	19	8.0%
Total	29	100.0%	209	100.0%	238	100.0%

Source: JICA Study Team



Source: JICA Study Team

Figure 8.2.7 Rate of structural type of existing culvert

By considering structural viewpoint, it is recommendable for all existing culvers to replace to new one in occasion of the road improvement because;

- Slab culvert : improper work for slab concrete, less design load, aging of RC slab and masonry abutment
- R.C. pipe : Un-known of pipe class for existing (NP-2 according to DPR) Soil accumulation issue for small diameter pipes

(3) Design standard

The design is based on the IRC standard in principal. For detailed design stage, it shall be designed based on IRC standard.

Major codes regarding to drainage design is referred to bridge design. The additional codes and typical drawings for drainage design is as follows.

Table 8.2.13 List of major codes for drainage design

IRC:SP: 13-2004	Guidelines for the Design of Small Bridges and Culverts (First Edition)
IRC: SP:42-2014	Guidelines on Road Drainage (First Edition)
MORTH	Standard Plans for Single, Double and Triple Cell Box Culverts with and without Earth Cushion
IS458 (2013)	Precast Concrete Pipes (with and without Reinforcement)

Source: JICA Study Team

Figure 8.2.8 **An example of existing slab culvert**

Figure 8.2.9 **An example of existing slab culvert (narrow inner width)**

Figure 8.2.10 **An example of existing pipe culvert**

(4) New drainage design

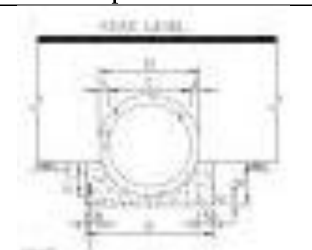
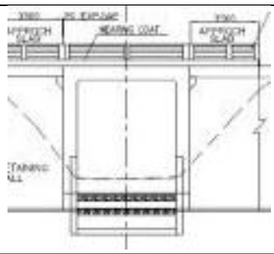
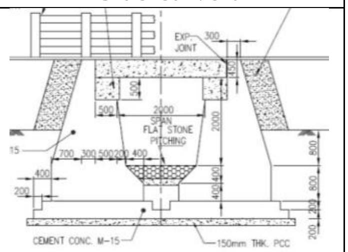
(a) Cross drainage structure

The structural type of cross drainage is classified as pipe culvert, BOX culver and slab culvert. Pipe culvert is most appropriate structure where the water discharge is comparably small. It has advantage for economy, provision of quality because of precast manufacturing for RC pipes. BOX culvert is appropriate where the water discharge is more than pipe capacity. Because BOX culvert is composed from all RC structure, it is reliable to keep durability and construction quality more than slab culvert which is composed from slab plate and masonry abutment.

In such reason, BOX culvert was applied to World Bank Road which is neighbor of NH54 constructed few years before.

Each type of culverts is compared in table below.

Table 8.2.14 Comparison for culver type

	Pipe culvert	BOX culvert	Slab culvert
Layout			
Economy	◎	○	△
Construction ability	◎	○	△
Durability	○	○	△
Capacity	○	◎	◎
Comment	To be applied for small discharge point	To be applied for large discharge point	Not applied

Source: JICA Study Team

Hence, pipe culvert is proposed where the water discharge is comparably small. BOX culvert is proposed where the water discharge is comparable large. The size is determined to satisfy the water discharge obtained by hydrological calculation.

The contents of pipe culvert and BOX culvert is explained below.

・Culvert length from inlet to outlet is 12m which is same as the road width in general section. However, it shall be widened to match with widening in curve section.

・BOX culvert is based on the IRC standard drawings. Approach slab is needed for approach part. RC railing is needed at kerb at both side. The size of 2mx2m to 4mx6m is planned to arrange to fit to satisfy the capacity for discharge.

・Pipe culvert is type of NP4 based on IRC:13. It is based on the standard of IS458: Precast concrete pipes. The size of diameter 1.2m is planned to arrange to fit to satisfy the capacity for discharge.

・At inlet of the culvert, catch pit is required. For the section of excavation at slope side, the chute is required.

・At outlet of the culvert, gabion is required to protect an erosion by the flowing water at hill slope.

・The headwall is required to retain earth at inlet and outlet. It should be considered with retaining wall at back and forth side.

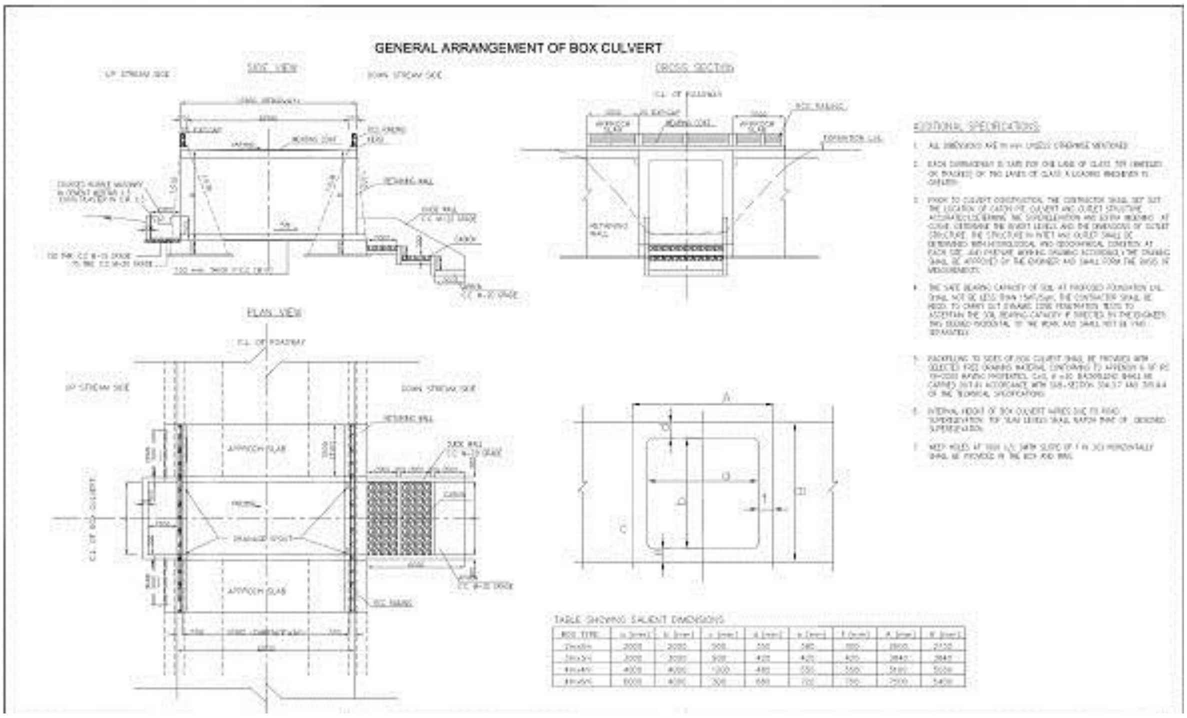
The capacity for each size of culverts is summarized in table below.

Table 8.2.15 Capacity for each size of culverts

	Size	A(m2)	n	i (%)	Capacity (m3)	Applied condition
Pipe culvert	ϕ 1.2m	1.028	0.013	5.0	4.17	Flowing full condition
BOX culvert	2mx2m	4.000	0.033	5.0	15.88	Flowing full condition
	3mx3m	9.000	0.033	5.0	36.19	Flowing full condition
	4mx4m	12.400	0.033	5.0	95.71	Open section with vertical clearance of 0.9m
	4mx6m	18.600	0.033	5.0	166.95	Open section with vertical clearance of 0.9m

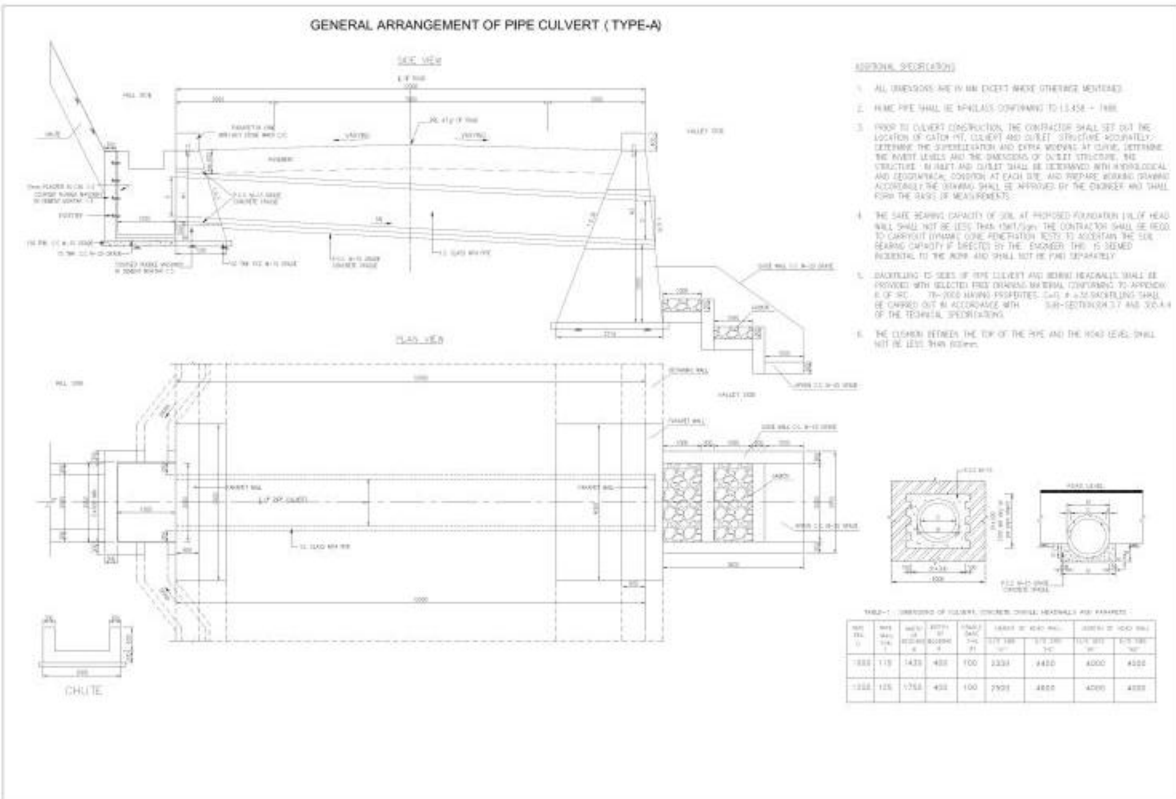
Source: JICA Study Team

General arrangement plan for BOX culvert and Pipe culvert is shown in figure below.



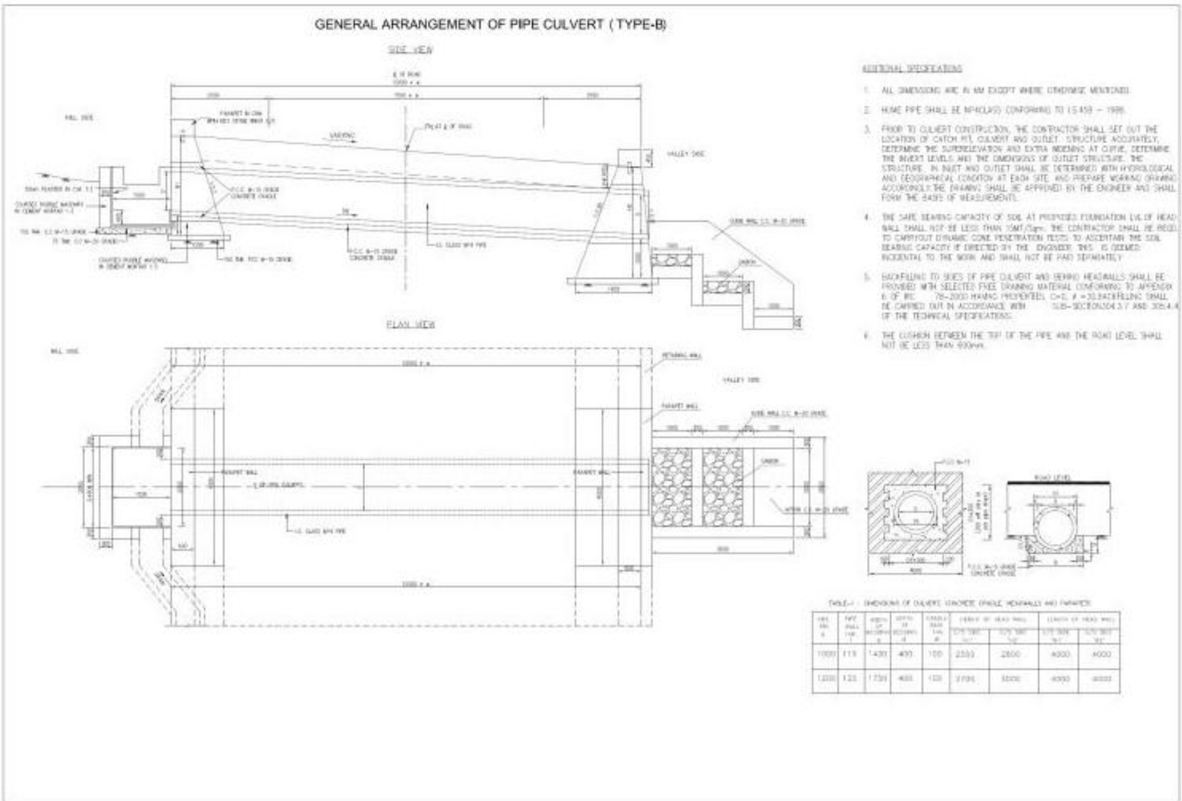
Source: JICA Study Team

Figure 8.2.11 General arrangement plan for BOX culvert



Source: JICA Study Team

Figure 8.2.12 General arrangement plan for pipe culvert (Type-A)



Source: JICA Study Team

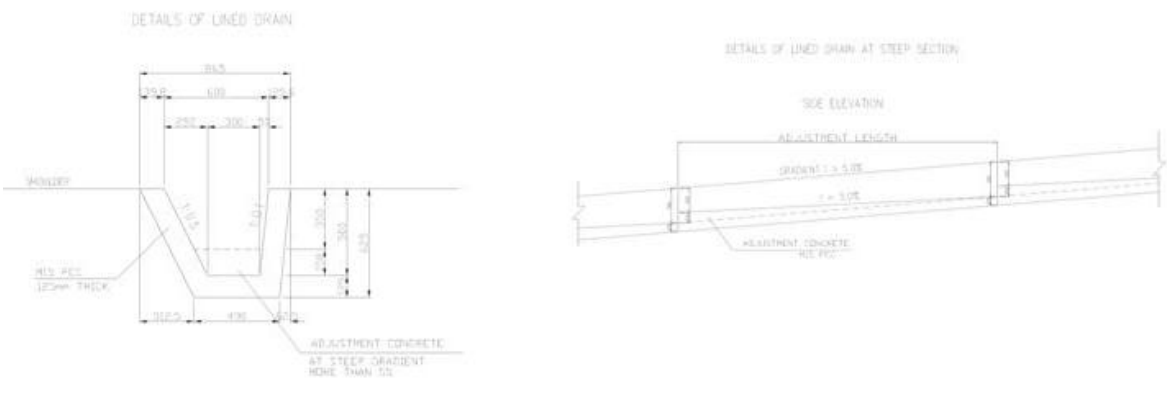
Figure 8.2.13 General arrangement plan for pipe culvert (Type-B)

(b) Side ditch structure

The side ditch on road is designed as concrete lined ditch for all section of cut side.

The sub-surface drain is designed under side ditch to deal with underground water properly.

General arrangement plan for side ditch is shown in figure below.



Source: JICA Study Team

Figure 8.2.14 General arrangement plan for side ditch

(c) Drainage arrangement plan

The cross drainage arrangement is planned with following policy.

(i) The cross-drainage which has capable dimension for the estimated discharge is arranged at the location where the crossing water estimated by hydrological map computation.

(ii) The location of existing culvert is high possibility of crossing water flowing. Hence, a pipe culvert 1.2m is planned at all location of existing culvert even the crossing water is not appeared by hydrological map computation.

The existing culvert location is based on topographical surveyed map prepared by DPR.

(iii) Side ditch capacity is not satisfied if an interval between cross-drainages is too long. Hence, a pipe culvert 1.2m is planned to complement the long interval to shorten to 300m in maximum.

The quantity of each culvert for each section is summarized in table below.

Table 8.2.16 Quantity for each culverts

	Quantity for NH51
Pipe culvert 1.2m	287
(TYPE-A)	115
(TYPE-B)	172
BOX culvert 2x2m	6
BOX culvert 3x3m	1
BOX culvert 4x4m	5
BOX culvert 4x6m	0
Total	299

Source: JICA Study Team

8.2.8 Traffic Safety Facilities Plan

8.2.8.1 Scope of Traffic Safety Facilities

Traffic safety facilities are to be provided on roads or roadside to secure safety of all road users as well as nearby residents. In this Study, considering road function of rural roads and usage situation of the target roads, facilities listed in Table X are discussed for application to the Project.

Table X　　Traffic Safety Facilities to be Applied for NH51

No.	Item	Remarks / Related Code
1	Traffic Sign	IRC67-2001, IRC7-1971, IRC-SP-31-1992
2	Road Marking	IRC35-1997, IRC-SP-31-1992, IRC2-1968
3	Road Delineator	IRC79-1981
4	Guard Rail	
5	Street Furniture (Blinker, Road Stud/Cats Eye)	MoRTH's Research Project R-63

Source: JICA Study Team

8.2.8.2　Traffic Safety Facilities proposed in DPR

JICA Study Team received some documents that constitute DPR of the target roads, though they are not necessarily a full set of the documents. Table X summarizes traffic safety facilities that are considered being proposed in DPR.

Table X　　Traffic Safety Facilities proposed in DPR for NH51

ITEM	NH51
Traffic Sign	To be provided in accordance with IRC67. No detailed quantities are available in Report.
Road Marking	Center line, Edge line, Continuity line, Stop line, Give-way line, Diagonal/Chevron, Zebra crossing and Parking areas No detailed quantities are available in Report.
Road Delineator	To be provided in accordance with IRC. No detailed quantities are available in Report.
Guard Rail	To be provided. No detailed quantities are available in Report.
Street Furniture (Blinker, Road Stud/ Cats Eye)	To be provided. No detailed quantities are available in Report.

Summarized by JICA Study Team

8.2.8.3　Approach for Traffic Safety Facilities Plan

The objectives of preparation of traffic safety facilities plan in this Study are to confirm facilities proposed in DPR and to propose alternative plans where necessary. Furthermore, it will become a part of the basis of the project cost estimate. However, since the documents are available only partially, some information is still missing as shown in Table X.

In this Study, every effort is made to consider facilities in the similar manner as DPR in case where they are clear and reasonable. The quantities are estimated by assuming various conditions. Therefore, it shall be noted that further examination shall be made in the next stage, that is, modification of DPR based on their design basis.

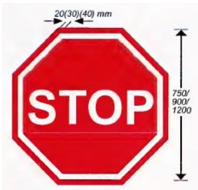
8.2.8.4 Traffic Sign

Traffic signs are to be installed to promote road safety and efficiency by providing the orderly movement of all road users in both urban and non-urban areas. Road signs notify road users of regulations and provide warning and guidance needed for safe, uniform and efficient operations.

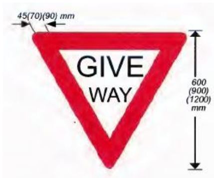
IRC:67-2012 stipulates three types of traffic signs, namely, 1) Mandatory/Regulatory Signs, 2) Cautionary/Warning Signs, and 3) Informatory/Guide Signs.

Figure X shows some of typical traffic signs to be installed for the target roads.

Mandatory/Regulatory Signs



Stop



Give Way

No Overtaking


No Parking

Cautionary/Warning Signs

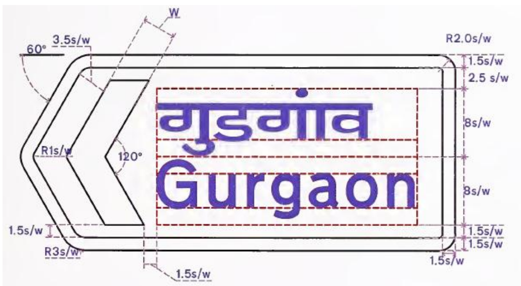

Hair-Pin Bend


Side Road


Narrow Road Ahead


Narrow Bridge Ahead

Informatory/Guide Sings



Flag Type Direction Sign


Toilet

Source: IRC:67-2012 Code of Practice for Road Signs (Third Revision)

Figure X Typical Traffic Signs

In DPR Report, no detailed information is available on the proposed traffic signs.

In this Study, therefore, traffic signs shown in Table X are considered for the whole target road based on unit quantity per kilometer of National Highway No.54 Section-3.

Table X Traffic Sign Estimated for NH51

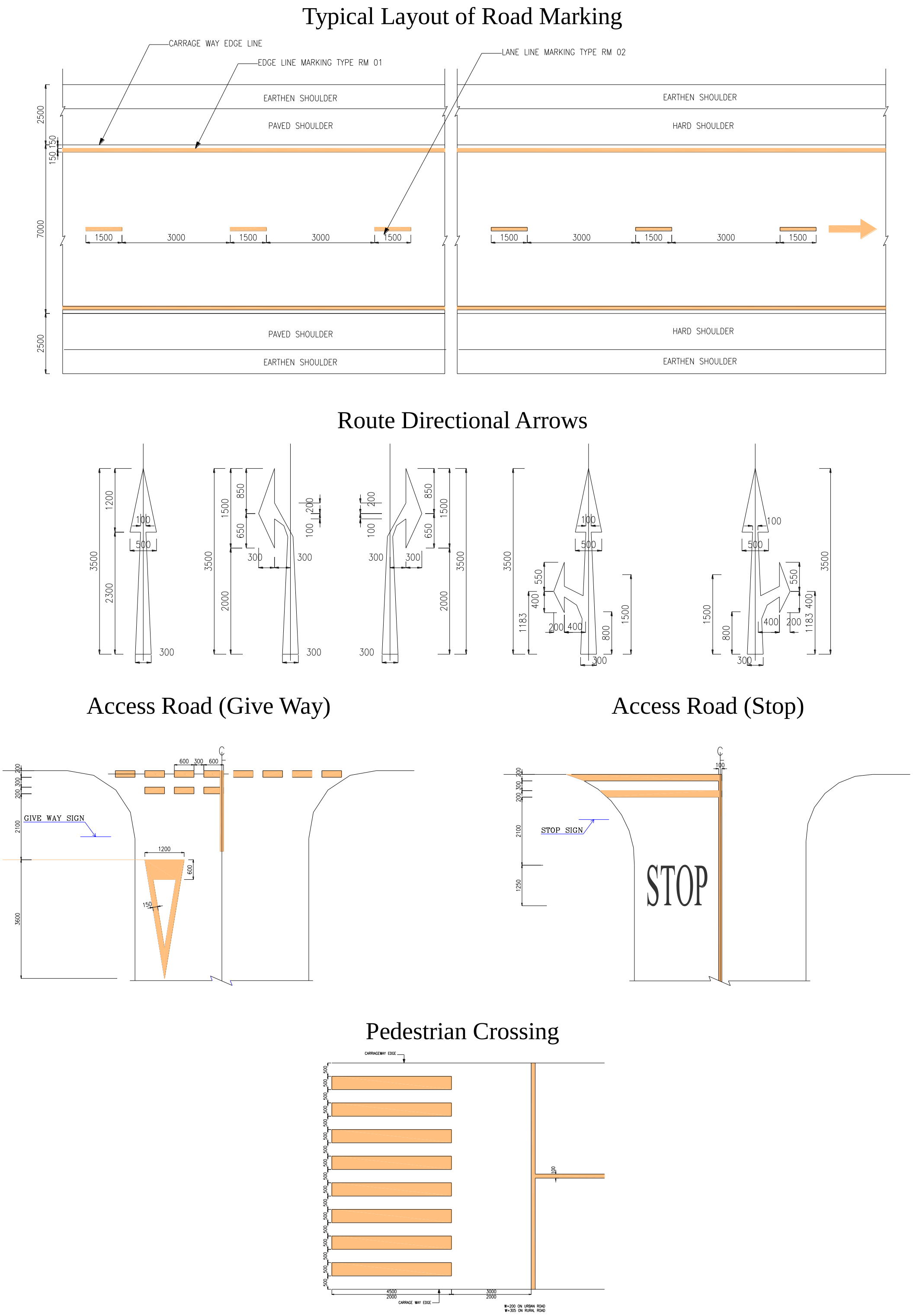
SOR No.	Item	Unit	Number
8.4	Providing and fixing of retro- reflectorised cautionary, mandatory and informatory sign as per IRC :67 made of encapsulated lens type reflective sheeting vide clause 801.3, fixed over aluminium sheeting, 1.5 mm thick supported on a mild steel angle iron post 75 mm x 75 mm x 6 mm firmly fixed to the ground by means of properly designed foundation with M15 grade cement concrete 45 cm x 45 cm x 60 cm, 60 cm below ground level as per approved drawing		
(i)	90 cm equilateral triangle	Each	11
(ii)	60 cm equilateral triangle	Each	24
(iii)	60 cm circular	Each	29
(iv)	80 mm x 60 mm rectangular	Each	22
(v)	60 cm x 45 cm rectangular	Each	24
(vi)	60 cm x 60 cm square	Each	26

Source: JICA Study Team

8.2.8.5 Road Marking

Road markings perform important functions of guiding and controlling traffic on roads. They serve as a psychological barrier and signify the delineation of traffic hazards for safe movement of traffic. Traffic markings also channelize, ensure smooth and orderly flow of traffic. Therefore, suitable road markings shall be provided on roads in accordance with IRC:35-1997.

Figure X shows some of typical road markings to be provided for the target roads.



Source: Detailed Project Report for National Highway No.54 Section-2

Figure X Typical Road Markings

In this Study, road marking shown in Table X is considered for the whole target road based on unit quantity per kilometer of 250sqm which is adopted in DPR.

Table X Road Markings Estimated for NH51

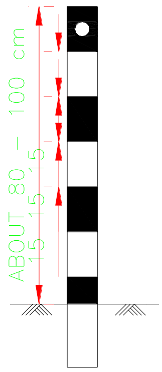
SOR No.	Item	Unit	Number
8.13	Providing and laying of hot applied thermoplastic compound 2.5 mm thick including reflectorising glass beads @ 250 gms per sqm area, thickness of 2.5 mm is exclusive of surface applied glass beads as per IRC:35 .The finished surface to be level, uniform and free from streaks and holes	sqm	13,500

Source: JICA Study Team

8.2.8.6 Road Delineator

Retro-reflective road delineators are to be installed to provide visual assistance for drivers to obtain information on the alignment of the road ahead particularly at night. These are effective at locations involving change in horizontal/vertical geometry and during severe weather condition of heavy rain, fog or snow. IRC:79-1981 stipulates the standards for the post type delineators with retro-reflective units.

Figure X shows typical type of road delineator with circular retro-reflector.



Source: Detailed Project Report for National Highway No.54 Section-2

Figure X Typical Road Delineator

In this Study, road delineators shown in Table X are considered for the whole target road based on unit quantity per kilometer of 0.89 which is derived from DPR.

Table X Road Delineators Estimated for NH51

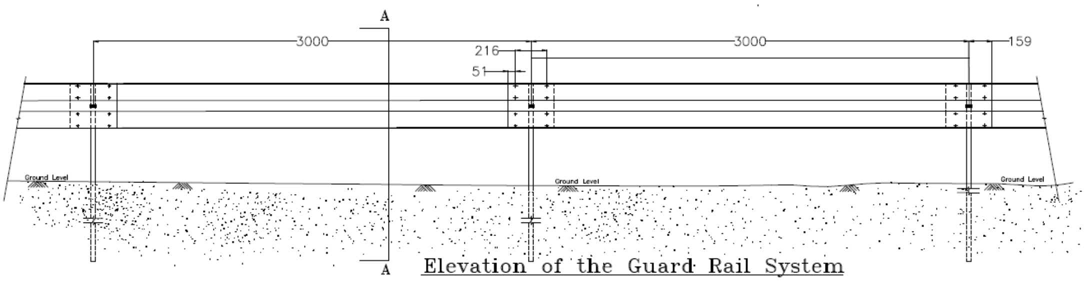
SOR No.	Item	Unit	Number
8.15	Road Delineators (Supplying and installation of delineators (road way indicators, hazard markers, object markers), 80-100 cm high above ground level, painted black and white in 15 cm wide stripes, fitted with 80 x 100 mm rectangular or 75 mm dia circular	each	48

Source: JICA Study Team

8.2.8.7 Guard Rail

DPR adopts single “W” type steel guard rails for selected locations including valley side of curves, high embankment sections, approaches to bridges and built-up areas.

Figure X shows typical single “W” type of guard rail.



Source: Detailed Project Report for National Highway No.54 Section-3

Figure X Typical Guard Rail

In this Study, the unit quantity per kilometer of National Highway No.54 Section-3 is used for the quantity calculation. As a result, guard rails shown in Table X are considered for the whole target road.

Table X Guard Rails Estimated for NH51

SOR No.	Item	Unit	Number
8.23-A	Type - A, "W" : Metal Beam Crash Barrier (Providing and erecting a "W" metal beam crash barrier comprising of 3 mm thick corrugated sheet metal beam rail, 70 cm above road/ground level, fixed on ISMC series channel vertical post, 150 x 75 x 5 mm spaced 2	metre	2,900

Source: JICA Study Team

8.2.8.8 Street Furniture

Street furniture known as road studs, blinker or cat's eye include equipment installed on road or roadside to assist visibility of road alignment/structures. They are retro-reflective safety devices used in road marking. Generally, it consists of two pairs of reflective glass spheres set into a white rubber dome, mounted in a cast-iron housing. This is the kind that marks the centre of the road, with one pair of devices showing in each direction. A single-ended form has become widely used in other colors at road margins and as lane dividers.

In this Study, considering unit quantity per kilometer adopted in DPR, guard rails shown in Table X are considered for the whole target road.

Table X Street Furniture Estimated for NH51

SOR No.	Item	Unit	Number
8.35	Road Markers/Road Stud with Lense Reflector (Providing and fixing of road stud 100x 100 mm, die cast in aluminium, resistant to corrosive effect of salt and grit, fitted with lense reflectors, installed in concrete or asphaltic surface by drilling hole 30 mm upto a depth of 60 mm and bedded in a suitable bituminous grout or epoxy mortar, all as per BS 873 part 4:1973)	each	5,997

Source: JICA Study Team

8.2.8.9 Locations Requiring Special Consideration

(1) Hair-Pin Bends

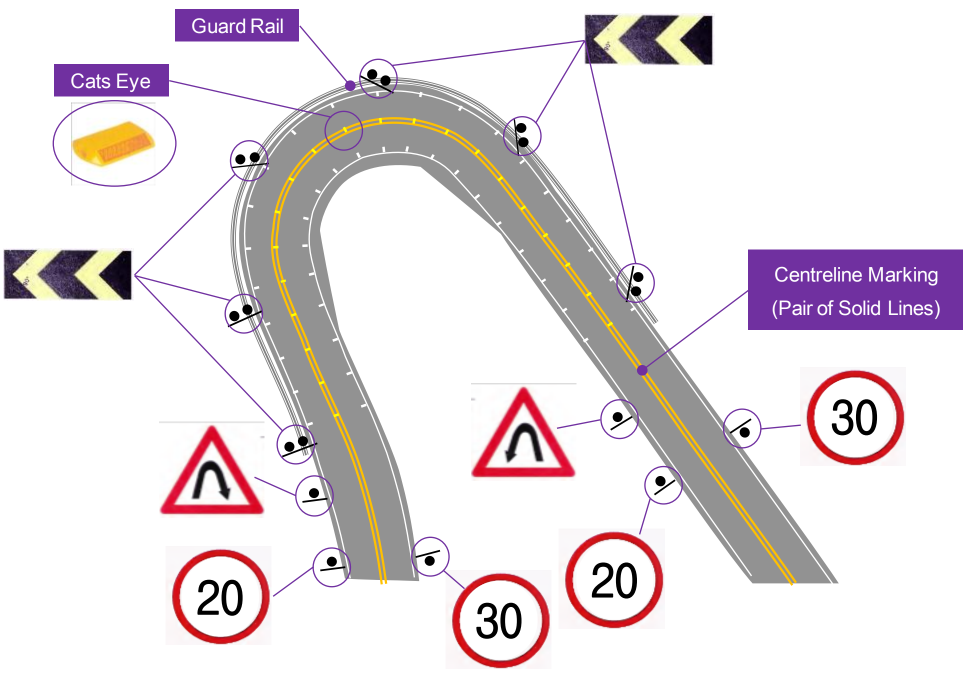
Since the target road is located in mountainous region, hair-pin bends are unavoidable from the viewpoint of cost and environmental impact. Design speed of 20km/h is applied for hair-pin bends, while design speed of 30km/h is adopted in general. Small horizontal curves such as R20m-R25m are used in steep terrain to avoid large-scale earthwork and/or demolition of houses. At those sub-standard sections, securing traffic safety by applying combination of facilities shall be considered.

In hair-pin bends, it is difficult to secure overtaking sight distance and thus, the section shall be designated as no-overtaking section. In order to inform that to drivers, the double centre line with marking of pair of solid lines is applied.

Cats eyes to delineate road alignment are to be installed on the centre line and lane edges so that drivers will be able to identify the direction he should go before entering into the curve.

Furthermore, traffic signs and guard rails shall be properly equipped to avoid hazardous accidents.

Figure X shows an example of combined traffic safety facilities to be installed at hair-pin bends.



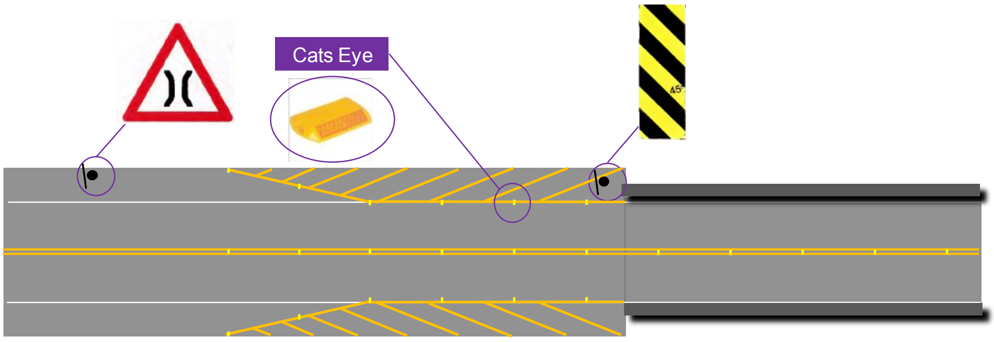
Source: JICA Study Team

Figure X Traffic Safety Facilities to be installed at Hair-Pin Bends

(2) Bridges with Narrow Width

In the locations where the existing bridges are to be utilized with rehabilitation works, carriageway width becomes narrower than that of earthwork sections due to the difference in shoulder width. It is, therefore, proposed to install facilities that notify drivers the decrease in carriageway width and existence of concrete curb.

Figure X shows an example of combined traffic safety facilities to be installed at narrow bridges.



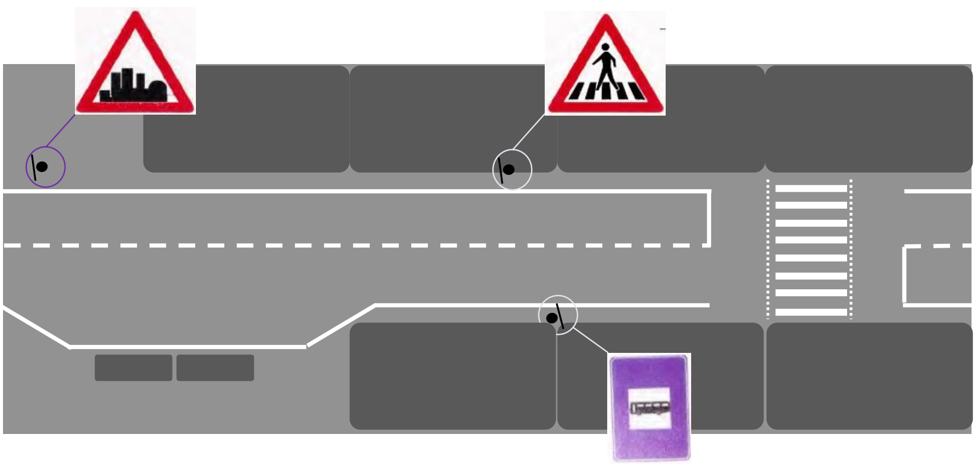
Source: JICA Study Team

Figure X Traffic Safety Facilities to be installed at Narrow Bridges

(3) Built-up Sections

In built-up sections, there are a lot of buildings, shops or houses at roadside as well as pedestrians going along the sidewalk and crossing the road. Furthermore, more kinds of road facilities such as bus stops are necessary than rural sections. Therefore, drivers have to handle much information on roads/traffic and decide their maneuvers in a short time at built-up areas. In order to assist road users in obtaining information, appropriate traffic signs and road markings shall be provided properly.

Figure X shows an example of combined traffic safety facilities to be installed at built-up sections.



Source: JICA Study Team

Figure X Traffic Safety Facilities to be installed at Built-up Sections

8.2.9 Road Appurtenances Plan

8.2.9.1 Scope of Road Appurtenances

Road appurtenances are miscellaneous facilities for road users to take a rest and obtain road-related information as well as for road administrators to maintain their roads efficiently. In this Study, considering road function of rural roads and usage situation of the target roads, facilities listed in Table X are discussed for application to the Project.

Table X Road Appurtenances to be Applied for NH51

No.	Item	Remarks / Related Code
1	Kilometer Stone	IRC8-1980, IRC26-1967
2	Boundary Stone	IRC25
3	Bus Bay	w/Bus Shed, IRC80-1981
4	Road Amenity	Public Toilet, Bazar Shed

Source: JICA Study Team

8.2.9.2 Road Appurtenances proposed in DPR

Table X summarizes road appurtenances that are considered being proposed in DPR.

Table X Road Appurtenances proposed in DPR for NH51

ITEM	NH51
Kilometer Stone	To be provided. No detailed quantities are available in Report.
Boundary Stone	To be provided at ROW boundaries. No detailed quantities are available in Report.
Bus Bay	To be provided at 20 locations.
Road Amenity	To be provided. No detailed quantities are available in Report.
Truck Lay By	No information is available in Report.

Summarized by JICA Study Team

8.2.9.3 Approach for Road Appurtenances Plan

The objectives of preparation of road appurtenances plan in this Study are to confirm facilities proposed in DPR and to propose alternative plans where necessary. Furthermore, it will become a part of the basis of the project cost estimate. However, since the documents are available only partially, some information is still missing as shown in Table X.

In this Study, every effort is made to consider facilities in the similar manner as DPR in case where they are clear and reasonable. The quantities are estimated by assuming various conditions. It is, therefore, noted that further examination shall be made for the modification of DPR based on their design basis.

8.2.9.4 Kilometer Stone

Kilometer stone is one of a series of numbered markers placed along a road or boundary at specific intervals. They are typically located at the side of the road. They are alternatively known as mile stones, mile markers or mileposts. Design of kilometer stones shall be made in accordance with IRC:8-1980.

Table X shows estimated number of kilometer stones for the whole target road.

Table X Kilometer Stones Estimated for NH51

SOR No.	Item	Unit	Number
8.14	Kilo Metre Stone (Reinforced cement concrete M15grade kilometre stone of standard design as per IRC:8-1980, fixing in position including painting and printing etc)		
(i)	5th Kilometre Stone (Precast)	each	10
(ii)	Ordinary Kilometre Stone (Precast)	each	44
(iii)	Hectometer Stone (Precast)	each	216

Source: JICA Study Team

8.2.9.5 Boundary Stone

Boundary stones are to be provided to establish the ROW and those shall be incorporated in the as-built drawings for future use. Design of boundary stones shall be made in accordance with IRC:25-1967.

Table X shows estimated number of boundary stones for the whole target road.

Table X Boundary Stones Estimated for NH51

SOR No.	Item	Unit	Number
8.16	Boundary pillar (Reinforced cement concrete M15 grade boundary pillars of standard design as per IRC:25-1967, fixed in position including finishing and lettering but excluding painting)	each	1,080

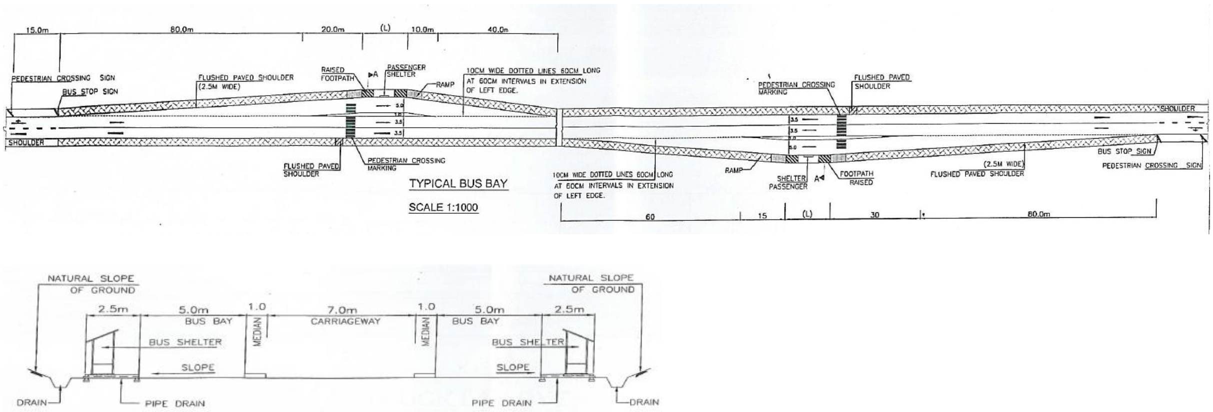
Source: JICA Study Team

8.2.9.6 Bus Bay

Buses standing indiscriminately on the carriageway to drop or pick-up passengers can seriously affect capacity of the roadway, besides being a source of accidents. It is, therefore, desirable that on all busy non-urban highways, consideration should be given to the construction of bus lay-byes of suitable design at required locations to ensure orderly movement of the through traffic.

Since the target road is part of National Highway with a function of important artery of the region, it is recommended to develop bus bays at appropriate locations.

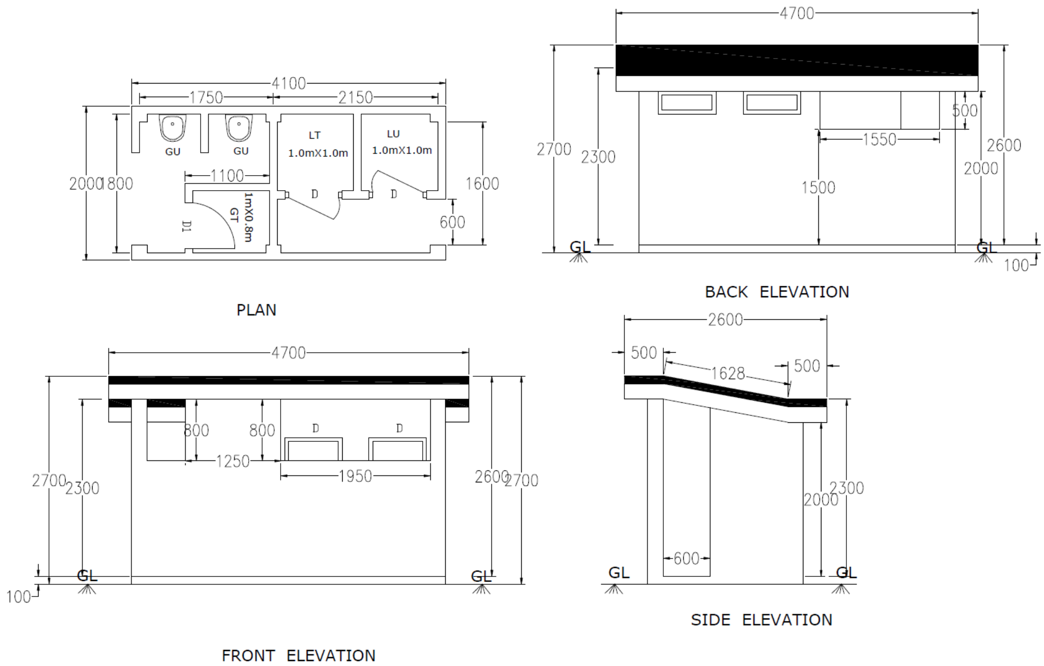
IRC:80-1981 stipulates general requirements for bus bays. DPR has applied the general layout suggested in that standard. This Study also follows the recommendations of IRC and assumes the application of the general plan shown in Figure X.



Source: Detailed Project Report for National Highway No.51

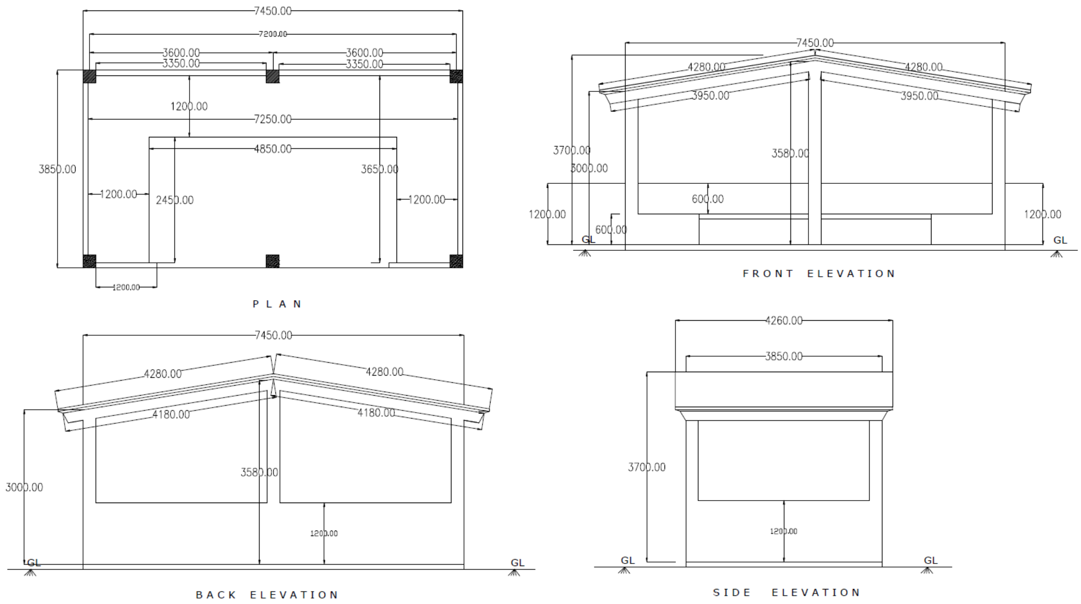
Figure X General Layout for Bus Bays

Road amenities for tourists to use the road comfortably shall be developed at suitable intervals. It is therefore suggested to equip road amenities including public toilets and bazar shed at bus bays. Figures X and X present general view of public toilet and bazar shed proposed in DPR.



Source: Detailed Project Report for National Highway No.54 Section-3

Figure X General View of Public Toilet



Source: Detailed Project Report for National Highway No.54 Section-3

Figure X General View of Bazar Shed

Proposed locations of Bus Bays for NH51 are presented in Table X.

Table X Proposed Bus Bay Locations for NH51

No.	Location	Distance from Babadam (km)	Section Length (km)
1	Babadam	-	
2	Champarea	0.2	0.2
3	Ganol	1	0.6
4	Rongan Hiran	4	3
5	Dap. of Agriculture Rongkhon	6	3
6	Tura	8	2
7	Dadaungiri	19	10
8	Rubber	19	0.2
9	Purakashya	26	7
10	Chokpot	30	4
11	Moropgre	41	12
12	Rengsipara	47	6
13	Rendapara	48	0.8
14	Megupara	55	7
15	Purakhasia	56	0.9
16	Dalu	57	1

Source: JICA Study Team

Notwithstanding the foregoing, considering that DPR proposes installing 20 bus bays for NH51, cost estimate of bus bays and road amenity is made for 20 locations in this Study.

8.2.10 Preliminary Study of Spoil Bank

(1) General

Concerning the result of preliminary design of NH-51 of JST, the necessary volume of spoil bank has been calculated as shown below table where NH-51 at least requires about 268 thousand cu.m capacity to deal with not only balance of cutting and filling but also replacement of soils for soil stabilization.

Table 8.2.XX Required Volume for Spoil Bank

Highway No.	Sec.	Item	Unit	Volume of Generated Soil	Coefficient of Compation	Volume of Compacted Soil	Required Volume of Spoil Bank
				Cu.m		Cu.m	Cu.m
NH51	1	Cut Soil	cu.m	41,840	0.9	37,656	37,656
		Fill Soil	cu.m			0	
	2	Cut Soil	cu.m	77,562	0.9	69,806	29,177
		Fill Soil	cu.m			40,629	
	3	Removed Soil for Replacement	cu.m			201,600	201,600
	Total						268,433

Source: JICA Study Team

(2) Condition of Spoil Bank Selection

JST has been examined to identify target locations where seems to have sufficient and necessary conditions for spoil bank construction. Followings are assumed conditions for suitable locations for that.

❖ To find out suitable place at every 5km length along NH-51 with following condition;
- Ground shape with concavity topography
- Less ground gradient than 22 degree which is assumed as average angle of spoil bank slope with necessary steps
- No built-up area
- No national sanctuary area

❖ To be able to construct the spoil bank in less than 30m height

(3) Result of Examination for Spoil Bank Locations

In accordance with above assumed conditions, 9 locations in 51 km stretch of NH-51 has been totally identified for spoil bank construction having about 342 cu.m capacities. Below table shows the list of that spoil banks with Sta. and capacities.

Table 7.2.XX List of Spoil Banks

No.	Section	Sta.	Capacity of Spoil Bank
			Cu.m
1	Sta. 85-94	88+000	47,120
2	STA.101-143	105+805	4,620
3		110+000	86,190
4		110+550	58,260
5		119+340	16,856
6		124+800	77,440
7		130+800	15,526
8		135+420	22,806
9		139+100	12,883
Total in NH-51			341,701

8.3 Consideration of Climate Change Adaption

As mentioned in clause 7.3, increase of frequency and intensity of heavy rain is concerned with climate change. In NH51, increase of annual rainfall is predicted 5-10% for the period of 2021 to 2050.

The design policy of each item mentioned in clause 8.2 is taken into consideration adaptation measures to the climate change. With increase of the rainfall frequency and intensity, river water and groundwater level are expected to be high, that cause inundation and damage to the road facilities. Therefore, JICA study team checks spring water points carefully and planned subsurface drainage where necessary. And also flood marker was checked in site reconnaissance and interview survey for the disaster countermeasure design.

Table 8.3.1 shows adaptation measures for climate change taken into consideration in this road design.

Table 8.3.1 Adaption Measures for Climate Change in NH51

Factor	Design Policy considering Adaptation
Side Slope	· Retaining wall is built all along the road. · Slope protection work is constructed on some weathered and loosen slopes. · Cut slope is covered with vegetation works to prevent erosion and collapse. · Replacement of subgrade and subsurface drainage are planned as countermeasure against sinking.
Embankment	· Drain filter is sandwiched in embankment. · Flood level is confirmed in site reconnaissance and interview survey near river bank in south of NH51.
Bridge & Drainage System	· Rainfall intensity is carefully determined based on the authorized data : ATLAS of Statewise Generalised ISOPLUVIAL MAPs of Eastern India published by Indian Meteorological Department. The isopluvial value from higher edge of counter range is applied. · The capacity of all structures is determined to be capable for the discharge

	of 50 years return period.
Pavement	· Super elevation is installed properly. · Pavement material is examined not to rise over 60 °C on the surface.
Road Sign	· Wind load and visibility is taken into consideration.

Source: JICA Study Team

CHAPTER 9 INDUSTRIAL POTENTIAL ANALYSIS

9.1 NH54

9.1.1 Present Conditions of NH54 Corridor

(1) **Study Corridor**

The Aizawl – Tuipang road section (approximately 381 km) is part of NH-54, and is located in Mizoram State. Due to its location, the state assumes a prominent importance vis-à-vis the possibility of movement of goods, services & trade with South-East Asian countries. Integration of this road section with the under construction Kaladan project would open up a second major transport link to the North-East region, benefitting the southern part of the region.

For the present context, the Study Corridor is considered as an area abutting the road section (NH54) under study, where the influence of the road improvement can be felt by way of supporting the overall economic activities in the corridor. It may be observed (Fig. 9.1.1.1) that the study road alignment runs almost through the entire state and traverses through or close to all the districts of Mizoram state. Thus all the 8 districts falling in Mizoram State has been considered to fall in the influence zone of the corridor. A brief description of the 8 districts is set out in Table 9.1.1.1

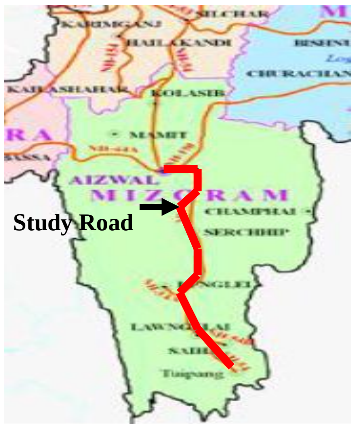


Fig 9.1.1.1: Study Corridor – NH54

In the following part of this chapter, the natural conditions prevailing in the Study Corridor, the economic activities (prevailing & potential) in Mizoram state as well as in the 8 districts has been studied and analyzed.

Table 9.1.1.1: Description of Districts falling in Study Corridor of NH54

District	Description
Aizawl	Situated between the Tlawng River valley in the West and Tuirial River valley in the East. It is home to the Mizo tribes who are said to have migrated from Myanmar's Chin Hills 300 years ago. Being the capital city of Mizoram it is a political, commercial, educational and cultural hub of the state, housing all important government offices, the State assembly and secretariat, and tourist spots, including some beautiful churches and markets.
Lunglei	It is the biggest district (21.52 % of the total land area) bounded on the north by Mamit and Serchhip Districts, on the south by Lawngtlai and Saiha districts, on the east by Myanmar and on the west by Bangladesh, having dense forest area covering 524.63 sq.kms.
Champhai	Located near the India-Myanmar border, it serves as a gateway of all business activities between India and Myanmar. It is a fast developing venue on the Indo-Myanmar border. The famous Rihdil Lake is only about 50 kms away from the town of Champhai. Champhai valley known as "The Rice bowl of Mizoram" is located towards the base of the town. A chain of green hills encircle luxuriant rice fields, which add to the beauty of this place.

Lawngtlai	Located in the southern most part of Mizoram having common international borders with Bangladesh in the west and Myanmar in the east. It also shares common boundaries with Lunglei and Saiha District in the north and south respectively. Unlike other districts, it has two Autonomous District Councils within the District, namely the Lai Autonomous District Council (LADC) and the Chakma Autonomous District Council (CADC) with their headquarters at Lawngtlai and Kamalanagar respectively, and are administered in accordance with the provisions of the Sixth Schedule of the Constitution of India.
Mamit	Mamit District was created after bifurcation of the erstwhile Aizawl District in 1998. It is bounded on the north by Assam state, on the west by Tripura state and Bangladesh, on the south by Lunglei district, and on the east by Kolasib and Aizawl districts. It is 4th largest district in Mizoram in terms of total area. It receives abundant rainfall. The five main big rivers are Tlawng, Tut,Teirei, Langkaih and Khawthlangtuipui. Women Play major role in the society as well as in the family.
Kolasib	The District is bounded by Assam on the north and north west side, on the south and east by Aizawl, and on the south west by Mamit District. The location of the district occupies an important site as it is the main stream of road communication from other state of Mizoram. NH 54 passes through the middle of the district from north to south direction. The only Rail head in the state located at Bairabi. There are some worth visiting sites in and around the district which include Dampa Wildlife Sanctuary and Tlawng River.
Serchhip	Serchhip is located in the central part of the state of Mizoram; adjoined by Champhai District in the East, Aizawl in the North and North West, and Lunglei District in the South. The district has the highest literacy all over India. It lies between the two very important rivers of Mat and Tuikum. While River Tuikum is source for drinking water for Serchhip, River Mat is source for irrigation water for Zawlpui, the rice bowl of Serchhip. Serchhip is also the main producer of cabbages and mustards in Mizoram.
Saiha	Saiha District is situated on the southern-most fringe of the North-eastern region of India and shares border with Myanmar on the eastern and southern side. Administratively, it is divided into two blocks-Saiha and Tuipang. It is the third most developed and also the third most populous town in Mizoram State apart from the state Capital - Aizawl and Lunglei. It is also the capital of the third largest tribe - the Maras in Mizoram.

(2) **Natural Condition**

Mizoram is a mountainous region sandwiched between Myanmar in the East and South, and Bangladesh in the West, occupying great strategic importance in the north-eastern part of India. It has a total of 722 Km. boundary with Myanmar and Bangladesh. It has steep hilly terrain separated by rivers, creating deep gorges between the hill ranges. The average height of the hill is about 1000 meters. The highest peak in Mizoram is the Blue Mountain (Phawngpui) with a height of 2210 meters. It is generally cool in summer and not very cold in winter. During winter, the temperature varies from 11ºC to 21ºC and in summer it varies between 20ºC to 29ºC. It rains heavily from May to September and the average rainfall is 254 cm, per annum. The average rainfall in Aizawl is 208 cm, and Lunglei has 350 cm. Mizoram has great natural beauty and endless variety of landscape and is also very rich in flora and fauna. Almost all kinds of tropical trees and plants thrive in Mizoram.

(3) **Socio-Economic Conditions**

(a) Demography & Social Condition

The population of Mizoram is 1091014 (according to 2011 census) and is scattered over an area of 21027 sq. km, consisting of 8 districts, 26 blocks and 817 villages. The State has the density of 52 persons per sq. km. The decadal growth rate of the population of the State has been observed at 22.78% over the period 2001-2011. The sex ratio of Mizoram is at 975 females to 1000 males, which is higher than 940 the average all India figure. The literacy of the State is 91.58% (93.35% Male and 89.27 Female) as compared to average all India literacy rate of 74.04% (82.14% Male and 65.46% Female). The district-wise population and social parameters are presented in Fig. 9.1.1.2.

District	Population (2011 Census)	Pop. Growth (%) 2001-2011)	Area (Sq Km)	Sex Ratio	Literacy (%)	Density	Pop.* (2014)
Aizawl	404054	24.07	3577	1009	98.50	113	431062
Lunglei	154094	12.29	4572	944	89.40	34	159547
Champhai	125370	15.66	3168	981	93.51	39	130963
Lawngtlai	117444	59.53	2519	945	66.41	46	135109
Mamit	85757	36.59	2967	924	85.96	28	94166
Kolasib	83054	25.92	1386	956	94.54	60	89000
Serchhip	64875	20.45	1424	976	98.76	46	68599
Saiha	56366	-7.68	1414	978	88.41	40	55031
Mizoram	**1091014**	**22.78**	**21027**	**975**	**91.58**	**52**	**1163476**

Fig 9.1.1.2 : Districts of Mizoram

Source: www.census2011.co.in

** Projected/ extrapolated by Study Team on the basis of the past growth rate

It may be observed from the above that more than one-third of the population of the state is concentrated in Aizawl district, which also has the highest population density among the districts. Saiha with the lowest number of people (56366) has shown a negative growth in the decade 2001 – 2011. The highest decadal increase (59.53%) of population was observed in Lawngtlai district. With 28 persons per sq km, Mamit district has the lowest population density.

The sex ratio has been observed highest (1009) for Aizawl district and lowest (924) for Mamit district. The percentage of literate people is highest at 98.76% in Serchhip district and lowest at 66.41% in Lawngtlai district of Mizoram state.

(b) Economy

Economic Growth

As per the data available, the Net State Domestic Product (NSDP) for the year 2012-13 was about Rs 7556 Crores, and the Per Capita Income (PCI) during the same period was Rs. 63413. It has also been observed that during the period 2004-05 to 2012-13 the economy of the state grew at a compound annual growth rate of 9.30%, with Primary Sector growing at 7.64%, Secondary Sector at 7.87% and the Tertiary Sector at 10.30%. During the same period the per capita income of the state grew at 6.77%. The sector-wise growth rates as well as the growth of PCI are summarized in Table 9.1.1.2.

Table 9.1.1.2: Economic Growth of Mizoram State

Sector	CAGR (2004-05 to 2012-13)
Agriculture & Allied – P (Primary Sector)	7.64%
Industry - S (Secondary Sector)	7.87%
Services – T (Tertiary Sector))	10.30%
NSDP (Net State Domestic Product)	9.30%
PCI (Per Capita Income)	6.77%

Note: CAGR – Compound Annual Growth Rate

Economic Structure

The structure of Mizoram State economy for the year 2012-13 (at Current Prices) is presented in Fig 9.1.1.3. The major share (60%) of the NSDP is accounted by Service Sector, followed by Secondary Sector (21%) and Primary Sector (19%). It can be observed that the contribution of Manufacturing to the state economy is very low at 4 % of Secondary Sector, which is equivalent to just 0.84% of the NSDP. The contribution of Transport, Storage & Communications was about 2.4% of the NSDP.

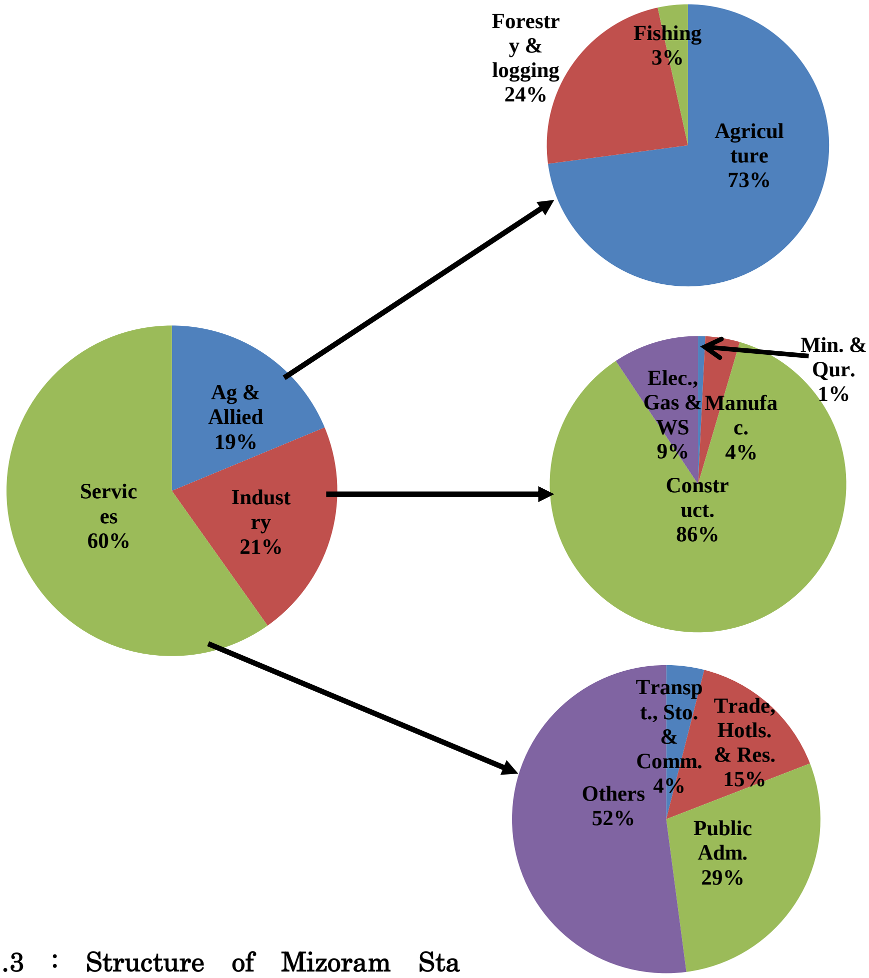


Fig 9.1.1.3 : Structure of Mizoram State Economy

In addition to the above snap-shot view of the economic structure of the State for the year 2012-13 as discussed above, a comparative analysis of the composition of the economic structure (at Constant 2004-05 Prices) over the period 2004-05 to 2012-13 was studied and is presented as Fig.9.1.1.4. It can be observed that the share of Secondary Sector has remained static at 15% over the period 2004-05 to 2012-13. However, the share of Primary Sector has decreased from 25% to 20% and that of Tertiary Sector increased from 60% to 65%.

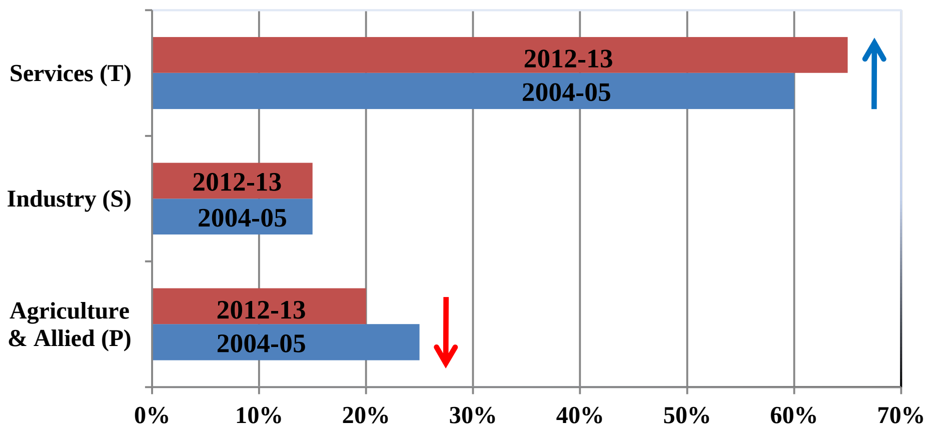


Fig 9.1.1.4: Structural Composition of Mizoram State Economy – 2004-15 to 2012-13

9.1.2 Industrial and Other Potential

(1) General

Mizoram has potential for developing its horticulture and Services Sector as the present economy is 60% dependent on Service Sector, and only 21 % on Industry (Secondary Sector). The potential for manufacturing is in the handloom, handicrafts and paper industries. The state has also developed a new Land-use policy which will have cluster based development. The production of rubber and palm oil can be taken up in a big way in the state. Due to its abundance in the bamboo cultivation there is a big potential of paper industry in the state.

The State also has potential for grapes, banana, large cardamom, ginger, pine apple and other horticulture products but the marketing chain has obstructed its growth. Once the Kaladan route is operationalised then these products will find markets in other Indian states.

(2) Thrust Areas of "The Mizoram Industrial Policy 2012"

In view of the hilly terrain of the State, underdeveloped infrastructure, and present Entrepreneurship level of the people, there is limited scope for development of large enterprises, so the policy is to encourage Medium & Small Manufacturing Enterprises (MSME) that has good cope of employment.

Thrust will be given for those industries based on value addition of locally available resources. Special incentives are available for speedy development of industrial units engaged in any of the following thrust sector Enterprises.

Forest-based Industries	The vast bamboo and other forest resources of Mizoram can be optimally harvested for setting up of industries for manufacturing of various high-value bamboo and other forest based products
Food Processing Industries	Primary production of various food items, whether agricultural based, horticultural or livestock based, shall be linked with processing Industries. Contract farming or management participation route to be encouraged to ensure proper supply chain management. Considering high cost of transportation, giving priority and favourable treatment to processing with high value content is a crucial element of food processing policy

Handloom Industries	Handloom sector shall continue to receive serious attention of the Government for improving quality product by introducing improved design, packaging, branding. Presence of innate designing skill of womenfolk in rural areas will be utilized for enriching the industry
Plantation of Fibre and Hill Brooms	Encouraging value addition and branding of hill-brooms to secure advantage in marketing the products outside the state. Cultivation of broom grass to be properly linked with the processing Industries so that the farmers will reap maximum benefit. Existence of large quantity of plantation gives ample scope towards development of fibre materials for different application.
Tea, Rubber, Palm and Coffee Industry	The climate and soil conditions are favourable for tea plantation. Commercial and scientific tea plantation linked with tea processing Industry to receive attention of the Govt. Rubber, Coffee and Palm based industries to also receive due attention of the Govt.
Textile related industries	Bulk production of readymade garments to be encouraged for market outside the state and exports. Procurement of raw materials and accessories will be arranged through marketing efforts and eventually by way of development of local industries.
Animal Feed and poultry feed Industries	Thrust towards having sufficient meat and meat products for which farming has been encouraged, in addition to encouraging production of sufficient quantity of animal and poultry feeds

Source: Derived from "The Mizoram Industrial Policy 2012"

(3) **Industry**

The natural resources, climatic conditions and policy incentives in the state support investments in bamboo, sericulture, tourism, agro-products and agro-processing sectors. Industrial units in the state primarily comprise of small scale industries. Mizoram has industrial estates at Zuangtui, Sailamkawn, Cahmphai Hmunhmeltha, Bairabi and Pukpui Lunglei.

Mizoram is setting up aSpecial Economic Zone (SEZ) in the Northeast with assistance from the North East Council. The SEZ will be located at Khawnuam village in Champhai. Bamboo-based industries would play a major role in the proposed SEZ.

Mizoram has abundant reserve of bamboo forest covering 1,254,400 hectares, with a yield of 3.2 million tonnes per year. Around 28,315 tonnes of bamboo is harvested per year, a 99 per cent surplus waiting to be exploited. Around 14 per cent of the bamboo stock in the country is available in Mizoram. The state grows 35 varieties of bamboo. The Cachar Paper Mill in South Assam (a unit of Hindustan Paper Corporation) is the largest consumer of bamboo resources of Mizoram. Bamboo Development Agency of the State Government has entered into Joint Venture (JV) with private partners for commercial production of bamboo floor boards, bamboo parquets and bamboo-teakwood doors. The Mizoram Government is keen to invite FDI in bamboo-based industries such as mat-ply, blinds, chopsticks, incense sticks, etc.

Mizoram accounts for about 12 per cent of the total fruits produced in the Northeast India, and the yield per hectare is on the rise because of adoption of modern horticultural practices. With abundant natural resources and supporting policies, the food processing sector offers potential for investment. Allied services such as cold-chain management also provide potential for investment. A Special Purpose Vehicle (SPV) has been formed with private sector companies to set up a plant for processing turmeric, ginger, chilli, fruits and other horticultural products.

The State Government had established one research & training institute at Zemabawk to impart training in sericulture. Mizoram has mineral deposits of shell limestone, siltstone, clay mineral, coal seam, oil and gas. Building-quality stones are exported to Bangladesh. Several agencies are involved in oil and gas exploration in Mizoram and have signed Memorandum of Understanding (MoU) with the State Government. Mizoram has numerous natural water springs and offers potential for manufacturing mineral water.

The state government has so far developed the following Industrial Areas with basic facilities:

- Industrial Estate at Zuangtui, Aizawl, Aizawl District.
- Industrial Estate at Bairabi, Kolasib District.
- Export Promotion Industrial Park at Lengte, Mamit District.
- Bamboo Technology Park at Sairang, Aizawl District.
- Integrated Industrial Development Centre at Pukpui, Lunglei District
- Integrated Industrial Development Centre at Zote, Champhai District
- Industrial Growth Centre at Luangmual, Aizawl District.

The capacity of Industrial Estates in terms of number of plots available is given in Table 9.1.2.1. As on 2011 the average number of plots allotted for the 4 industrial Estates was about 64%, with the highest percentage (87%) being for EPIP, Lengte, followed by Zuangtui (84%), IGC Luangmual (61%) and BTP Siarang (30%). This indicates the need to strengthen activities relating to bamboo, a product that is widely available in Mizoram.

Table 9.1.2.1: Availability of Industrial Plot in Industrial Areas:

Sl. No	Industrial Estate	District	No of Plots	No of Plots Allotted
1.	Industrial Estate, Zuangtui	Aizawl	232	196
2.	Bamboo Technology Park (BTP), Sairang	Aizawl	10	3
3.	Export Promotion Industrial Park (EPIP), Lengte	Mamit	30	26

4.	Industrial Growth Centre (IGC), Luangmual	Aizawl	99	6
Total			**371**	**236**

Source: Statistical Abstract of Mizoram 2011

The district-wise cluster of activities and trade in the project corridor is presented in Table 9.1.2.2. It can be observed that in the clusters the main activities are linked to agriculture and support the villages located in these districts. A good road infrastructure is expected to provide boost to these activities and generate additional income to the villagers.

Table 9.1.2.2: District-wise Cluster of Activities and Trades

District	Major Trades	District	Major Trades
Mamit	i) Animal Husbandry & Veterinary ii) Agriculture iii) Industries	Serchhip	i) Horticulture ii) Agriculture iii) Industries
Kolasib	i) Horticulture ii) Soil & Water Conservation iii) Animal Husbandry & Veterinary	Lunglei	i) Horticulture ii) Industries iii) Agriculture
Aizawl	i) Industries ii) Animal Husbandry & Veterinary iii) Soil & Water Conservation	Lawngtlai	i) Horticulture ii) Agriculture iii) Animal Husbandry & Veterinary
Champhai	i) Horticulture ii) Animal Husbandry & Veterinary iii) Agriculture	Saiha	i) Horticulture ii) Animal Husbandry & Veterinary

Source: Mid Term Assessment Report on NLUP of Government of Mizoram, 2012-13

The number of Small Scale Industrial (SSI) Units under Directorate of Industry and assisted by it, along with the Working Enterprises in Mizoram is presented in Table 9.1.2.3. It is observed that number of SSI units directly under the Directorate has declined over the years, with increase in 2013-14 (214 units) over 2012-13 (122 units), whereas the assisted SSI units by the Directorate has shown increasing trend.

Table 9.1.2.3: SSI Units and Working Enterprises in Mizoram

Year	SSI Units Registered Under Directorate of Industry		No. of SSI Units Assisted	Working Enterprises	Employment
	Numbers	Employment			
2004-05	319	1116	566	NA	NA
2005-06	315	1228	740	NA	NA
2006-07	344	1376	871	3715	26032
2007-08	205	594	161	3941	27616
2008-09	487	4113	-	4419	30965
2009-10	457	3977	-	4919	34469
2010-11	203	1310	1800	5403	37860
2011-12	131	906	1335	NA	NA
2012-13	122	1032	-	NA	NA
2013-14	214	-	-	-	-

Source: Statistical Abstract of Mizoram 2013

The further break-up of the SSI units (registered under the Directorate) into the districts (Table 9.1.2.4) reveals higher concentration of SSI units in Champhai and Aizawl (with drastic reduction in SSI units in Aizawl from 115 units to 29 units, over 2010-11 to 2012-13).

Table 9.1.2.4: District-wise Units Registered Under Directorate of Industries

District	2012-13		2010-11	
	Units	Employment	Units	Employment
Mamit	5	35	3	18
Kolasib	16	118	2	10
Aizawl	29	511	115	814
Champhai	41	206	18	150
Serchhip	3	23	2	12
Lunglei	9	35	32	147
Lawngtlai	14	72	24	92
Saiha	5	32	7	67

Source:Statistical Abstract of Mizoram 2013

In terms of type of industrial units (SSI units under the Directorate), it can be observed from Table 9.1.2.5 that SSI units are engaged in wood products (25.7%), hosiery & garments (22.9%), metal products (15.4%), repairs services (9.4%) and food products (7.0%) account for 80.4% of the total SSI units (214) in the year 2013-14.

Table 9.1.2.5: Number of SSI by Type

(under Directorate of Industry)

	Type of Industry	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
1	Food Production	36	35	17	10	15	15
2	Beverages, Tobacco Production	1	-	-	-	-	-
3	Wool, Silk, Synthetic, Fibre Textile	24	-	3	-	-	-
4	Hosiery & Garment	23	72	32	28	24	49
5	Wood Production	62	55	24	36	29	55
6	Paper Products and Printing	20	23	14	3	2	3
7	Leather Product	3	-	1	-	-	-
8	Rubber & Plastic Product	3	11	10	-	1	1
9	Chemical & Chemical Products	1	21	1	2	1	-
10	Non-Metallic and Mineral Product	5	34	11	7	4	7
11	Metal Product	149	122	34	14	17	33
12	Machinery & Parts except Electrical	-	-	-	-	-	-
13	Electrical Machinery & Apparatus	-	-	-	-	-	-
14	Misc. Manufacturing Industries	42	-	-	5	-	14
15	Water Works and Supply	-	-	1	1	2	-
16	Construction	23	-	-	-	-	-
17	Activities allied to Construction	5	-	-	-	-	5
18	Restaurants and Hotels	3	-	-	-	1	3
19	Education, Scientific & Research Services	13	-	1	-	-	1
20	Medical & Health Services	5	7	4	2	1	2
21	Personal Services	26	-	18	9	11	6
22	Repair Services	26	47	29	14	10	20
23	Services not elsewhere classified	7	-	-	-	-	-
24	Others	10	-	3	-	4	-
	Total	**487**	**427**	**203**	**131**	122	**214**

Source: Statistical Abstract of Mizoram 2013

Planned development of Industry & Industrial Infrastructure is a key to the progress of industry in the NER states. A summary describing the efforts of the various agencies/ programs (other than the Directorate of Industry) for development of industry & infrastructure in Mizoram is set out in Table 9.1.2.6.

Table 9.1.2.6: Agencies Involved in Development of Industry & Industrial Infrastructure in Mizoram

S. N	Agency/ Program	Description
A	Bamboo Development Agency (A Society Constituted by Government of Mizoram)	The Agency has set up Bamboo Technology Park (BTP) at Sairang which is located around 36 km from Aizawl city. Within the Park, 10 nos of industrial plot were developed for use by bamboo based industries on lease basis. BTP is also used for demonstration of bamboo technology and Research and Development purpose. Japan Bamboo Research Team, University of Kyoto has also conducted research on bamboo at BTP. The Agency is responsible for the following schemes under ASIDE (Assistance to States for Developing Export Infrastructure and Other Allied Activities) • Industrial Centre for Export (ICE) at Tlabung (Lunglei District) • Bamboo Industrial Centre for Export (BICE) at Bungthuam (Mamit District) • Export Promotional Industrial Park at Lengte (Mamit) • Export Import Business Training Centre at Zuangtui (Aizwal District) • Skill Development Training -cum- Product Design Centre at Lunglei (Lunglei District)
B	**Zoram Industrial Development Corporation *(ZIDCO)***	ZIDCO is a joint venture of the Government of Mizoram and IDBI (Industrial Development of India). It is responsible for the overall development of industrial infrastructure in the state. The main function of the Company is financing and loan recovery. The company is also venturing into handling of steel and coal; implementation of Integrated Infrastructure Development Center (IIDC) at at Pukpui, Lunglei.
C	**Zoram Handloom and Handicrafts Development Corporation Limited (ZOHANDCO)**	Handloom and handicrafts are the most important and popular industrial activities in Mizoram. Mizoram has highly gifted skilled handloom and handicraft artisans. ZOHANDCO's main objective is to develop, aid, advise, assist, finance, protect and promote interest of handloom and handicrafts unit in the State, whether owned or conducted by the Government, statutory body, company, firm or individuals and to provide them with capital, credit means of resources and technical and managerial assistance for the conduct of their methods of manufacture, management and marketing and their techniques of production.
D	Mizoram Food and Allied Industries Corporation Lt d. (MIFCO)	MIFCO was formed to harness the limited resources endowment of the State, an d nurture its potential for the welfare and well-being of its people. Agro and allied food industries acquire prior ity due to their advantage in terms of high potential for employment generation per unit of investment, the backward and forward li nkages that the development can lead to, the level of demands and capability to absorb and promote local resources, predominantly agricultural and horticultural produce. MIFCO has the following units. • Pork & Poultry Processing Plant, Zemabawk • Food Processing Plant, Sairang (Upgradation/Expansion) • Fruit Juice Concentrate Plant, Chhingchhip. (Upgradation//Expansion) • Food Park, Chhingchhip It is also adding Mega Food Park & Modern Abattoir
		MKVIB Board is a statutory and a promotional body with a power to take up trading and business activities for the benefit of its registered Village Industries units. The Board provides for the better facilities, development

E	Mizoram Khadi & Village Industries Board (MKVIB)	and regulation of Khadi & Village Industries. It is constituted to promote Khadi & Village Industries following the Gandhian principle to uplift village artisans and give employment at their door step. The Board also promotes the following two schemes. (a) **Rural Industries Consultancy Service (RICS):** Board provides RICS facilities for the benefit of Entrepreneurs and artisans by opening RICS at Main Office All Officers of the RICS are ready to help artisan and Entrepreneurs, in their efforts start industries (b) **Prime Minister's Employment Generation Programme (PMEGP): It is a central sector scheme to be administered by the Ministry of Micro, Small and Medium Enterprises (MoMSME). The Scheme is to be implemented by Khadi and Village Industries Commission (KVIC), a statutory organization under the administrative control of the Ministry of MSME as the single nodal agency at the National level. At the State level, the Scheme is implemented through State KVIC Directorates, State Khadi and Village Industries Boards (KVIBs) and District Industries Centres (DICs) and banks.** **List of Applicable Trade under PMEGP Scheme** • **Food Processing Industry** • **Forest and Agro Based Industry** • **Handmade Paper and Fibre Industry** • **Mineral Based Industry** • **Polymer And Chemical Based Industry** • **Rural Engineering and Bio Technology Industry** • **Textile/Service Industry**
F	Tea Board	**The Tea Board undertakes the following main functions.** • **provide scientific & commercial tea plantation by helping small tea growers family forming Small Tea Grower Society / SHG (Self Help Group)** • **assist Tea Nursery & Plantation activities to adopt Scientific & Commercial method & practices** • **implement Tea Board Scheme under provision of Tea Rules – 1954 for various Subsidies to growers after registering them with Tea Board** • **provide subsidy limited up to 25% of Total Cost of Plant & Machinery for Tea Processing Factory**
G	New Land Use Policy (NLUP)	NLUP is the flagship programme of the state Government for economic up-liftment of the people. The main objectives of the programme are summarized as follows. • provide sustainable income to farming families by weaning them away from the destructive and unprofitable shifting cultivation practice • provide urban poor with livelihoods by encouraging small scale industries and petty trades • converging schemes funded by the Government of India to NLUP for better utilization of funds • Land reclamation and forestation • Environment protection and restoration through various means The Industries Department is one of the eight Line Departments selected to implement the NLUP programme. During 2012-13, under Industry Sector of NLUP, 19579 families were assisted.

Source: Taken from various documents

(4) Forest Produce

Table 9.1.2.7 presents the production of major forest products during the period 2004-05 to 2012-13. A significant change in bamboo production and bamboo based products can be observed. In the year 2004-05 about 101 million bamboos was produced and by 2012 the production fell drastically to 113 thousand, whereas the production of broom sticks during the same period increased from 275 quintals to 5787 quintals. This indicates that with the fall in production of bamboos the production of other bamboo products was stopped in favour of broom sticks. It also indicates the need to revive the production of bamboo based products.

Table 9.1.2.7: Production of Forest Products – Mizoram

Year	Teak (Cu. M)	Round Timber (Cu. M)	Swan Timber (Cu. M)	Fire – Wood (Cu.M)	Bamboo (‘000 Nos)	Broom Sticks (Qtls.)	Anchiri (Qtls.)
2004-05	-	-	85	-	100800	275	-
2005-06	-	-	117	-	75200	3375	-
2006-07	-	-	1924	-	72800	4430	-
2007-08	-	-	21311	-	23440	1500	-
2008-09	3672	74	1217	2115	6126	1280	3127
2009-10	-	11	605	5027	4257	9000	1078
2010-11	110	39	1203	7165	3586	1727	-
2011-12	-	6	1461	7468	452	2227	-
2012-13	1681	417	2222	73318	113	5787	-
Division-wise Production during 2012-13							
Aizawl	-	376	283	63768	29	40	-
Kolasib	-	-	140	43	30	3967	-
Mamit	-	-	186	29	3	498	-
Kawrthah (Champhai)	1681	-	192	-	2	1065	-
Thenzawl (Serchhip District)	-	-	506	41	16	15	-
Lunglei	-	-	169	125	1	-	-
Tlabung (Lunglei District)	-	-	-	-	3	60	-
Lawngtlai	-	-	-	-	-	-	-
N. Vanlaiphai (Serchhip District)	-	-	696	683	-	-	-
Champhai	-	-	45	8610	26		-
Darlawn (Aizawl District)	-	41	4	19	3	142	-

Source: Statistical Abstract of Mizoram 2013

(5) **Sericulture**

Sericulture is one of the income generation sources of income in the rural areas of the state. Table 9.1.2.8 presents the information on number of villages & families engaged in sericulture. While the number of families engaged in sericulture activities and area under sericulture plantation has decreased over a period, the number of sericulture villages/ farms has remained almost static. The highest number of activities relating to sericulture is done in Aizawl, followed by Lunglei.

Table 9.1.2.8: Number of Sericulture Villages, Families engaged in Sericulture, Area under Sericulture Plantation and Number of Seri-Farms

Year	No. of ericulture Village	No. of Families ıgaged in Sericulture Activities	Area under Sericulture lantation (Ha.)	No. of ericulture Govt. Farms
2004-05	153	3913	3399	17
2005-06	176	5543	4060	17
2006-07	176	7293	4200	17
2007-08	176	7293	4900	17
2008-09	176	7293	5000	17
2009-10	175	7293	5100	17
2010-11	175	7000	4300	17
2011-12	175	2500	6345	17
2012-13	175	3880	2972	17
District-wise 2012-13				
Mamit	10	194	80	1
Kolasib	15	474	577	4
Aizawl	85	1778	1003	5
Champh	15	419	290	2
Serchhi	10	209	311	2
Lunglei	35	772	660	2
Lawngtl	3	22	47	-
Saiha	2	12	4	1

Source: Statistical Abstract of Mizoram: 2013

The figures relating to production of cocoons and raw silk is presented in Table 9.1.2.9. The silk production activity is more concentrated in Aizawl, Champhai, Serchhip and Lunglei districts.

Table 9.1.2.9: Production of Cocoons, Raw Silk and Seeds Distribution

Year	Production of Cocoons				Production of raw silk (ton)
	Mulberry (MT)	Muga (lakh)	Eri (MT)	Oak Tasar (lakh)	
2004-05	45	5.0	4.0	0.6	4.0
2005-06	47	3.6	4.0	3.0	2.0
2006-07	48	3.6	3.8	1.5	4.0
2007-08	48	2.5	4.0	1.5	4.3
2008-09	55	1.0	4.6	1.2	3.4
2009-10	60	1.2	4.2	0.25	6.5

2010-11	65	2.0	4.0	2.0	8.0
2011-12	190	4.4	10.0	3.2	24.2
2012-13	300	19.18	7.1	1.18	29.67
District-wise 2012-13					
Mamit	43.02	1.23	-	-	71.5
Kolasib	16.4	9.95	1.7	-	63.0
Aizawl	151.5	8.0	3.98	-	186.4
Champhai	31.08	-	-	1.18	103.0
Serchhip	33.24	-	-	-	108.0
Lunglei	24.48	-	1.42	-	150.0
Lawngtlai	-	-	-	-	1.0
Saiha	0.28	-	-		2.1

Source: Statistical Abstract of Mizoram: 2013

(6) **Trade**

There are three LCS in Mizoram, two with Bangladesh and one with Myanmar. The one at Kawrapuchchiah near Tengamukh in Bangladesh is not yet notified but is identified to be developed as an LCS. However the other with Bangladesh at Demagiri, opposite Rangamati in Bangladesh, is functional. The one with Myanmar is Zokhawthar, opposite Rhi in Myanmar. A LCS has been recently notified by the commerce Ministry at Zorinpui in Lawngtlai district on the Kaladan Muti Modal route. However all these are in nascent stages of development and not suited for any major trade partnership. In the year 2011 -12, the betel nuts imports from LCS, Zokhawthar was 40 metric tons with a value of Rs. 1.49 million.

(7) **Mineral Resource**

Being a hilly state, Mizoram is rich in minerals. The figures on production of stone and sand are set out in Table 9.1.2.10. The stone & sand production is mainly concentrated in Aizawl, and in Mamit, Kolasib and Lunglei districts (Table 9.1.2.11).

Table 9.1.2.10: Number of Quarry Permit Issued and Mineral Production

Year	No. of Quarry Permit Issued	Production form Quarry (Stone) (Cu.M)	Rs. in Lakhs	Sand Production (Cu.m)	Rs. in Lakhs
2005-2006	191	NA	NA	NA	NA
2006-2007	164	NA	NA	NA	NA
2007-2008	33	312797.083	37.54	36176.54	18.09
2008-2009	78	418208.316	50.19	118585.26	59.29
2009-2010	48	261488.330	31.38	62611.40	31.31
2010-2011	97	212937.325	85.18	136303.94	68.15

Source: Statistical Abstract of Mizoram 2011

Table 9.1.2.11: District wise Number of Quarry Permit Issued and Mineral Production, 2010-11

District	No. of Quarry Permit Issued	Production form Quarry (Stone) (Cu.M)	Rs. in Lakh)	Sand Production (Cu.m)	Rs. in Lakh
Mamit	4	11087.50	4.43	1980.00	0.99
Kolasib	6	11594.90	4.64	11312.20	5.66
Aizawl	28	171776.725	68.71	67189.04	33.59
Champhai	15	4913.95	1.97	29825.70	14.91
Serchhip	8	4799.70	1.92	5435.00	2.72
Lunglei	31	8294.55	3.32	20562.00	10.28
Lawngtlai	5	470	0.19	-	-
Saiha	-	-	-	-	-
Total	**97**	**212937.325**	**85.18**	**136303.94**	**68.15**

Source: Statistical Abstract of Mizoram 2011

(8) **Tourism**

Tourism is one of the revenue generation sources depending on the availability of good road infrastructure. While there are attractive tourist spots in Mizoram, it accounted for only about 1% of the total tourists (domestic and foreign) visits in NER, during 2013 (Table 9.1.2.12). Thus there is a need to make all possible efforts to increase the visits of tourists in the state by increasing the accessibility and developing/ improving tourism related infrastructure, including road network and condition.

Table 9.1.2.12: Domestic and Foreign Tourist Visits

States	2012			2013		
	Domestic	Foreign	Total	Domestic	Foreign	Total
Mizoram	64,249	744	64,993	63,377	800	64,177
NER Total	6,663,933	66,302	6,730,235	6,135,939	84,820	6,220,759
Study States Total	5,788,152	34,678	5,822,830	5,974,840	42,276	6,017,116
India Total	1,036,346,657	20,731,495	1,057,078,152	1,036,346,657	20,731,495	1,057,078,152

Source: India Tourism Statistics 2012, Ministry of Tourism, Govt. of India.

The important tourist attraction points/ locations in Mizoram is shown in the map placed in Fig 9.1.2.1, along with a brief description of theses spots.

Aizawl: It is a hill station at 3715 ft. above sea level, having fair temperature throughout the year. It is surrounded on the east by deep green valley of river Tuirial, on the west by river Tlawng, on the north protected by high hills of Durtalang.
Bung, Paikhai, Sairang, Tamdial Lake & Hmuifang: Picnic spots with adequate facilities
Vantawng: The highest waterfall in the state, surrounded by a lush green tropical forest filled with bamboo groves.
Champhai Town: Virgin forest with view of the hills of Myanmar and has interesting village life. It is also a Trade Center between India and Myanmar and the rice bowl of Mizoram.
Dampa Wildlife Sanctuary: Tiger Reserve with an area of 500 sq. km along the international border.
Murlen National Park: Full with wildlife such as Tigers, Chamber Deer, Himalayan Bear, Barking Deer, Serow and birds
Lunglei Town: Hill station with natural landscape, cool and pleasant climate, rich flora. The remains of the British Missionaries and the first church of Mizoram are located there.
District Park Zobawk: An archetype place for the tourists craving for nature.
Chhimtuipui: Located at 4020 feet, ideal Hill Station for tourists looking for solitude and clean air.
Kolodyne River: the biggest river in Mizoram, having its source from the eastern Myanmar after flowing through Chhimtuipui District enters in the Bay of Bengal near Myanmar.

Fig 10.1.2.1: Tourist Sport in Mizoram

Phawngpui National Park: The highest mount in the state at 2157 mts with an area of 3000 sq. meters, this park is rich in Flora and Fauna. Its' a home for Tigers, Sambar Deer, Hoolog Gibbon, Barking Deer, Bear, Serow and birds.
Palak Lake: An oval shaped lake, the biggest in the state, surrounded by thick forests rich in Flora and Fauna (including Wild Elephants). Various types of water lilies and birds have nested in these plants cover a large part of the waterfronts.

9.2 NH51

9.2.1 Present Conditions of NH51 Corridor

(1) Study Corridor

The Tura – Tuipang road section (approximately 54 km) is part of NH-51 and is located in Meghalaya State. Due to its location the state assumes a prominent importance vis-à-vis the possibility of movement of goods, services & trade with Bangladesh and Assam State, and beyond to rest of India.

For the present context, the Study Corridor is considered as an area abutting the road section (NH-51), where the influence of the road improvement can be felt by way of supporting the overall economic activities in the corridor. It may be observed (Fig. 9.2.1.1) that the road alignment runs almost through the south-west part of the state and traverses mainly through South Garo Hills district and close to the other two districts, viz., West Garo Hills and East Garo Hills in Meghalaya state. On 24th of March, 2012, East Garo Hills District was further bifurcated to form the new district of North Garo Hills. However for the purpose of this study and the availability of data, North Garo Hills district has been considered as a part of East Garo Hills district.

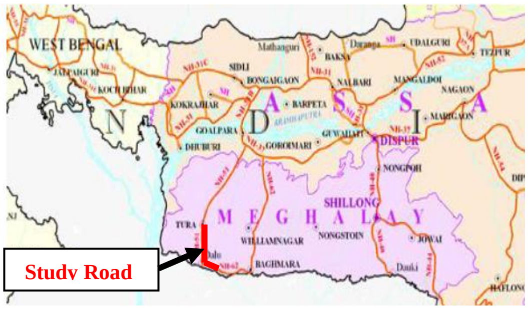


Fig 9.2.1.1: Study Corridor – NH51

Thus the above 3 districts have been considered as the influence zone of the road corridor. A brief description of the 3 districts is set out in Table 9.2.1.1

In the remaining part of this section, the natural conditions prevailing in the Study Corridor, the industrial and other economic activities (prevailing & potential) in Meghalaya state as well as of the 3 districts has been studied and analyzed.

Table 9.2.1.1: Description of Districts falling in Study Corridor of NH-51

District	Description
South Garo Hills	The district lies in the southern part of the state of Meghalaya with its headquarter at Baghmara, the only town in the district. It is situated between 25˚10’ and 25˚35’N latitudes and 90˚15 and 91˚0’ E longitude. It covers an area of 1887 sq. Km. It is bounded in the North by East Garo Hills, in the East by the west Khasi Hills district, in the West by West Garo Hills district and in the South by Bangladesh. The major mineral resources include Coal, Limestone, Uranium, Quartz, etc.
West Garo Hills	West Garo Hills is one of the largest districts of Meghalaya, having its headquarters at Tura, the second largest town after Shillong. It is situated on the western part of the state of Meghalaya bounded by the East Garo Hills district on the east, the South Garo Hills on the south-east, the Goalpara district of Assam on the north and north-west and Bangladesh on the south. The district is approximately between the latitudes 90° 30' and 89° 40' E, and the longitudes of 26° and 25° 20' N. The district is mostly hilly with plains fringing the northern, western and the south-western borders.
East Garo Hills	East Garo Hills district is between 25.24ºN & 26.10ºN Latitude and 90ºE & 91.3ºE Longitude. It is bounded by South Garo Hills on the south, West Garo Hills on the west, and East Khasi Hills on the East and North Garo Hills on the north. Its new headquarters (Williamnagar) is a well planned township with all the amenities of a modern town and is the largest growth centers in Garo Hills, next to Tura.

(2) Natural Condition

The State of Meghalaya is situated on the north east part of India. It extends for about 300 kilometres in length and about 100 kilometres in breadth. It is bounded on the north by Goalpara, Kamrup and Nowgong districts, on the east by Karbi Anglong and North Cachar Hills districts, all of Assam, and on the south and west by Bangladesh.

Meghalaya, one of the most beautiful States in the country, is blessed with abundant rainfall, sun-shine, virgin forests, high plateaus, tumbling waterfalls, crystal clear rivers and meandering streamlets. Meghalaya is subject to vagaries of the monsoon. The climate of Khasi and Jaintia Hills is neither too warm in summer nor too cold in winter, but over the plains of Garo Hills, the climate is warm and humid, except in winter. The average annual rainfall is about 2600 mm over western Meghalaya, between 2500 to 3000 mm over northern Meghalaya and about 4000 mm over south-eastern Meghalaya. There is a great variation of rainfall over central and southern Meghalaya. At Sohra (Cherrapunjee), the average annual rainfall is as high as 12000 millimeters, but Shillong located at a distance of about fifty kilometres from Sohra receives an average of 2200 mm of rainfall annually.

(3) **Socio-Economic Conditions**

(c) Demography & Social Condition

According to 2011 Census, the population of Meghalaya is 2961001 and is scattered over an area of 22,429 sq. km. The State has the density of 132 persons per sq. km. The decadal growth rate of the population of the State was 27.82%, over the period 2001-2011. The sex ratio of Meghalaya is 986 females to 1000 males, which is higher than the average all India value of 940. The literacy rate in the State is 75.46% as compared to average all India literacy rate of 74.04%. The district-wise population and social parameters are presented in Fig. 9.2.1.2.

Fig9.2.1.2 : Districts of Meghalaya

District	Population (2011 Census)	Pop. Growth (%) 2001-2011)	Area (Sq Km)	Sex Ratio	Literacy (%)	Density (Persons/ Sq Km)	Pop.* (2014)
East Garo Hills	317917	26.87	2603	972	60.44	122	344241
West Garo Hills	643291	24.09	3677	984	55.76	175	690919
South Garo Hills	142334	33.05	1887	945	57.65	75	156917
Meghalaya	**2964001**	**27.82**	**22429**	**986**	**75.46**	**132**	**3089742**

Source: www.census2011.co.in

** Projected/ extrapolated by Study Team on the basis of the past growth rate

It may be observed from the above table that about 37% of the population of Meghalaya State reside in the 3 districts and it covers about 36% of the total area of the state. Of the total population of the 3 districts, about 58% population is concentrated in West Garo Hills, about 29% in East Garo Hills and remaining 13% in South Garo Hills. In terms of area, West Garo Hills occupies about 45% (of the total area of 3 districts), East Garo Hills 32% and South Garo Hills 23%.

The literacy rate in the 3 districts is less than the average literacy rate (75.46%) of the State. Similarly, the sex ratio is also lower than the state average of 986 (number of female population per 1000 male population).

(d) Economy

Economic Growth

As per the data available, the Net State Domestic Product (NSDP) at current prices for the year 2013-14 was about Rs 18504 Crores, and the Per Capita Income (PCI) during the same period was Rs. 58522. It has also been observed that during the period 2004-05 to 2013-14 the economy of the state grew at a compound annual growth rate of 7.82%, with Primary Sector growing at 2.12%, Secondary Sector at 10.11% and the Tertiary Sector at 8.72%. During the same period the per capita income of the state grew at 4.76%. The sector-wise growth rates as well as the growth of PCI are summarized in Table 9.2.1.2 (the figures are at Constant 2004-05 Prices).

Table 9.2.1.2: Economic Growth of Meghalaya State

Sector	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	CAGR (%)
Agriculture & Allied (P)	14296	15000	15156	14946	15519	15814	15948	16696	16954	17739	2.12
Share to NSDP (%)	24%	24%	22%	21%	20%	19%	17%	16%	16%	15%	
Industry (S)	14465	15737	17949	18671	22071	23300	25667	31951	31438	34978	10.11
Share to NSDP (%)	25%	25%	26%	27%	28%	28%	28%	31%	30%	30%	
Services (T)	29696	32290	34672	36293	41303	44850	50646	54341	56510	65664	8.72
Share to NSDP (%)	51%	51%	51%	52%	52%	53%	55%	53%	54%	55%	
NSDP	58457	63028	67777	69909	78893	83964	92261	102988	104902	118381	7.82
Population`(in 000)	2427	2458	2488	2518	2548	2578	2609	3010	3085	3162	3.06
PCI (INR)	24086	25642	27242	27764	30963	32569	35363	34217	34004	37439	4.76

Source: Derived from Central Statistical Origination. Government of India

Note: CAGR – Compound Annual Growth Rate

Economic Structure

The structure of Meghalaya State economy for the year 2013-14 (at Current Prices) indicates that the major share (53%) of the NSDP is accounted by Tertiary Sector (Services), followed by Secondary Sector (31%) and Primary Sector (15%). It can be observed that the contribution of Manufacturing to the state economy is 4.86 % of the NSDP, and the same figure for Mining & Quarrying is 4.15% and that for Construction activities it is 21.91%.

In addition to the above snap-shot view of the economic structure of the State for the year 2013-14 as discussed above, a comparative analysis of the composition of the economic structure (at Constant 2004-05 Prices) over the period 2004-05 to 2012-13 was studied as per the data presented as Table 9.2.1.2. It can be observed that the share of Secondary Sector has increased from 25% in the year 2004-05 to 30% in 2013-14. During the same period the share of Primary Sector has decreased from 24% to 15%, and that of Tertiary Sector increased from 51% to 55%.

9.2.2 Industrial and Other Potential

(1) **General**

Meghalaya shares a 443kms long international border with Bangladesh and is rich in mineral resources. This combination puts the state in a unique advantage for setting up of industries that can tap the local resources and gain an edge in production at low cost to be competitive. Added to it, the improvement of the road network shall be an added advantage that would support the industrialization process of the areas falling in the influence zone of the improved road network.

(2) **Salient Features of "Meghalaya Industrial & Investment Promotion Policy 2012 (MIIPP - 2012)"**

The salient features of the MIIPP – 2012 is listed below.

- Promoting private enterprises and healthy growth of existing industries by ensuring sustainability of existing business.
- Strictly monitoring the transfer/lease of land to the units on need based and actual requirement basis.
- Creation of New Industrial Areas/ Estates for manufacturing and service enterprises, early completion of Growth Centre
- Enterprises promoted and managed by "Woman Entrepreneur"/physically challenged will get additional 10 % (ten percent) incentives on the State Capital Investment Subsidy.

- 10 Kms towards the State from the International border is declared as "PRIORITY AREA" and enterprises set up within the 10 Kms area will be given special incentives to be known as "Border Area Subsidy".
- Meghalaya Industrial Development Corporation Ltd (MIDC) to be restructured

Potential Areas

The following areas have been declared as potential area in the promotion of industrial activities in the state of Meghalaya.

- Agro & Horticulture Processing Unit: Thrust on the post harvest management
- Processing of Plantation Crops: Processing of tea, rubber, including medicinal plant (into herbal medicine)
- Development of Traditional Handloom & Handicraft.
- Tissue Culture and Bio-Technology: Export oriented Orchid cultivation (Tissue Culture) is given the status of an industry
- Spices Oleoresin and other Essential Oils Units: Export oriented unit on spice oils, oleoresin and other essential oils will be encouraged.
- Animal Husbandry and Meat Processing Industries dairy products including hygienic and scientific processing of poultry, piggery and other meat products.
- Development of Mineral based Industries: The following mineral based industries will be encouraged.
  - ✓ Cement
  - ✓ Lime and hydrated Lime (coal fired)
  - ✓ Precipitated and Activated Calcium Carbonate
  - ✓ Calcium Carbide
  - ✓ Coal briquette and high temperature Carbonization Plant
  - ✓ Low Ash Metallurgical Coke/Coke Breeze
  - ✓ Wall/Floor tiles
  - ✓ Earthen-wares (crockery, novelties etc)
  - ✓ Stone wares (sanitary wares etc.)
  - ✓ Fire bricks
- Electronics & Information Technology: setting up of electronic/IT based industries and complexes in private sector as well as in PPP mode.
- Bamboo/Reclaimed Wood based & Products: setting up of Bamboo/Reclaimed Wood based Industries in rural areas to encourage local entrepreneurs at the village level.

- Hotel/Nursing Homes/Captive Power Generation: setting up Hotels/Nursing Homes/Power Generation units in private sector or in PPP model.

(3) Agriculture

Meghalaya is basically an Agricultural State with about 80% of its total population depending entirely on Agriculture for their livelihood. The total cropped area in the State has increased by about 42% during the last twenty-five years. Food grain production covers an area of over 60% of the total crop area. With the introduction of different crops of high yielding varieties in the mid-seventies, remarkable increase in food grain production has been made. A major breakthrough was achieved when High Yielding Varieties of paddy which is suitable for Rabi season, fitting in the multi-cropping system have been widely cultivated all over the feasible areas of the State. Besides the major food crops of Rice and Maize, the State is also renowned for its Horticultural crops like Orange, Lemon, Pineapple, Guava, Litchi, Banana, Jack Fruits and Temperate fruits such as Plum, Pear, Peach etc. Potato, Ginger, Turmeric, Black Pepper, Areca nut, Tezpatta, Betelvine, Short-staple cotton, Jute, Mesta, Mustard and Rapseed etc. are some of the important cash crops in the State.

Apart from the above, the State has achieved success in the cultivation of non-traditional crops like Tea, Cashewnut, Oilseeds, Tomato, Mushroom, Wheat, etc. New emphasis is laid on pulses, oilseeds and cash crops. An autonomous board is set up to promote plantation crops, pioneering work is being done in tea cultivation, with the State having 253 small tea growers at present. Marketing of agricultural produce is facilitated by establishing Secondary Regulated Markets and building rural godowns.

The production, yield and area under major crops in the year 2011-12 are presented in Table 9.2.2.1. In terms of production and area, rice is the main crop in Meghalaya.

Table 9.2.2.1: Area, Production and Average Yield per Hectare of Principal Crops -2011-12

States	**Meghalaya**			**All India**		
Commodity	**A**	**P**	**Y**	**A**	**P**	**Y**
Rice*	108.9	216.5	1988	44006.3	105301	2393
Wheat	0.4	0.6	1564	29864.8	94882.1	3177
Maize	17.4	26.5	1529	8781.9	21759.4	2478
Small Millets	2.2	1.7	771	798.8	451.5	565
Total Cereals	**128.2**	**245.3**	**1904**	**100292.7**	**242197.1**	**2415**
Gram	0.6	0.4	625	8299.1	7702.3	928
Tur (Arhar)	0.8	0.6	759	4007.4	2654.1	662
Total Pulses	**4.2**	**3.7**	**896**	**24462.2**	**17088.9**	**699**
Total Food grains	**133**	**249.1**	**1873**	**124754.9**	**259286**	**2078**

Ground-nut	–	–	–	5263.7	6963.7	1323
Soyabean	1.1	1.8	1694	10109.1	12213.5	1208
Total Oilseeds	**9.9**	**7.6**	**766**	**26308.2**	**29798.7**	**1133**
Sugar-cane	0.1	0.2	2714	5037.7	361036.6	71668
Jute**	3.9	34.4	1600	809	10735.6	2389

Sources: 1) 58th Fertiliser Statistics 2012-13, Fertiliser Association of India

2) Directorate of Economics and Statistics, Ministry of Agriculture.

Notes: A= Area in '000 hectares; P= Production in '000 tonnes; and Y= Yield in Kg/hectare

*- Cleaned rice; **-'000 bales of 180 kg, each

(4) Horticulture & Agro-Based Industries

The potential for Agro-based industries in the state of Meghalaya is very high. The state produces substantial quantities of oranges, peaches, pineapples, pears, guavas, plums and bananas of superb variety. It also grows plenty of potatoes, tapioca, bay leaves, ginger, maize and jackfruit.

Meghalaya's turmeric, particularly the variety that is grown in Shangpung in the Jaintia Hills, is considered the best in the world. There is enough potential for setting up a starch based processing unit in the State. Plantation crops like coffee, rubber, black pepper and areca nut are also becoming important products. A major breakthrough has been made in tea cultivation and tea gardens have come up in various parts of the State.

One of the areas in which there is tremendous potential for investment and development is food processing. There is ample scope for setting up a large scale fruit processing unit.

(5) Mineral based Industry

Meghalaya with its wealth of mineral deposits has tremendous industrial potential. There are extensive deposits of coal, limestone, granite, clay and other minerals. Table 9.2.2.2 presents information about various mineral resources in the State and the places of occurrence. It can be observed that limestone and coal are the major mineral resources available in the state.

Table 9.2.2.1: Mineral Reserves in Meghalaya

Minerals	Reserve (in million tonnes)				Grades	Major Places of Occurrences
	Proved	Indicated	Inferred	Total		
Limestone	9515	41599	3986	15100	Cement, Metallurgical, and	Cherrapunjee, Mawlong, Ishamati, Shella, Komorrah, Borsora, Bagli in Khasi Hills District, Lakadong, Lumshonong,

					Chemical	Nongkhlieh in Jaintia Hills District, Darrang Era-Aning, Siju and Chokpot in Garo Hills District.
Coal	133.13	-	443.35	576.48	Sub-bituminous with medium to high sulphur	Langrin and East Darrangiri in Khasi Hills District, Bapung in Jaintia Hills District and West Darranggiri in Garo Hills District
Clay (Lithomargic)	-	-	97.0	97.0	White ware, earthen ware, furnace lining, curing soap etc.	Cherrapunjee and Mahadek in Khasi Hills District, Tongseng in Jaintia Hills District, Nangwalbibra and Rongrenggiri in Garo Hills District
Granite	24.0	-	26.0	50.0 million m3	Table top, wall cladding etc	Nongpoh in Ri-Bhoi, Mylliem and Mawkyrwat in Khasi Hills District, Rongjeng in East Garo Hills District
Kaolin	3.20	1.94	0.10	5.24	White ware	Mawphlang, Smit, Laitlyngkot in Khasi Hills District, Thadlaskein, Mulieh Shangpung, Mynsngat in Jaintia Hills District and Darugiri in Garo Hills District
Iron ore	3.60	-	-	-	Low grade	West Khasi Hills and East Garo Hills District
Glass sand	-	-	3.0	3.0	Ordinary glass ware	Laitryngew, Umstew and Kreit in Khasi hills, Tura in Garo Hills District
Quartz	-	0.5	0.5	0.5	Ordinary ceramic grade	
Feldspar	-	-	0.127	0.127	Ceramic grade	Bonsamgiri and Rombhagiri in East Garo Hills District
Silimanite	-	-	0.045	0.045	High temp. furnace lining.	Sonapahar in West Khasi Hills District
Bauxite	-	-	1.45	1.45	Low grade (40%Al2O3)	Sung valley in Jaintia Hills District
Rock phosphate	-	0.015	-	0.015	Low grade(15-30%P2O5)	Sung valley in Jaintia Hills District
Phosphatic Nodule	Nominal				P2O5: 5-15%	Rewak in South Garo Hills District
Gypsum	Nominal				Crystals of salanite variety	Mahendraganj in West Garo Hills District
Uranium	AMD, Govt of India, has established a reserve of 9.22 mt., higher grade 0.104% U2O3 at Domiasiat, West Khasi Hills District					
Base metal /trace metal	1.14% Cu:0.80mt, 1.61%Zn:0.85mt, 1.88%Pb:0.88mt. with traces of Cd, Bi, Ag, Tenor of gold encountered in 3 bore Holes of Tyrsad					

The dispatch of limestone & coal from different regions of Meghalaya is set out in Table: 10.2.2.3 and Table 10.2.2.4. The major dispatch of limestone is from Khasi Hills, followed by Jaintia Hills and Garo Hills. Similar pattern of dispatch is observed for the movement of coal.

Table 9.2.2.3: Dispatch of Limestone from the State

Year	Jaintia Hills (Metric Tonnes)	Garo Hills (Metric Tonnes)	Khasi Hills (Metric Tonnes)
2003-2004	1,90,718	34,768	4,96,264
2004-2005	1,83,091	55,197	4,16,685
2005-2006	5,80,901	51,452	4,11,812
2006-2007	8,88,264	42,383	12,02,080
2007-2008	12,53,947	68,913	7,99,203
2008-2009	14,85,909	69,672	23,20,328
2009-2010	14,97,360	41,687	23,43,106

Table: 9.2.2.4 Dispatch of Coal from the State

Year	Jaintia Hills (Metric Tonnes)	Garo Hills (Metric Tonnes)	Khasi Hills (Metric Tonnes)
2003-2004	39,18,037	10,58,440	4,62,791
2004-2005	36,10,603	11,01,088	6,33,499
2005-2006	38,79,738	11,20,525	5,65,451
2006-2007	40,45,710	11,74,635	5,66,307
2007-2008	43,59,878	13,70,263	8,11,004
2008-2009	28,90,865	15,94,170	10,03,613
2009-2010	37,22,211	15,62,008	4,82,798

(6) **Industry**

To facilitate prospective entrepreneurs in acquiring site for industries, Industrial Estates/ Areas and Export Promotion Industrial Park (EPIP) and Growth Centers have been created and more are likely to come in the near future. The following are the existing Industrial Sites.

1. Barapani Industrial Area with an area spread of over 44 Hectares.
2. Growth Centre at Mendipathar, in East Garo Hills District
3. Industrial Estate in Shillong, Jowai, Mendipathar, Tura and Nongstoin.
4. Export Promotion Industrial Park (EPIP) at Byrnihat with an area spread over 259.35 Hectares was in operation from April, 2001.

Table 9.2.2.5 presents the existing industrial sites in the State. All these places are well connected, having basic facilities such as road, power, water, hospital, Post & Telegraph, shopping complex, school, colleges etc.

Table 9.2.2.5: Existing Industrial Sites in the State

Location	Industrial Estates (Area in acres)	Growth Centre Area (in hectares)	EPIP/Industrial (Area in Acres)
Shillong	10.22	-	-
Tura	19.83	-	-
Jowai	14.56	-	-
William Nagar	15.30	-	-
Mendipather	7.00	36.00	-
Nongstoin	10.00	-	-
Byrnihat	-	-	259.00(EPIP) 51.00-Extended Area
Umiam	-	-	109.67(IA)

The figures on Small Scale Industries registered with Directorate of Industries are presented in Table 9.2.2.6. As compared to Khasi Hills, the number of Small Scale Industries (SSI) is lesser in Garo Hills. Within the Garo Hills, the number of SSI is highest in East Garo Hills, followed by West Garo Hills and South Garo Hills.

Table 9.2.2.6: District wise Employment in Small Scale Industries Registered with Directorate of Industries

District	2007-2008			2008-2009		
	No. of Small Scale Industries	Investment in Plants & Machinery (Rs. in lakh)	No. of Persons Employed	No. of Small Scale Industries	Investment in Plants & Machinery (Rs. in lakh)	No. of Persons Employed
East Khasi Hills	2839	4762.13	17314	3087	18200	5172.52
Ri-Bhoi	314	2963.05	3169	331	3387	4288.07
Jaintia Hills	816	1239.84	3154	836	3292	1309.89
West Khasi Hills	1154	415.61	4806	1178	4914	433.97
East Garo Hills	676	309.98	3556	683	3584	316.67
West Garo Hills	549	545.17	3598	563	3680	606.90
South Garo Hills	163	46.93	596	164	599	47.08

Source: Statistical Handbook Meghalaya 2008-09

Trade Avenues

There are eleven LCS in Meghalaya catering to Bangladesh. Out of these one at Dawki is being developed to Integrated Check-post. Out of remaining 10 four at Ghasupara, Bholaganj, Balat, and Ryngku are non –functional. The remaining LCS at Borsora, Shellabazar, Dalu, Mahendraganj, Baghamara and Kaliachar are functional.

The details of the 10 (Ten) Land Custom Stations in the State with the routes through which export-import business/trading activities are carried out, are mentioned in Table 9.2.2.7.

Table 9.2.2.7: Land Custom Stations in Meghalaya

District	Land Custom Station	Trade Routes
South Garo Hills	Baghmara	Someshwari River
		Baghmara - Durgapur
	Gasuapara	Gandibo-Karaitoli-Haluaghat
West Garo Hills	Mahandraganj	Mahandraganje Dhanua
		Jinjiram River
	Dalu	Bugal River
		Dalu Nalitbari Road
East Khasi Hills	Shella	Shella River
		Pharang Karuh (Maula River)
	Ichamati	Ichamati River
	Bholaganj	Dholai River
		Bholaganj to Company Ganje
		Komorrah- Chhatak Ropeway
		Darogakhal River
		Sonai River
		Duba Channel
		Dear Valley
	Balat	
West Khasi Hills	Borsora	Cherragaon quarry-Cherragaon
		Borsora- Tahirpur
		Chalitachera- Samsar Bil
		Gauripur-Samsar Bil
Jaintia Hills	Dawki	Piyan River
		Shillong-Sylhet Road

The imports and exports (for the year 2012-13) of commodities through Dhubri Custom Division, likely to use the improved Tura – Tuipang road section of NH-51, are given in Table 9.2.2.8 and Table 9.2.2.9. The study road is located in Dhubri Custom Division and its improvement will facilitate the movement of goods. In the year 2012-13the imports (in value terms) at LCS Mahendraganj and LCS Dalu was almost 63% of the total imports at Dhubri Customs Division.

Table 9.2.2.8: Imports at Dhubri Custom Division: 2012-13

Land Customs Stations (L.C.S.)	Item/Commodity	Volume	Value (RS.)
L.C.S., Mahendraganj	Synthetic Net Fabrics	180 MT	18,035,678
	Cement	2200 MT	9,334,670
	Cotton Waste	1010 MT	13,732,596
	Melamine	8305 Kgs	488,813
	Chakra Ball Soap	61960 Kgs	4,090,981
	Vermi Celli	2880 Kgs	280,800
	Saree	3000 Pcs	504,656
	Plastic Door	1525 Kgs	72,615
		Total	**46,540,809**
L.C.S., Mankachar	Cement	5430 MT	26,024,736
	Printed Books, Calendar	3050 Kgs	70,468
	Melamine	4400 Kgs	281,338
	Tissue Paper	300 Kgs	101,240
	Religious Books	8600 Kgs	462,910
	Chakra Ball Soap	86400 Pcs	545,412
		Total	**27,486,104**
L.C.S. Dalu	Cement	4700 MT	13,977,528
	Tangai tat Sari	209032 Pcs	28,863,507
	Synthetic Net Fabric	5000 Kgs	420,546
		Total	**43,261,581**
L.C.S., Hatisar	Extra Natural Alcohol	668000 BL	24,084,000
	Plywood/Block Board	6146.30 Sq.m	1,007,603
	Dried Grain	50.75 MT	710,500
		Total	**25,802,103**

Source: Commissioner of Customs (Preventive), NER, Shillong

Similarly, in terms of exports, the highest percentage (in value terms) to the total exports from Dhubri Custom Division was observed for LCS Ghasuapara (53.28%), followed by LCS Hatisar (32.04%), LCS Dalu (10.89%), LCS Baghmara (2.46%), LCS Mahendraganj (1.18%) and LCS Mankachar (0.14%). Thus it can be seen that LCS Ghasuapara and LCS Hatisar, together account for 85.32% of the total exports (in 2012-13) at Dhubri Custom Division.

Table 9.2.2.9: Exports at Dhubri Custom Division: 2012-13

Land Customs Stations (L.C.S.)	Item/Commodity	Volume	Value (Rs)
L.C.S., Mahendraganj	Coal	228 MT	876,638
	Boulder Stone	52825 MT	23,502,055
	Fresh Ginger	852 MT	11,458,575
	Betel Nuts	337 MT	2,304,937
	Dry Fish	37.5MT	893,758
	Tamarind	72 MT	740,240
		Total	**39,776,203**
L.C.S., Ghasuapara	Coal	467045.9 MT	1,792,385,339
		Total	**1,792,385,339**
L.C.S., Mankachar	Boulder Stone	2788 MT	976,174

	Coal	243 MT	674,672
	Fresh Ginger	297 MT	3,913,426
		Total	**4,588,098**
L.C.S., Baghmara	Coal	22293 MT	82,842,643
		Total	**82,842,643**
L.C.S., Dalu	Coal	95799 MT	362,898,081
	Boulder Stone	8215 MT	3,567,432
		Total	**366,465,513**
L.C.S., Hatisar	Rectified Spirit	920000 BL	33,369,000
	S.K.O.	1284 KL	17,014,342
	H.S.D.O.	19168.5 KL	770,566,821
	Empty Bottles	3274414 Pcs	22,912,611
	Bricks	5784350 Nos	32,205,750
	L.P.G.	63036 Nos	22,357,598
	Rice	6879.14 MT	103,690,342
	Oranges	255967 Boxes	75,632,800
		Total	**1,077,749,264**

Source: Commissioner of Customs (Preventive), NER, Shillong

(7) Tourism

Meghalaya is overwhelmingly beautiful, where everything is green and alive. The rolling mists in the valleys, the undulating hills, numerous lakes, waterfalls, caves, sacred forests, exotic flora and fauna, together with the unique and interesting destinations.

The number of domestic and foreign tourist inflows into Meghalaya for the period 2001 to 2011 is set out in Table 9.2.2.10. There are about 70 tourist's attraction points in the state. The cumulative average growth rate over the period 2001 to 2011 in total tourist arrival in the state has been observed at about 11%. The number of foreign tourist is not only negligible in numbers to the total tourist arrival, but its percentage share has declined over a period of time (from 1.32 % in 2001 to 0.71% in 2011).

Table 9.2.2.10: Number of Domestic and Foreign Tourists Inflows in Meghalaya

Year	No. of Tourist Spots	No. of Visitors		Total
		Indian	Foreign	
2001	64	178697	2390	181087
2002	64	268529	3191	271720
2003	64	371953	6304	378257
2004	64	433495	12707	445902
2005	70	375911	5099	381010
2006	70	400287	4259	404546
2007	70	457685	5267	462952
2008	70	549954	4919	554873
2009	70	591398	4522	595920
2010	70	652756	4177	656933
2011	70	667504	4803	672307

Source: Directorate of Tourism, Govt. of Meghalaya.

The main tourist places in the 3 district falling in the Study Road corridor is listed in Table 9.2.2.11.

Table 9.2.2.11: Tourist Places in Study Corridor

East Garo Hills	1. Patogan Nengminza Memorial at Chisobibra 2. Tasek Lake 3. Nangalbibra 4. Resubelpara Hot-spring 5. Nakachikong 6. Jolding Lake 7. Rasina Falls
West Garo Hills	1. Tura Peak 2. Nokrek Biosphere 3. Dachi lake, Anogre 4. Chibragre Picnic Spot 5. Charontolla Temple 6. Rongbagre Fish Sanctuary 7. Rombang Fall 8. Silbalgre Holookh Gibon Reserve 9. Mirjumlla Tomb, Mankachar
South Garo Hills	1. Siju Cave 2. Captain W.A. Sangma Memorial 3. Kanai River 4. Rongdong fall near Siju 5. Rewak View Point 6. Balpakram National Park.

Source: Directorate of Tourism, Govt. of Meghalaya

CHAPTER 10 IMPLEMENTATION PLAN

10.1 Implementation Schedule

Provisional implementation schedule of the project is shown below. To complete the final ROW drawing, additional topographic survey will have to be carried out, followed by the implementation of RAP based on the final ROW.

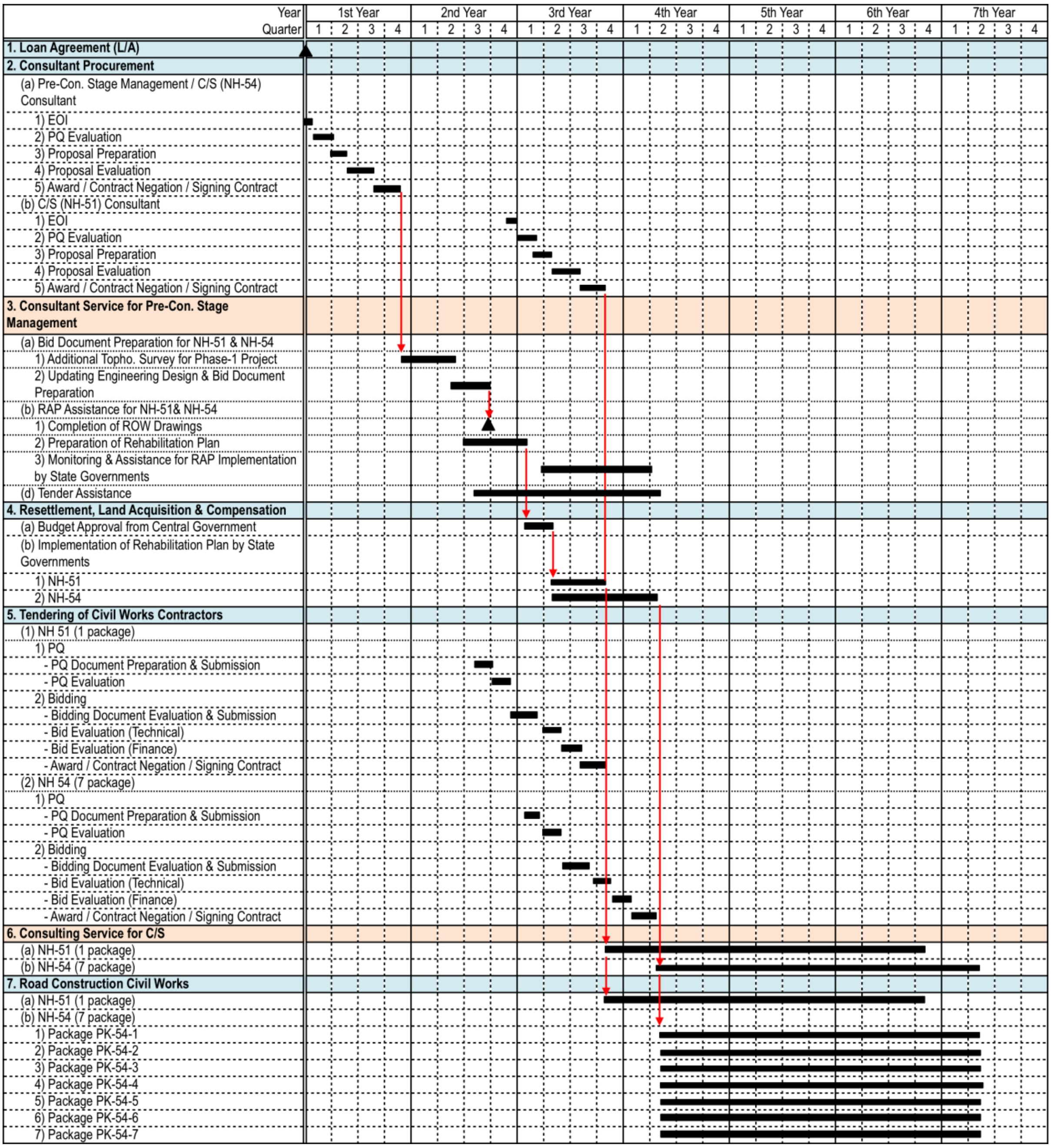


Figure 11.1.1: Implementation Structure for NH54 and NH51

10.2 Project Implementation Framework

(1) Implementation Organizational Structure

NH54 will be implemented in a total of 11 packages, each consisting of about 30-35km stretches. Three supervision consultants under Manager will be responsible for supervision for S1 (3 packages), S2 (4 packages) and S3 (4 packages) sections respectively. General Manager (to be based in Mizoram) will coordinate the implementation of all packages with inputs from Environment and Social Officers. Meanwhile, NH51 project will be carried out in one package under General Manager based in Meghalaya. The implementation structure for NH54 and NH51 is shown below.

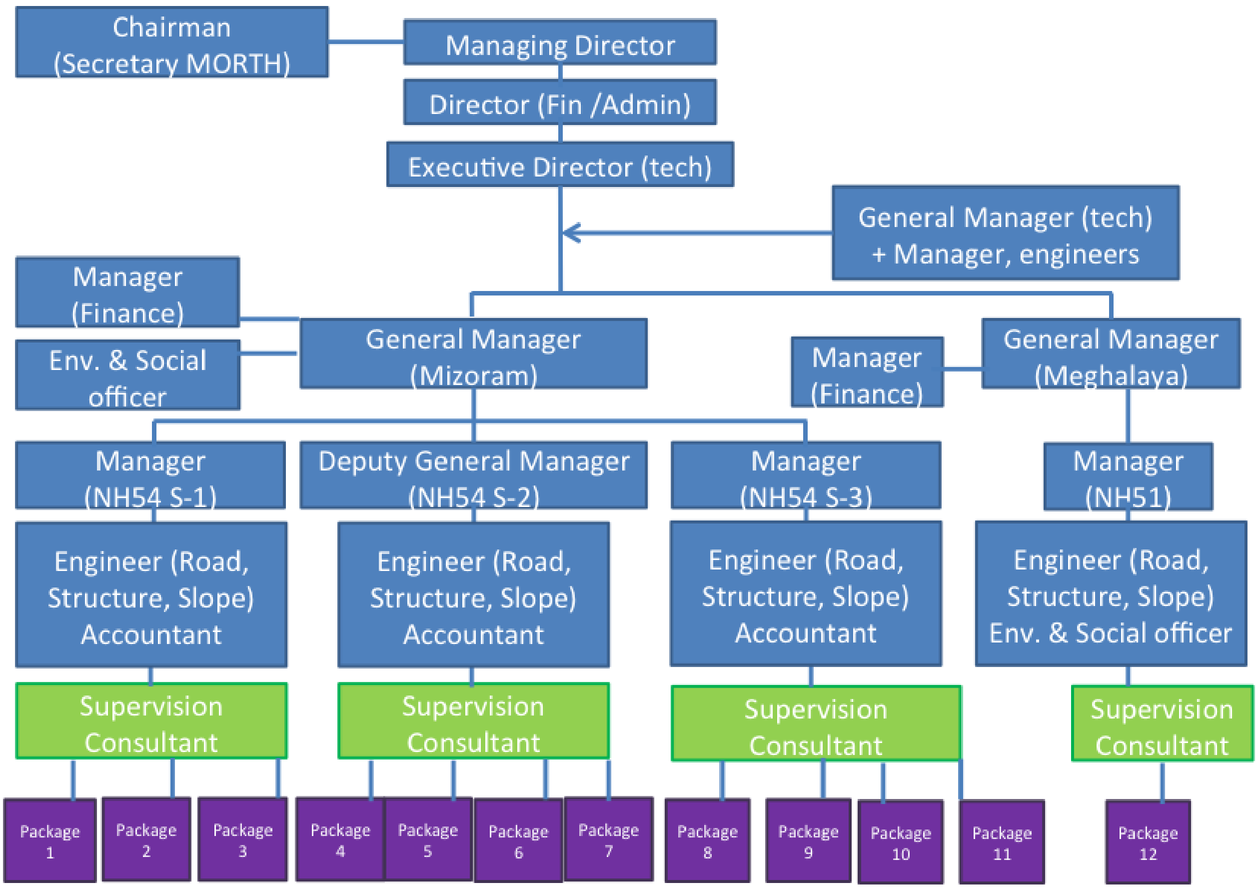


Figure 11.1.2: Implementation Structure for NH54 and NH51

(2) Executing Agency (Legal position, Organization, Staffs, Budget, Capacity, Experience)

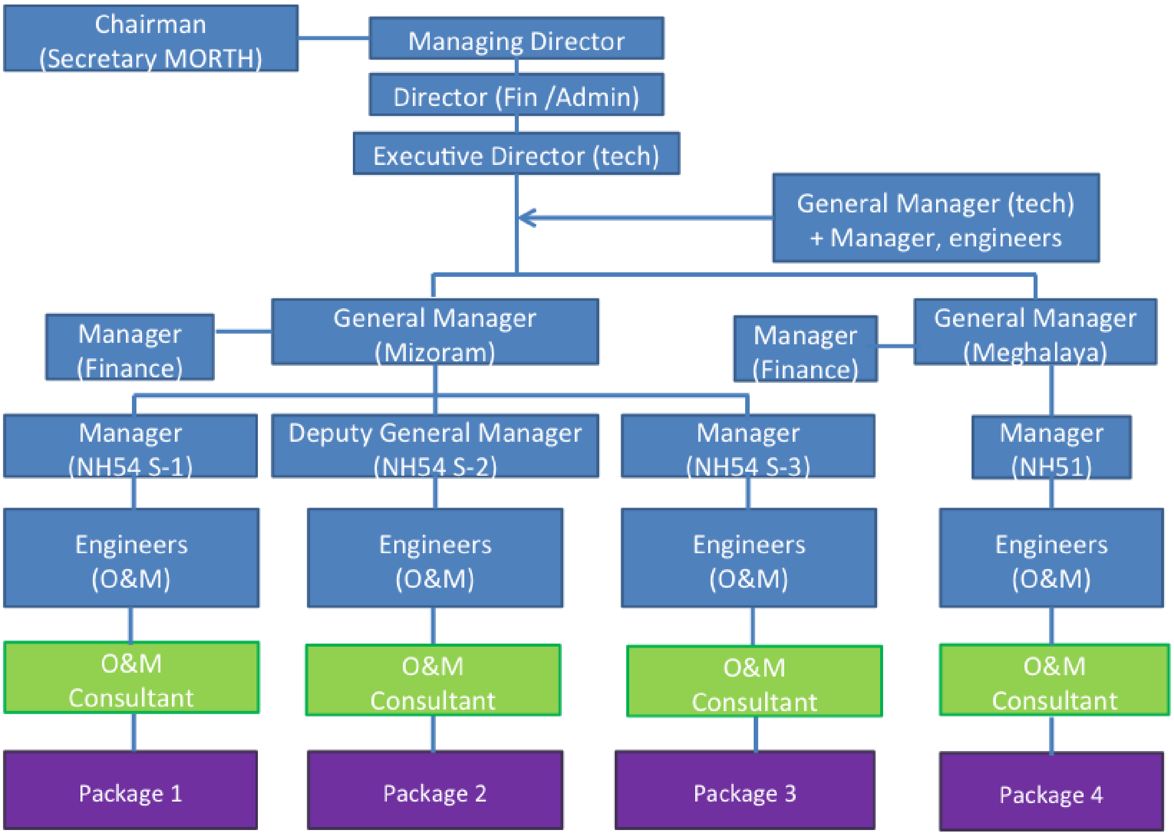
(3) Examination of Contract Scheme (EPC / FIDIC)

10.3 Construction Supervision Service

10.4 Operation and Maintenance Plan

(1) Operation and Maintenance Organizational Structure

Operation and Maintenance organizational structure is shown below. For O&M work, NH54 will be divided into three packages. OM Consultant and Engineers will be responsible for each package



(2) Executing Agency (Legal position, Organization, Staffs, Budget, Capacity, Experience)

CHAPTER 11 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

11.1 Introduction

The environmental and social consideration in the preparatory study has been carried out in two-stages. In the first stage, the 10 study roads and bridges were screened from environmental and social point of view2. Along with consideration from technical and economic points of view, the process informed the selection of two priority projects (NH54 and NH51). The screening was carried out through field visits and review of literatures. For study roads in Manipur and Nagaland (5, 6, 7 in the Table 11.1), however, the review was done only by a review of literature due to security concern in the area.

Table 11.1 List of Study Roads & Contents of Request

No.	Target Roads	Target Length	Request Type
①	Mizoram State, Aizawl – Tuipang Section, NH54	381km (Approx.)	Improvement
②	Meghalaya State, Dudhanal – Dalu Section, NH62	183km (Approx.)	Improvement
③	Meghalaya State, Tura – Dalu Section, NH51	54km (Approx.)	Improvement
④	Meghalaya State, Shillong – Dawki Section, NH40	84km (Approx.)	Improvement
⑤	Manipur State, Imphal – Jiribam Section, NH53	221km (Approx.)	Improvement
⑥	Manipur State, Imphal - Nagaland State, Kohima Section, NH39	138km (Approx.)	Improvement
⑦	Manipur State, Ukhrul – Tadubi Section, NH102A	115km (Approx.)	Improvement
⑧	Tripura State, Manu - Simlung Section NH44	110km (Approx.)	New / Improvement
⑨	Assam State, Badarpurghat Bridge near Silchar	360m	Improvement
⑩	Assam State, Dhubri – Phulbari Section	Bridge: 18km (Approx.) Access Road: 21km (Approx.)	New Bridge

Source: JICA Study Team

NH54 in Mizoram and NH51 in Meghalaya were selected as propriety project3. In the next stage of environmental and social consideraitons, EIA and RAP studies for both NH51 and NH54 have been carried out based on their preliminary design.

2 Originally, there were 11 study roads/bridge. However, improvement of Koliabhomora Bridge near Tezpur in Assam was dropped from GOI request subsequently and thus review of environmental and social issues for this bridge has not been carried out.

3 See Chapter 6 of the report for specific criteria and ranking of study roads.

11.2 Legal and Regulatory Issues

11.2.1 Requirement of EIA under Indian Regulation

As per EIA Notification dated 14.09.2006 (as amended in August 2013) by Ministry of Environment and Forest, any highway project falls under Category A and thus requires EIA and prior Environmental Clearance if the project entails *i) New National Highways; and ii) Expansion of National Highways greater than 100km involving additional right of way or land acquisition greater than 40m on existing alignments and 60m on re-alignments and bypasses.*

Improvement of National Highways envisioned in this project is widening from 1-lane to 2-lane, and therefore, additional right of way or land acquisition is well below the 40m thresholds. Therefore, the project 1 to 7 will not trigger EIA requirement as per Indian regulatory framework. On the other hand, project 8 in Tripura is a combination of improvement and new construction and thus may trigger EIA requirement. Manu - Simlung Section NH44 is only partially completed and thus some section may be considered as "new National Highway". On the other hand, this may be considered as expansion of existing highway because the new section will still be NH44, not "new" highway. The preparation of Manu - Simlung section project is still in an early stage without a feasibility study by Indian side (Detailed Project Report), and at this stage, it is not clear whether MOEF consider this project as Category A or not. From JICA's screening criteria, however, this will be Category A project as the project involves clearing of open forest for construction of highway where none exists today.

In Indian regulation, bridge is not included in project categories that require EIA. From this point of view, EIA will not be required for project 10 (new bridge between Dhubri – Phulbari). A recent example is 675-metre Signature Bridge project across the Yamuna in Wazirabad to connect East and West Delhi for which MOEF decided that environmental clearance is not required. The decision, however, was contested and in February 2015, National Green Tribunal's principal bench ordered Delhi Tourism and Transportation Development Corporation, the project proponent, to prepare an EIA for the project. From strictly statutory point, bridge is different from road is exempt from the EIA notification. Given the recent judgment of National Green Tribunal, however, it is highly likely that EIA will be required for the new bridge project in Assam if an appeal is made.

Table 11.2 EIA Requirement under Indian Regulation and JICA Guidelines

No.	Target Roads	EIA under Indian Requirement	JICA Project Category*
①	Mizoram State, Aizawl – Tuipang Section, NH54	No	A
②	Meghalaya State, Dudhanal – Dalu Section, NH62	Recommended as the road traverses several reserve forests and	A

No.	Target Roads	EIA under Indian Requirement	JICA Project Category*
		elephant corridor.	
③	Meghalaya State, Tura – Dalu Section, NH51	No	A
④	Meghalaya State, Shillong – Dawki Section, NH40	No	A
⑤	Manipur State, Imphal – Jiribam Section, NH53	No	A
⑥	Manipur State, Imphal - Nagaland State, Kohima Section, NH39	No	A
⑦	Manipur State, Ukhrul – Tadubi Section, NH102A	No	A
⑧	Tripura State, Manu - Simlung Section NH44	EIA may be required for part of the section where new road will be constructed, depending on the decision/ definition of MOEF about “new highway”	A
⑨	Assam State, Badarpurghat Bridge near Silchar	No	B
⑩	Assam State, Dhubri – Phulbari Section	Legally not required but it is highly likely that EIA is required if such appeal is submitted.	A

Note: * Project category is estimated based on the scope of project and preliminary review of existing environmental conditions.

Source: JICA Study Team based on EIA notification and amendment and JICA Guidelines

11.2.2 Current Status of LARR 2013

The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act (LARR), 2013 provides for enhanced compensation and assistances measures and adopts a more consultative and participatory approach in dealing with the Project Affected Persons. Enhanced compensation provision for land acquisition provides for 1-2 times the prevailing market rate (as determined by stipulated mechanism, primarily relying on officially recorded/registered rates) in urban areas (as determined by the state) and 2-4 times the prevailing market rate in rural areas. The original law also made provision for need for ‘consent’, while exempting 13 existing laws (having sections governing land acquisition processes for projects coming under its ambit). Subsequently, in 2015 an amendment bill was brought in the bill and enforced through ordinance by the current central government. Key changes made by this bill vis-à-vis the original law are:

The Bill creates five special categories of land use: (i) defence, (ii) rural infrastructure, (iii) affordable housing, (iv) industrial corridors, and (v) infrastructure projects including Public Private Partnership (PPP) projects where the central government owns the land. The LARR 2013 requires that the consent of 80% of landowners is obtained for private projects and that the consent of 70% of landowners be obtained for PPP projects. The proposed amendment to the Bill, currently under the parliamentary discussion, exempts the five categories mentioned above from this provision of the Act. If the amendment is enacted, all 10 study roads/bridge will be exempt from this consent clause as all of them are rural infrastructure project. As per the proposed amendment, projects that belong to five categories do not require social impact assessment.

The amendment has not yet passed as shown in Table below. Regardless the passage of the amendment, however, the project seeks to obtain support from the affected community in keeping with the principle of JICA Guidelines for Environmental and Social Guidelines. For widening/improvement proposal for NH51 and NH54 for which EIA and RAP study have been carried out, the consultation and the baseline survey indicate that majority of the affected people support the project.

Table 11.3 Process of Amending LARR 2013

Date	Action
1 January 2014	LARR 2013 comes into existence, repealing the Land Acquisition Act, 1984
31 December 2014	LARR (Amendment) Ordinance, 2014 promulgated
24 February 2015	LARR (Amendment) Bill, 2015 introduced in Lok Sabha
10 March 2015	LARR (Amendment) Bill, 2015 passed in Lok Sabha with amendments but could not be passed by the Rajya Sabha and remains pending
3 April 2015	LARR (Amendment) Ordinance, 2015 incorporating the amendments made by the Lok Sabha promulgated
10 April 2015	Public interest litigation (PIL) filed in Supreme Court to declare LARR (Amendment) Ordinance, 2015 as "unconstitutional" and ultra vires of the Constitution and as a "colorful exercise of power"
13 April 2015	Supreme Court issues notice in the PIL but refuses to stay the LARR (Amendment) Ordinance, 2015.
11 May 2015	LARR (Amendment) Second Bill, 2015 introduced in the Lok Sabha
13 May 2015	LARR (Amendment) Second Bill, 2015 referred to the Joint Committee of Parliament
30 May 2015	LARR (Amendment) Second Ordinance, 2015 promulgated. The ordinance will lapse if it is not passed by Congress within six months.

Source: JICA Study Team based on PRS Legislative Research, India

11.3 Scoping and Analysis of Alternative based on Generic Concept of Hilly Road

Scoping and preliminary analysis of alternative were undertaken during the first stage. The design of particular target road was not yet developed when the analysis was carried out. In other word, the scoping matrix and concept of alternative presented below are generic one that can be used as a reference for road sector projects in hilly and mountainous region in general. A specific scoping matrix for priority project (NH54 and NH51) has been developed based on this and is included in a separate EIA report along with analysis of alternatives.

Table 11.4 Generic Scoping Matrix for Hilly/Mountainous Road

Item	Scoping Results			
	Pre-construction Stage	Construction Stage	Operation Stage	Rational of the Assessment
Natural Environment				
Climate/ Meteorological Phenomena	D	D	D	P: No impact is expected.
				C/O: The impacts on micro-climate and micro meteorological phenomena are negligible because the project-related structures will not disturb wind path.
Topography	D	B-	D	P: No impact is expected.
				C: Changes in topographic conditions are expected due to the requirement of cutting filling work. Balancing the volume of cutting and filling is recommended to minimize the volume of spoil soil.
				O: Topographic condition will b stable after the completion of construction work which include slope protection and slope stabilization.
Geology	D	D	D	P: No impact is expected.
				C: No impact is expected.
				O: No impact is expected.
Soil Erosion	D	B-	B+/ B-	P: No impact is expected.
				C: Soil erosion is expected particularly during the monsoon period. Construction work should avoid the monsoon period.
				O: Poor condition of drainage causes soil erosion in existing road. The project is expected to improve the condition and thus reduce the risk of soil erosion, but measures for slope protection and stabilization and prevent soil erosion, particularly during the monsoon period, must be in place and regularly monitored.
Hydrology	D	C-	C-	P: No impact is expected.
				C: Construction work may cause minor, temporary impacts on hydrology.
				O: Cutting and/or filling may result in changes in local hydrology. The impact should be managed through adequate drainage measures.
Groundwater	D	D	D/ B-	P: No impact is expected.
				C: The project does not envision the use of groundwater and thus no impact is expected. If the tunnel is constructed for bypass sections, however, appropriate measures should be undertaken to avoid/minimize the impact.
				O: No impact is expected during the operation stage, but measures should be undertaken if the project involves construction of tunnel.
Ecosystem, Flora, Fauna and Biodiversity	D	B-	B-	P: No impact is expected.
				C: The project will not affect pristine ecosystem as the work will be carried out along the existing road. However, construction work could affect mountain ecosystem and local flora and fauna including jhum and plantation.
				O: Increases in traffic volume will have negative impact ecosystem and flora and fauna along the road.
Protected Areas/Forest	D	B-	B-	P: The highways proposed for expansion/improvement does not traverse or border with national parks. However, one of the proposed road (NH62 in Meghalaya) traverses reserve forest.
				C: By the construction work, some of the forest area will be opened up.
				O: The level of sunshine may increase due to the expansion of the open area, potentially influencing the vegetation in the edge of the forest. Increases in emissions due to greater traffic volume will negatively affect forest and surrounding ecosystem.

Item	Scoping Results			
	Pre-construction Stage	Construction Stage	Operation Stage	Rational of the Assessment
Coastal Zone	D	D	D	P/C/O: No impacts are expected, because the alignment is far away from the coastal zone and the planned alignment will not pass the tidelands and the mangrove forests which are peculiar to the coastal region.
Landscape	D	D	B+	P: No impact is expected.
				C: Changes in landscape during the construction work will be minor and temporary. The project should explore possibilities to utilize scenic/view points along the road to strengthen tourism potential in north eastern region of India.
				O: Improved road network facilitates access to scenic places and tourist attractions, thereby positively contributing tourism in the region.
Natural Disaster	D	B-	B+	P: No impact is expected.
				C: Many areas of the road are prone to landslide and thus appropriate measures should be in place during the construction work to avoid accidents. Construction during the monsoon period is risky and should be avoided.
				O: Slope protection/stabilization measures and drainage are expected to significantly reduce the risk of natural disaster.
Living Environment				
Air Pollution	D	B-	B-	P: No impact is expected.
				C: Some negative impacts are expected due to operation of construction equipment and vehicles. One of these is the dust incidental to earthwork especially during the dry season.
				O: Air pollution is expected to increase due to increase traffic volume on the road.
Offensive Odor	D	D	D	P/C/O: No impact is expected.
Water Pollution	D	B-	B-	P: No impact is expected.
				C: Turbid water due to the earthworks, bridge pier construction work and wastewater effluents from construction workers' camps/yards are expected to pollute the surrounding rivers/canals to some extent.
				O: Some impacts on water quality in surrounding water bodies are expected due to water discharge from road users and wastewater from maintenance activities.
Bottom Sediment Contamination	D	D	D	P: No impact is expected.
				C: Some construction materials such as cement and sand are expected to be washed out mainly by the rain, but the impacts on bottom sediment are expected to be negligible.
				O: Some wastewater will be generated from maintenance activities along the road, the impacts on bottom sediment from the wastewater will be negligible.
Soil Contamination	D	C-	D	P: No impact is expected.
				C: Impacts on soil from deposition of pollutants from construction materials in the construction site are expected to be small. Since there is no major industrial activity along the road, it is unlikely that soil along the road is already polluted.
				O: No impact is expected.
Ground Subsidence	D	D	D	P/C/O: No impact is expected.
Noise/	D	B-	B-	P: No impact is expected.

Item	Scoping Results			
	Pre-construction Stage	Construction Stage	Operation Stage	Rational of the Assessment
Vibration				C: Noise and vibration are generated by operation of construction equipment and vehicles, although they are temporary. Construction schedule should take into account the location of schools, hospitals and religious facilities that require silence in part of the day.
				O: Noise and vibration level are likely to increase due to greater traffic volume along the road. Specific measures may be required to minimize impacts on schools, hospitals and religious facilities.
Sunshine Obstruction	D	D	D	P/C/O: No impact is expected.
Wastes/Hazardous Materials	D	B-	B-	P: No impact is expected.
				C: Waste from construction workers' camps are expected to be generated. Waste generated from construction and demolition work may include hazardous materials that must be treated before final disposal.
				O: Waste will be generated from road users and workers of maintenance works.
Social Environment				
Involuntary Resettlement	A-	A-	A-	P: The project will result in large-scale involuntary resettlement, particularly in built-up areas where structures exist in both sides of the road. Minimizing the resettlement should be the priority for road design.
				C: Temporary relocation might be required for accommodation of construction yards and workers' camps. Resettlement may cause cultural and social conflict between resettling people and host community.
				O: Resettlement may cause cultural and social conflict between resettling people and host community.
Land Use	A-	A-	A-	P: Land acquisition and involuntary resettlement are likely to cause changes in existing land use pattern.
				C: The project will be carried out along the existing road, and as such, changes in land use associated with construction work are relatively minor, and land clearance for construction yards and workers' camps is temporary.
				O: Greater traffic volume may affect the use of road and surrounding area by local residents. Uncontrolled jhum (shifting cultivation) along the road may undermine the effectiveness of slope protection/ stabilization measures and increase the risk of land slide and soil erosion.
Utilization of Local Resources	D	A-	A-	P: No impact is expected.
				C: Mass-scale use of local resources such as sand and quarrying for the construction activities may obstruct there utilization by the local people for other purposes.
				O: Improvement in road infrastructure may change the flow of commodity distribution, potentially impacting the use of local resources.
General, Regional /City Plans	D	D	C+/ C-	P: No impact is expected.
				C: No impact is expected.
				O: Better infrastructure network may trigger influx of outsiders and economic development in the region.
Social Institutions and Local Decision-making	A-	A-	A-	P: Land acquisition and involuntary resettlement are likely to affect social institutions such existing as social capital and local decision-making institutions.
				C: Existing as social capital and local decision-making institutions will be affected by the influx of resettling population and construction workers.

Item	Scoping Results			
	Pre-construction Stage	Construction Stage	Operation Stage	Rational of the Assessment
Institutions				O: Existing as social capital and local decision-making institutions will be affected by the influx of resettling population.
Social Infrastructure and Services	A-	A-	A-	P: Communal facilities such as public hall may be affected by the project, which negatively affect social infrastructure and services.
				C: Access to social infrastructure and services may be temporarily affected due to construction of construction yard and accommodation for workers as well as traffic jams due to the operation of construction vehicles.
				O: The resettlement can result in prolonged disturbance in social infrastructure and services. In the long term, however, the project is expected to improve access to social infrastructure and services by providing better road network.
Local Economy and Livelihood	A-	A-	A-	P: Loss of income source and livelihood due to involuntary resettlement are expected to negatively affect the local economic and livelihood.
				C: Loss of income source and livelihood due to involuntary resettlement are expected to negatively affect the local economic and livelihood. On the other hand, construction work will have positive impact on local economy by creating employment and business opportunities in the project area.
				O: The project may trigger unintended side effect with detrimental impact on local community, e.g. influx of non-local people and more competition in business and pressure on local natural resources. Over the long term, the project is expected to have positive impact on local economy as improved road network ensures more stable supply of essential goods. However, the end of construction work may create short-term unemployment of construction workers.
Unequal Distribution of Benefit and Damage	A-	A-	A-	P: Land acquisition and involuntary resettlement will lead to unequal distribution of benefits and damage between groups who are directly affected by the project and who are not.
				C: While resettling households bear much of the damage, others may even enjoy benefits from new business opportunities created by construction work, resulting in unequal distribution of benefit and damage
				O: People residing along the road may accrue greater benefits compared with others, potentially increasing rich-poor gap within the community.
Local Conflicts of Interest	A-	A-	A-	P/C/O: Unequal distribution of benefit and damage may trigger and/or intensify local conflicts of interests in the community.
Water Usage, Water Rights and Communal Rights	C-	C-	D	P: Water usage and water rights of the affected households may be curtailed due to resettlement. However, irrigation is not common in the region and thus, the impact will be minor, if any.
				C: Disturbance to water usage, water rights and communal rights during construction work is expected to be minor and short-term in nature. However, communal rights and distribution should be carefully examined to avoid negative impacts.
				O: No impact is expected.
Cultural and Historical Heritage	C-	C-	D	P: The targeted roads do not traverse or runs near major ruins and/or cultural heritage. There are, however, several observation decks and memorial stones along the road which may be affected depending on the widening width.
				C: Several observation decks and memorial stones along the road which may be affected depending on the widening width.
				O: No impact is expected.

Item	Scoping Results			
	Pre-construction Stage	Construction Stage	Operation Stage	Rational of the Assessment
Religious Facilities	A-	A-	A-	P: Several memorial stones and graves are located along the road and may be affected depending on the widening width. Small religious facilities in built-up areas may also be affected.
				C/O: Roadside religious facilities may be affected by noise and vibration during construction and operation due to construction work and greater traffic volume.
Sensitive Facilities (ex. hospital, school, precision machine factory)	A-	A-	A-	P: Community facilities (public halls etc.) will have to be relocated incase road widening is implemented within the built-up area.
				C: Noise and vibration during construction work may affect school and hospitals.
				O: These facilities can be affected due to noise and vibration resulting from increase in traffic volume. Also, congestion may undermine the utility of such facilities.
Poor People	A-	A-	A-	P: Given the limited coping capacity of the poor, it is necessary to assess their vulnerability and develop appropriate mitigation measures.
				C: The poor may bear disproportionally higher burden due to their limited coping capacity, although they can be benefited from employment opportunities during construction work.
				P: In the long-term, economic development in the region is likely to benefit the poor, however, the poor may fail to benefit from the project due to the lack of skills and coping capacity
Ethnic Minorities/ Indigenous People	A-	A-	A-	P/C/O: North East States are home of diverse tribal groups (Scheduled Tribe) with distinct language and cultures. Preparation of RAP and livelihood restoration plan, therefore, must take into account this diversity.
Gender	D	C-	B+	P: No impact is expected.
				C: Equal opportunity should be sought for employment during construction work. Prevailing social and cultural norms must be carefully studied to avoid gender-related conflict.
				O: Better road condition is expected to reduce the burden of girls and women who carry water and fuel wood and improve their safety.
Children's Rights	D	D	D	P: No impact is expected.
				C/O：Child labor is unlawful according to article 24 of Indian Constitution. Only adult is eligible for potential employment opportunity created by the project.
Public Health (sanitation and infectious diseases)	D	B-	B-	P: No impact is expected.
				C: Influx of construction workers is likely to increase the health risk, particularly that of STD/STI and HIV/AIDS. The risk of malaria should be properly managed in construction work in areas where malaria is prevalent.
				O: An increase in traffic volume and road users may have negative impact on public health.
Occupational Health and Safety (OHS)	D	B-	B-	P: No impact is expected.
				C: Occupational health and safety of construction work should be properly managed through adequate Environment Management Plan.
				O: Maintenance and repair work should take into account the occupational health and safety of the workers.
Other				
Accidents	D	B-	C+/ C-	P: No impact is expected.
				C: Increase of risks of accidents associated with construction activities is expected due to the operation of heavy equipment and vehicles.

Item	Scoping Results			
	Pre-construction Stage	Construction Stage	Operation Stage	Rational of the Assessment
				O: Risks of accidents is expected to increase due to greater traffic volume and speed. On the other hand, installment of accident-prevention measures (such as mirrors at curves) will reduce the risk of accidents.
Climate Change	D	B-	B+/ B-	P: No impact is expected.
				C: The use of construction machines and operation of vehicles will result in an increase in GHG emissions, though the impact is small and short-term.
				O: The GHG emission will increase due to an increase in traffic volume. The project is expected to improve the resilience of road against climate change by factoring long-term climate change (changes/increase in precipitation etc.) into the road design.

Source: JICA Study Team

Table 11.5 Generic Concept of Alternatives

No.	Option	Contents
0	Zero-Option (without project)	Existing road and slope conditions will persist. Poor pavement condition will lead to more vehicular emissions with detrimental impacts on health and ecosystem. Also, continuation of uncontrolled encroachment will increase the risk of traffic accident in built-up areas. Poor road network continues to be a bottleneck of economic development and also undermine positive benefits of ongoing Kaladan Multimodal Transport Project, which provides additional network from Mizoram to Haldia/Kolkata ports through NH54 and Kaladan River in Myanmar.
1	Applying the same design standard across the whole stretch based on the IRC	The same standard for widening/improvement will be applied across the whole stretch irrespective to geological condition and socio-economic conditions. While the positive impact of widening is significant, the project will trigger significantly more resettlement compared with option 2. Also, geometric improvement of many hair-pin curves will trigger more cutting and filling, increasing impacts on forest and leads to higher project implementation cost. The number of traffic accident will also increase due to the increased speed of vehicles passing through built-up areas.
2	Selective widening considering social impacts	The level of widening will be minimized in heavily built-up area to reduce the scale of resettlement. This option is desirable from socio-economic point of view, but the positive impact in terms of improvement of the road network in the region may be slightly limited compared with option 1.
3	New bypass to avoid densely built-up areas	A new bypass will be constructed in densely built-up areas to avoid resettlement. The option will minimize the scale of resettlement, but the impact on forest and agricultural land (jhum) will be significant as the new road will be constructed in open forest. The bypass will be required in the longer-term to accommodate project increase in traffic demand in the future, but its environmental impact as well as economic feasibility will have to be studied in more details.

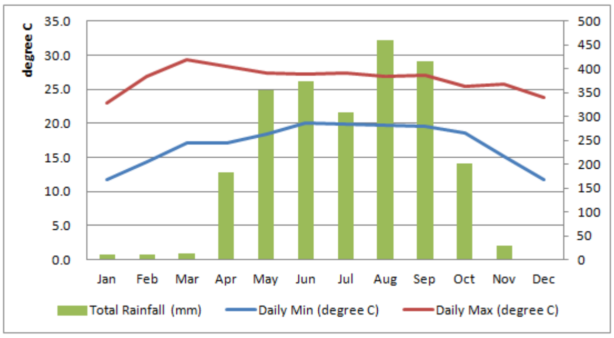
Source: JICA Study Team

11.4 Screening of 10 Study Roads from Environmental and Social Point of Views

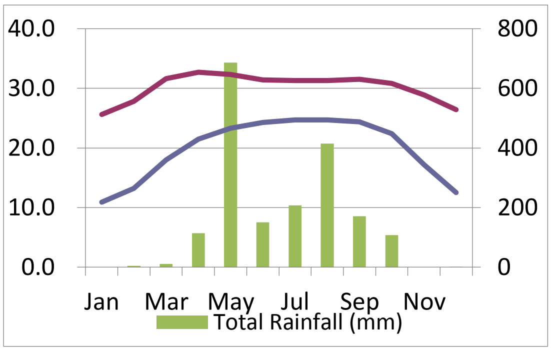
11.4.1 Climate

The North East region of India has distinct climate variations. The rapid changes in topography result in climate changes within short distance. This is particularly evident in NH40 where significant difference in altitude exists within the stretch. Generally the daily temperature in the plains of Assam as well as in Tripura and in the western portion of Mizoram is about 15 °C in January, whereas in other parts of the region, the temperature is between 10°C to 15°C. From April it rises and in July except the south-eastern portion of Mizo hills and Shillong in Meghalaya (where the targeted section of NH40 begins), the mean temperature ranges from 25°C to 27.5°C. During October, daily mean temperature in the hilly areas ranges between 20°C and 25°C, whereas in Assam, Tripura and the western portion of the Mizo hills it is above 25°C. The region has distinct monsoon season, which generally begins in May and ends in October/November. The area is known for its high rainfall during the monsoon. In particular, Mawsynram in East Khasi Hills district of Meghalaya near NH40 is known to be the wettest place on Earth with an average annual rainfall of 11,872 mm. The monthly maximum and minimum temperature and rainfall of key towns in study roads are shown below.

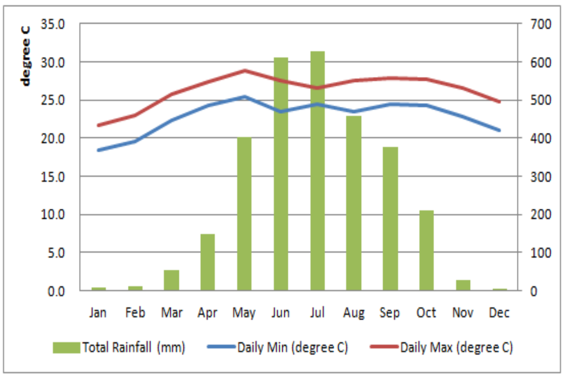
Aizawl (NH54), Mizoram



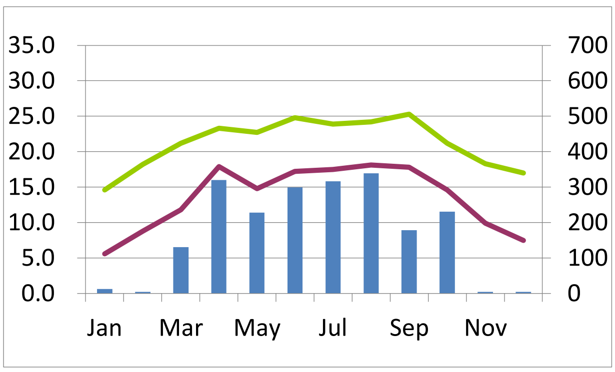
Manu (NH44), Tripura

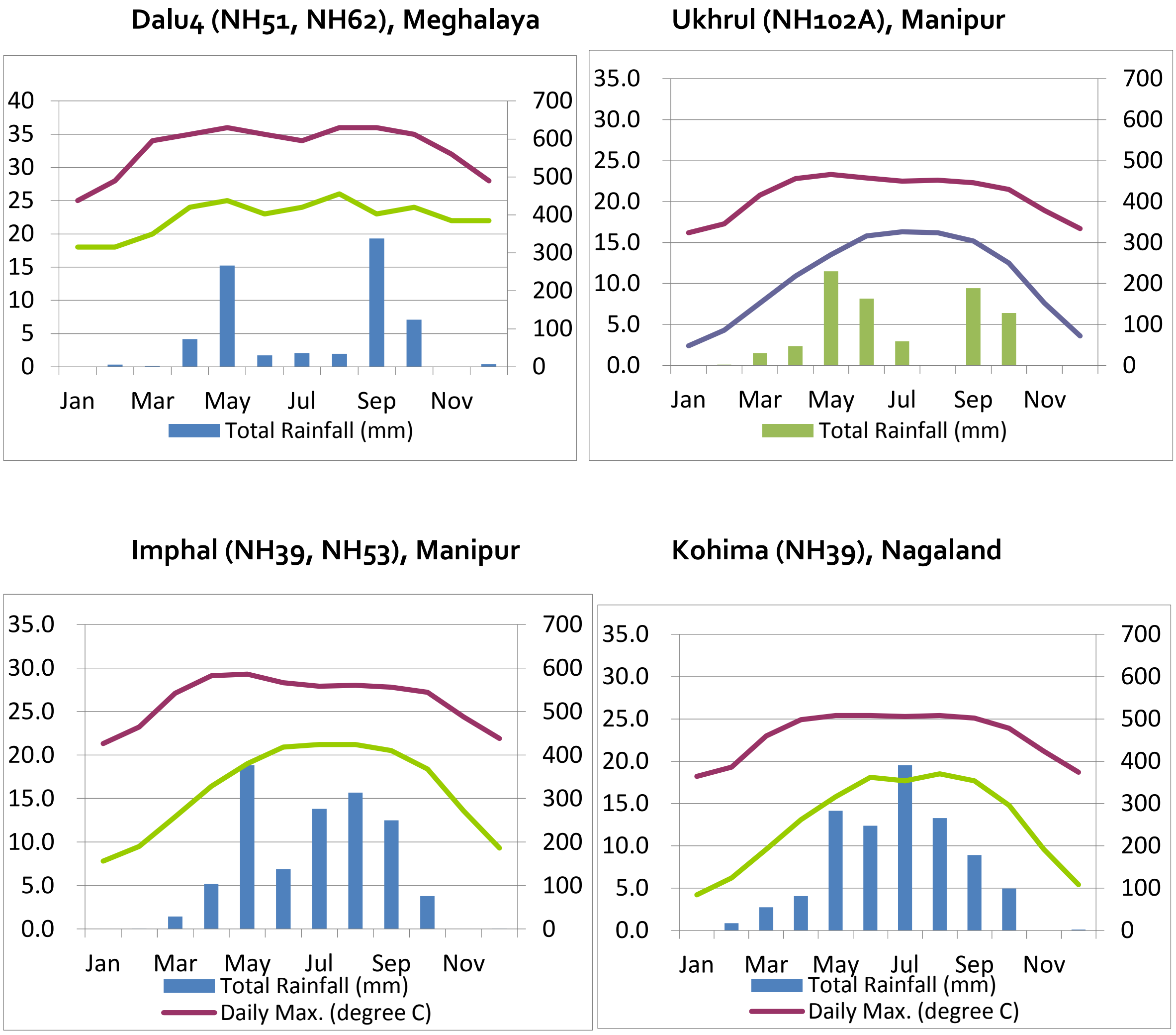


Tura (NH51), Meghalaya



Shillong (NH40), Meghalaya





Source: India Meteorological Department

Figure 11.1 Monthly Rainfall and Daily Maximum and Minimum Temperature in Project Area5

11.4.2 Forest and Ecosystem

North East region of India is geographically located in one of the most biodiversity-rich regions of the world. During the past three decades, the region has been through several priority-setting processes on the initiative of the national and international conservation agencies. The region is not a homogenous entity but a highly diverse mosaic of ecological, social and physiological landscapes. The World

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4 The climate data for Dalu is not available. Hence, the data for Baghmara in South Garo Hillis, about 50km away from Dalu, is used as proxy.

5 The data for 2012-2013 except for Shillong where 2005 data is used.

Wildlife Fund (WWF) has identified the entire Eastern Himalayas as a priority Global 200 Ecoregion. Conservation International has up-scaled the Eastern Himalaya Hotspot, which initially covered the states of Arunachal Pradesh, Sikkim, Darjeeling Hills, Bhutan, and Southern China, to the Indo Burma (Hotspot) which now includes all the eight states of North-East India, along with the neighboring countries of Bhutan, southern China and Myanmar. The region has been identified by the Indian Council of Agricultural Research as a center of rice germplasm. Meanwhile, the National Bureau of Plant Genetic Resources, India, has highlighted the region as being rich in wild relatives of crop plants. As a total, forests in the region is estimated to harbor 80,000 out of 15,000 species of flowering plants. The richness of plant species in six states where study roads/bridges are located is shown below.

Table 11.6 Richness of Plant Species in Study Area

No.	State	Species Richness (flowering plants)
1	Mizoram	2,200
2	Meghalaya	3,500
3	Manipur	2,500
4	Nagaland	2,250
5	Tripula	1,600
6	Assa,	3,010

Source: Review of Biodiversity in North East India, WWF-India, 2006

The list of National Park and Wildlife Sanctuary in the six states and their relevance to the target roads/bridge are shown below. As discussed below, no project roads/bridge traverses or boarder with these protected area. On the other hand, NH62 traverses four reserve forests and NH40 runs along Upper Shillong Protected Forest in the first few kilometers from the beginning of the targeted section (See Figure 11.3 below). There are also areas identified as elephant crossing points on NH62. While these roads have not been selected as priority project, serious efforts to avoid and minimize disturbance to ecosystem is necessary should they be chosen in the future phase of the project. A brief overview of forest and ecosystem in study area is presented below.

Table 11.7 Richness of Plant Species in Study Area

No.	Target Roads	Traverses or borders with National Park, Wildlife Sanctuary	Traverses or borders with Protected/Reserve Forest
①	Mizoram State, Aizawl – Tuipang Section, NH54	No	No
②	Meghalaya State, Dudhanal – Dalu Section, NH62	No	Yes
③	Meghalaya State, Tura – Dalu Section, NH51	No	No
④	Meghalaya State, Shillong – Dawki Section,	No	Yes

No.	Target Roads	Traverses or borders with National Park, Wildlife Sanctuary	Traverses or borders with Protected/Reserve Forest
	NH40		
⑤	Manipur State, Imphal – Jiribam Section, NH53	No	No
⑥	Manipur State, Imphal - Nagaland State, Kohima Section, NH39	No	No
⑦	Manipur State, Ukhrul – Tadubi Section, NH102A	No	No
⑧	Tripura State, Manu - Simlung Section NH44	No	No
⑨	Assam State, Badarpurghat Bridge near Silchar	No	No
⑩	Assam State, Dhubri – Phulbari Section	NO	No

Source: JICA Study Team

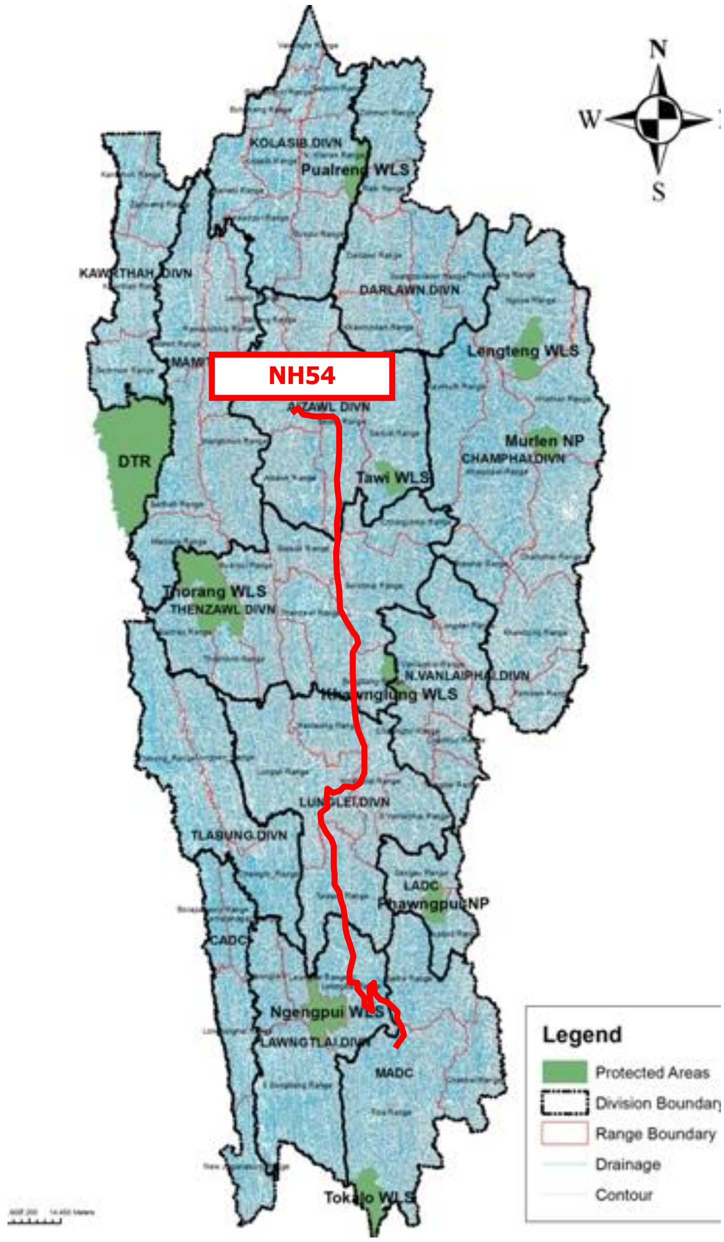
Table 11.8 National Park and Wildlife Sanctuary in Six States where Study Roads are Located

Name	Year	Area(km^2)	District	Name	Year	Area(km^2)	District
Mizoram				**Assam**			
Murlen NP	1991	100.0	Champhai	Dibru-Saikhowa NP	1999	340.0	Tinsukia,Dibrugarh
Phawngpui NP	1992	50.0	Saiha	Kaziranga NP	1974	859.0	Golaghat,Nagaon
Dampa WLS	1985	500.0	Mamit	Manas NP	1990	500.0	Barpeta,Bongaigaon
Khawnglung WLS	1992	35.0	Lunglei, Serchhip	Nameri NP	1998	200.0	Sonitpur
Lengteng WLS	1999	60.0	Champhai	Orang NP	1998	78.8	Darrang,Sonitpur
Ngengpui WLS	1991	110.0	Lawngtlai	Amchang WLS	2004	78.6	Kamrup
Pualreng WLS	2004	50.0	Kolasib, Aizawl, Champhai	Barail WLS	2004	326.3	Barak Valley
Tawi WLS	2001	35.8	Aizawl, Serchhip	Barnadi WLS	1980	26.2	Darrang
Thorangtlang WLS	2002	50.0	Lunglei	Bherjan-Borajan-Podumoni WLS	1999	7.2	Tinsukia
Megharaya				Burachapori WLS	1995	44.1	Sonitpur
Balphakram NP	1985	220.0	South Garo Hills	Chakrashila WLS	1994	45.6	Dhubri
Nokrek Ridge NP	1986	47.5	East, West & South Garo Hills	Dihing Patkai WLS	2004	111.2	Dibrugarh, Tinsukia
Baghmara Pitcher Plant WLS	1984	0.0	South Garo Hills	East Karbi Anglong WLS	2000	221.8	Karbi-Anglong
Nongkhyllem WLS	1981	29.0	Ri Bhoi	Garampani WLS	1952	6.1	Karbi-Anglong
Siju WLS	1979	5.2	South Garo Hills	Gibbon WLS	1997	21.0	Jorhat
Tripura				North Karbi Anglong WLS	2000	96.0	Karbi-Anglong
Clouded Leopard NP	2007	5.1	West Tripura	Laokhowa WLS	1972	70.1	Nagaon
Gumti WLS	1988	389.5	South Tripura	Marat Longri WLS	2003	451.0	Karbi-Anglong
Rowa WLS	1988	0.9	North Tripura	Nambor WLS	2000	37.0	Karbi-Anglong
Sepahijala WLS	1987	13.5	West Tripura	Nambor Doigrung WLS	2003	97.2	Karbi-Anglong
Trishna WLS	1988	194.7	South Tripura	Pabitora WLS	1987	38.8	Marigaon
Nagaland				Pani-Dihing WLS	1995	33.9	Sibsagar
Intanki NP	1993	202.2	Dimapur	Sonai-Rupai WLS	1998	220.0	Sonitpur
Fakim WLS	1980	6.4	Tuensang	**Manipur**			
Puliebadze WLS	1980	9.2	Kohima	Keibul-Lamjao NP	1977	40.0	Bishnupur
Rangapahar WLS	1986	4.7	Dimapur	Yangoupokpi-Lokchao WLS	1989	184.4	Chandel

Note: NP=National Park, WLS=Wildlife Sanctuary
Source: National Wildlife Database Cell

Mizoram (NH54)

The state has 10 National Parks, Wildlife Sanctuary and Tiger Reserves. As shown below, the project does not traverse or boarder with these protected areas. No government reserve forest in Mizoram will be affected by NH54 project.



Source: Department of Environment and Forests, Government of Mizoram

Figure 11.2Protected Area in Mizoram

Mizoram has third highest total forest cover with 1,594,000 hectares (3,940,000 acres), and highest percentage area (90.68%) covered by forests, among the states of India, according to 2011 Forest

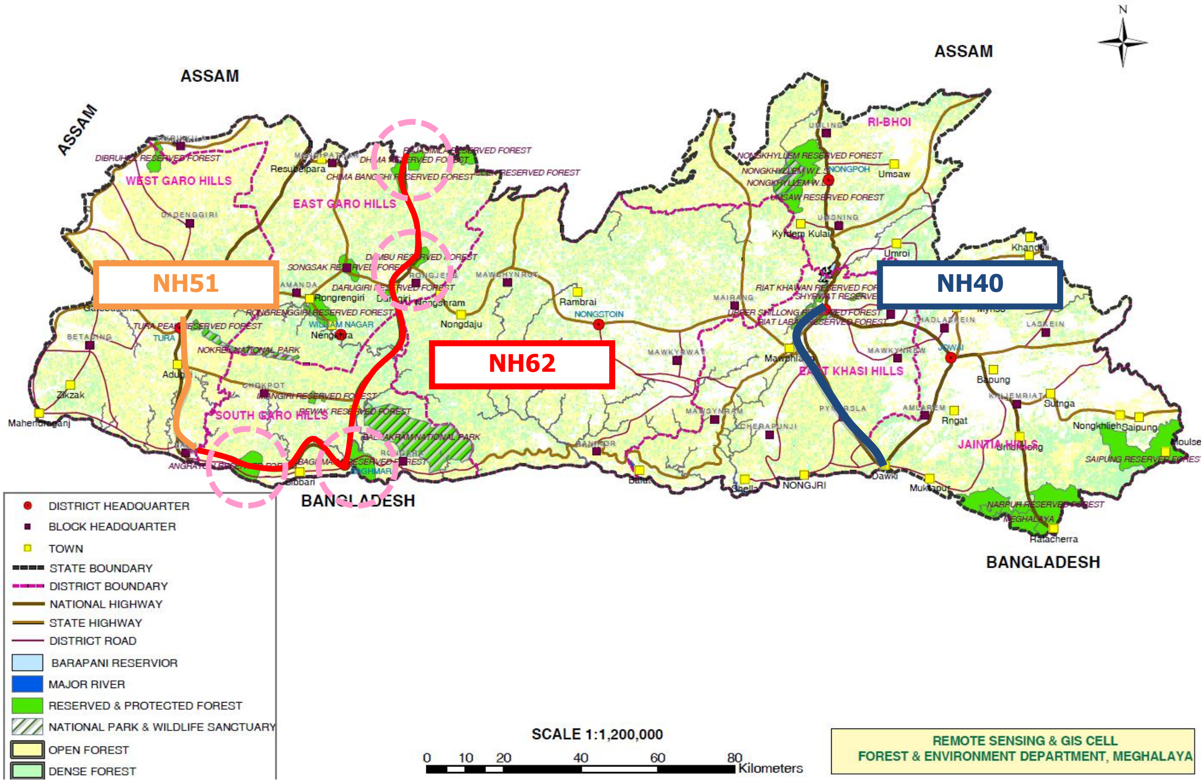
Survey of India6. Tropical Semi Evergreen, Tropical Moist Deciduous, Subtropical Broadleaved Hill and Subtropical Pine Forests are the common vegetation types found in Mizoram. Bamboo is common in the state, typically intermixed with other forest vegetation; about 9,245 km2 (44%) of state's area is bamboo bearing. Jhum cultivation, or slash-and-burn practice, were a historic tradition in Mizoram and a threat to its forest cover. This practice has reduced in recent decades from a government-supported initiative to support horticultural crops such as pineapple and banana plantations. Only 17% of the land is non-forested area for cultivation, industry, mining, housing and other commercial human activity.

Meghalaya (NH51, 40, 62)

The Meghalaya subtropical forest is part of a mountain subtropical moist broadleaf forest eco-region of North East India. The eco-region covers an area of 41,700 km^2, encompassing the Khasi Hills, Garo Hills, and Jaintia Hills of Meghalaya and adjacent portions of Assam state. The eco-region is one of the most species-rich place in India with a rich diversity of birds, mammals, and plants. Also, it is one of the wettest eco-regions in the world, with some places, notably Mawsynram and Cherrapunji, receiving up to eleven meters of rain in a year. As per Forest Survey of India 2011, the recorded forest area of the state is 9,496 sq.km, which is 42.34% of its geographical area. The Reserved Forests constitute 11.72%, Protected Forest 0.13% and Unclassed Forests 88.15%. Acacia, rubber and cashew plantation are commonly found along NH51. Meanwhile, cashew is the dominant plantation in most parts of NH62, interspersed with patches of natural forest. Sections near Dalu (both NH51 an NH62) are mostly interspersed with paddy fields, patches of natural forests and cashew plantations.

As discussed above, NH62 traverses four reserve forests and NH40 runs along Protected Forest in section near Shillong. Other National Park, Wildlife Sanctuary and researve forest in Meghalaya is shown below.

6 The figure is 79.3% in a different estimate.



Source: Forest & Environment Department, Meghalaya State

Figure 11.3 Protected Area in Mizoram

Manipur (and Nagaland) (NH39, NH53, NH102A)

Geographically, Manipur can be divided into two parts: the hills comprising five districts and the plains with four districts. The valley has an average altitude of 872 meters above MSL and the climate is subtropical and warm in the summer season. This part is the "rice bowl" of the state. The hill areas are under temperate subtropical climate at the average altitude of 3000 meters above MSL.

Shifting cultivation or Jhum (Paamlou in Manipuri language) is widely practised in the state with more than 83,000 families are reportedly practicing the shifting cultivation or jhuming. This is particularly widespread in Tamenglong district. The vast area of bamboo growing zone of the district suitable for low-cost shifting cultivation. Bamboo land could be used for shifting cultivation. The improved method of shifting cultivation is developed by the Tribals of Machi Block of Chandel district in Manipur, because of the acute problem for acquiring agricultural land and inadequate facility for terracing. In Manipur, there is a project called 'Improved Machi Model of Shifting Cultivation', which controls Jhum cultivation in an environmental-friendly way by setting a price on different items related to the way of shifting cultivation.

the natural vegetation occupies an area of about 14,365 km² which is nearly 64% of the total geographical area of the state. The vegetation consists of a large variety of plants ranging from short and tall grasses, reeds and bamboos to trees of various species. Broadly, there are four types of forests - Tropical Semi-evergreen, Dry Temperate Forest, Sub-Tropical Pine and Tropical Moist Deciduous.

The location of National Park and Wildlife Sanctuary in Manipur is shown below. None of the three study roads in Manipur traverses or boarder with National Park or WLS.

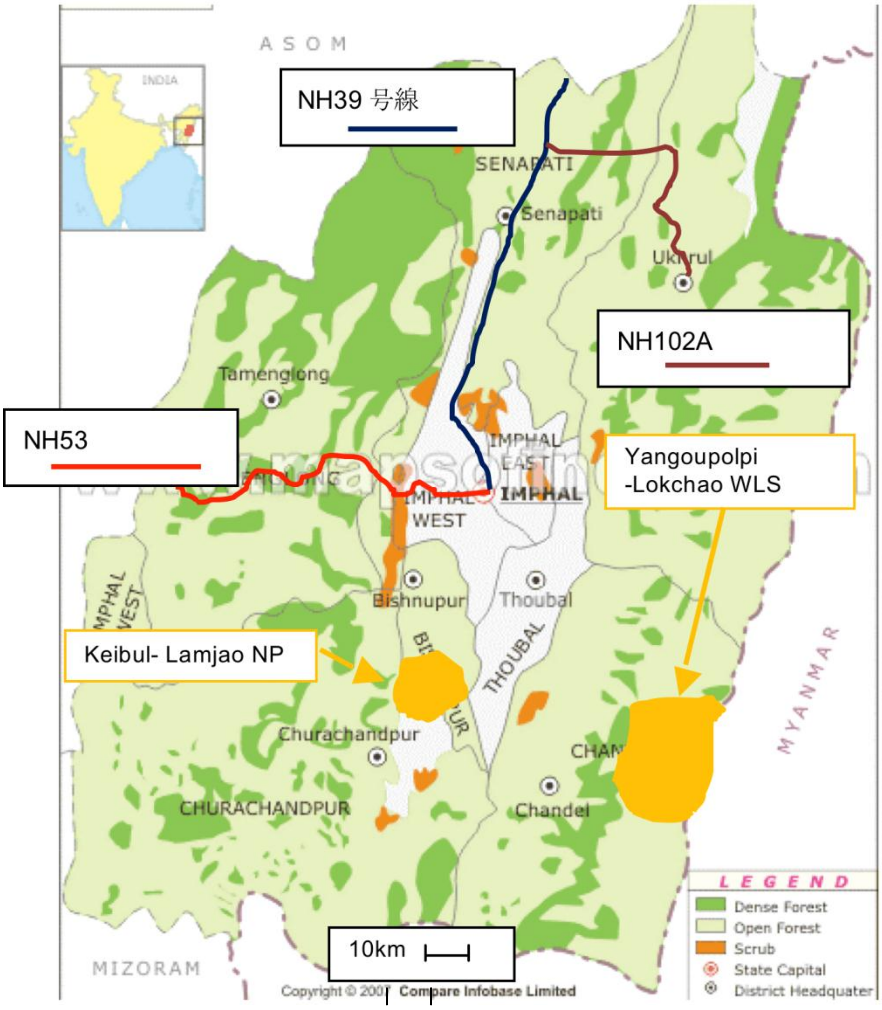
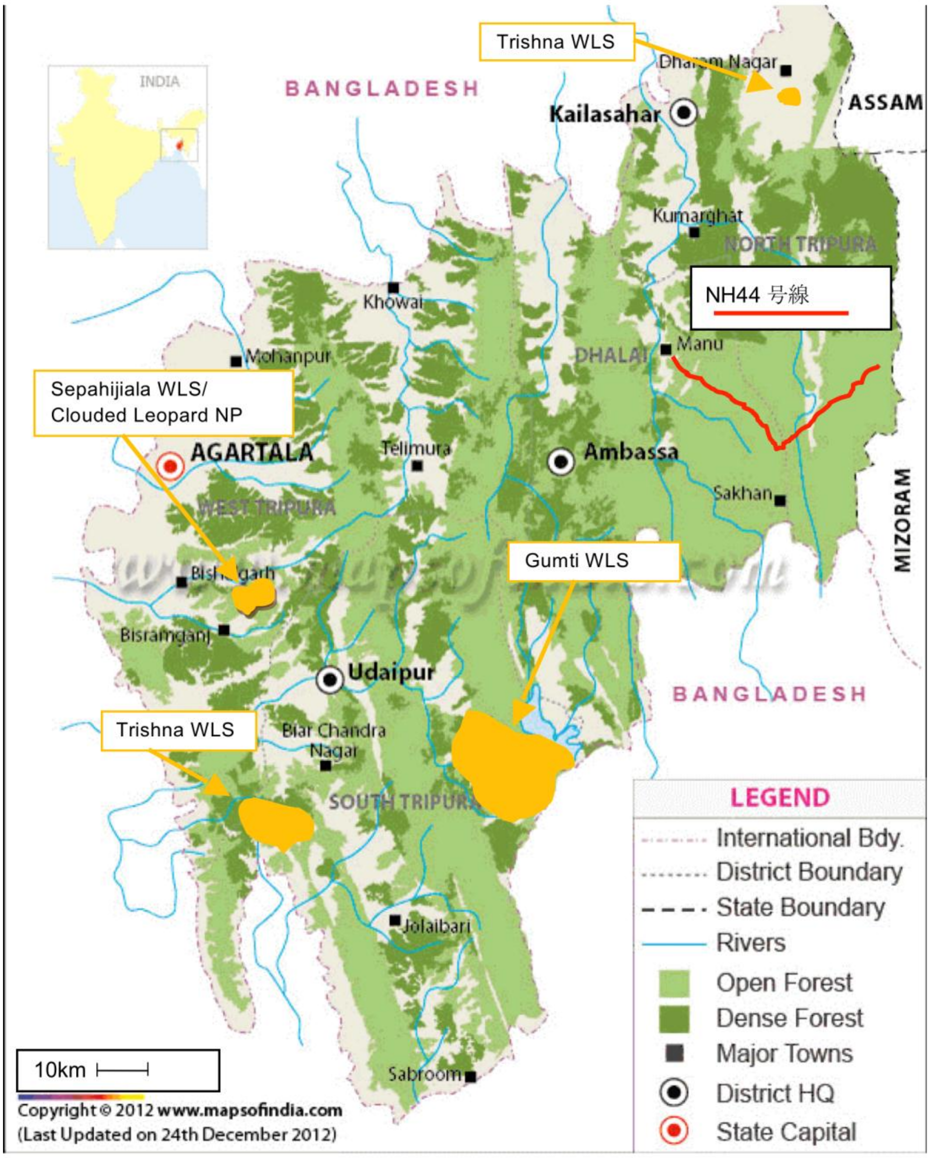


Figure 11.4Protected Area in Manipur

Tripura (NH44)

The forests in the state are mainly tropical evergreen, semi evergreen, and moist deciduous. The cropping pattern in Tripura is characterized by two distinct farming systems, i.e., Settled Cultivation in the plains and Shifting Cultivation in the hills. Shifting cultivation has been the main source of livelihood for communities in Tripura and a sizeable portion of population in the hills of Tripura still depending on jhum cultivation. According to the Task Force on Shifting Cultivation, Ministry of Agriculture (1983), the annual area under shifting cultivation was 223 km^2. As per the survey conducted by Tribal Welfare Department (1990), around 55,000 tribal households practice jhum in Tripura. For settled cultivation, paddy, pulses and oilseeds are the major crops grown in the state. Paddy is grown in 55% of gross cropped area in three seasons viz, Aush (pre-Kharif), Aman(Kharif) and Boro(Summer). Fruits and vegetables account for 21% of gross cropped area, 10% is under rubber and 9% are under other miscellaneous crops like tea, medicinal plants etc. The major Kharif crops are rice, maize, pigeon pea, black gram, green gram, cowpea, ground nut, sesame, jute, mesta, cotton, and Kharif vegetables. Different crops taken during Rabi season are rice, wheat, pea, green gram, lentil, rapeseed-mustard, potato, and Rabi vegetables. The targeted section of NH44 is mainly forested (teak forests) with patches of tea gardens and orange orchards. The map of protected area in Tripura is shown below.



11.5Protected Area in Tripura

Assam (Dhubri Bridge and Badarpurghat Bridge)

The location of National Park, Wildlife Sanctuary and Reserve Forest in Assam is shown below. The two bridge projects proposed in Assam do not interfere with protected areas.

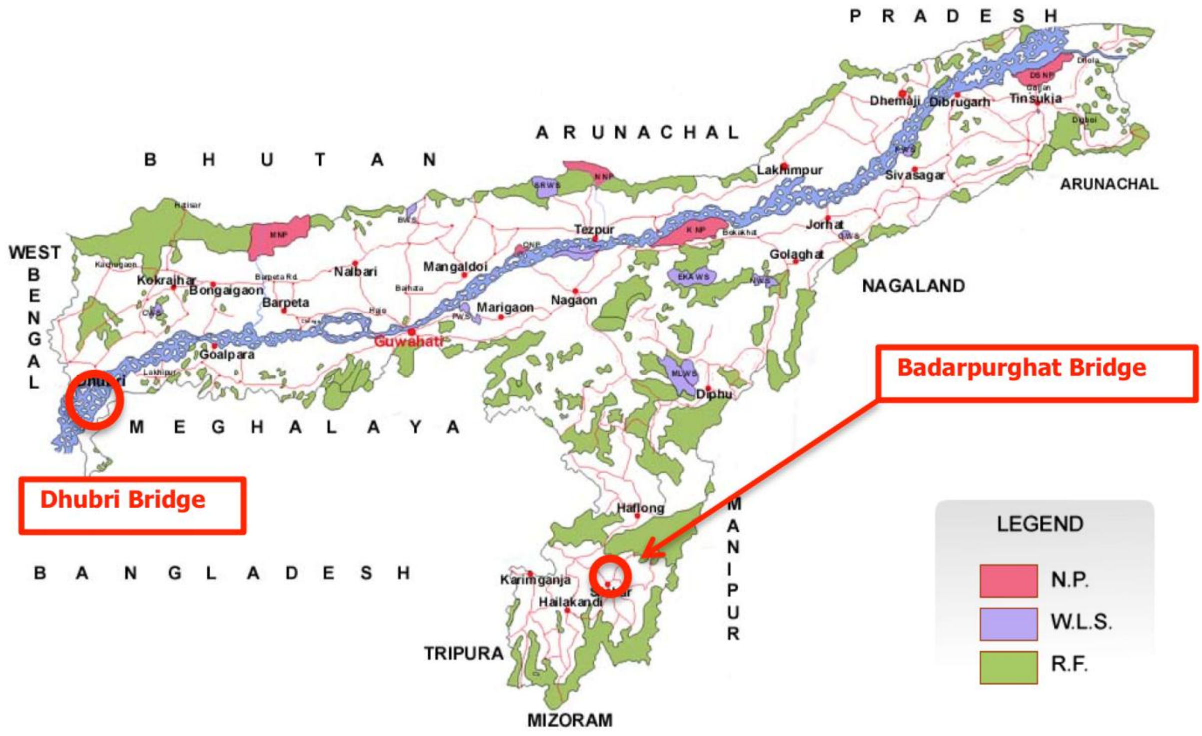


Figure 11.6Protected Area and Reserve Forest in Assam

11.4.3 Tribal/Ethnic Profile

Mizoram (NH54)

The Mizo people are an ethic group native to North-Eastern India. The termed ‘Mizo’ is made of two words, Mi means people and Zo means hill. Thus Mizo literary means “hill people”. The Mizos are broadly divided into 5 major tribes and 11 minor tribes. The 5 major tribes are Lushai, Ralte, Hmar, Paite and Pawi. The minor sub tribes are known under the common name of Awzia. The Mizos (formerly Lushais) are the largest group and influenced culturally and linguistically other tribes. Most of the people living along NH54 belong to Lushai, Lai (Pawi) or Mara (Lakher).

Mizo is the official language and most widely used language for verbal interactions, but English being important for education, administration, formalities and governance, is also widely used. The Duhlian dialect, also known as the Lusei, was the first language of Mizoram and has come to be known as Mizo language. All the tribes still have their own unique languages which are slightly different from the dominant Mizo (Duhlian) language but they can speak Mizo and communicate each other either through Mizo or English.

The Mizo ancestors had no written language and the British missionaries, but today, it has one of the highest literacy rate (91%) in India. The population of Mizoram is 1,097,206 as per 2011 Census. Christianity is the dominant region in Mizoram, followed by nearly 90% of the population. Other religions include Buddhism, Hinduism, Muslim and Sikh. There are also few tribal religions such as Lalchhungkua, Lalhnam and Nunna Lalchhungkua. Also, a modernized traditional Mizo religion called Hnam sakhua put a particular emphasis on Mizo culture and seeks to revive traditional Mizo values.

Meghalaya (NH51, 40, 62)

Meghalaya is one of the three states in India to have a Christian majority. About 70% of the population practices Christianity, with Presbyterian and Catholics the more common denominations. Close to 90% of the Garo tribe and 80% of the Khasi is Christian, while more than 97% of the Hajong, 98.53% of the Koch tribes are Hindu. The Garo people have their own religion known as Songsarek but, are followed by a very small population. Also, there are small number of Garos who follow Hindus and Buddhism. Khasi people too have their own religion followed by a large group of people and is known as Niam Shnong or Niamtre. There is also a small population of Khasi people who practice Islam. Kuki-Chin people are mostly Christians while majority of the Raba tribes are Hindu.

NH51and NH62 runs through the West Garo Hills District in Meghalaya. West Garo Hills is an administrative district in Garo Hills of the state of Meghalaya in India. Tura town is the administrative headquarters of the district. It is one of the three districts in Meghalaya currently receiving funds from the Backward Regions Grant Fund Programme (BRGF). West Garo Hills District is divided into six blocks, after the creation of South West Garo Hills District. The six blocks are Dadenggiri, Dalu, Gambegre, Rongram, Selsella and Tikrikilla.

The majority of the inhabitants of the district are Garo. Tura has a mixed population of Garos or Achiks (as they prefer to call themselves), Bengalis, Nepalese, Assamese, members of other ethnic groups such as the Hajong, Bodo, Rabhas and Koches. The languages used in this district are Garo, English, Khasi, A'tong and Hindi. Languages in West Garo include A'tong, a Tibeto-Burman language spoken by 10,000 people in Bangladesh and India.

While the whole stretch of targeted section of NH51 falls within West Garo Hills District, NH62 runs through East Garo Hills District and South Garo Hills District too. East Garo Hills District was formed in 1976 with its headquarters at Williamnagar. The district occupies an area of 2603 km^2, comprising of 5 blocks as, which are: Dambo Rongjeng, Kharkutta, Resubelpara, Samanda and

Songsak. The majority of the population are the Garos, while the other indigenous inhabitants are the Hajongs, Rabhas, Koches, Rajbansis, Kacharis and Dalus. Assamese, Bengali and Nepali are also found in this area. Garo language and English are used. East Garo's languages include A'tong language. Hindi is also used in this area.

South Garo Hills District is headquartered in Baghmara. The district occupies an area of 1850km^2. It is divided into four blocks, namely Baghmara, Chokpot, Gasuapara and Rongara. Like other Garo Hills Districts, Garo is the main language spoken. English and Hindi are also used for communication.

Shillong is the administrative headquarter of Khasi district and the capital of Meghalaya. It is the starting point of targeted section of NH40. Khasis make up the majority of the population. All the other North East tribes are represented here as well as significant numbers of Assamese, Bengali and a bit of Nepalese. Khasi language is the official language of the district and Shillong. English is also widely used. Other languages like Hindi, Assamese, Nepali and other minor dialects are also used. Apart from Khasi district, NH40 runs through Jantia Hills District near the Bangladesh boarder. West Jaintia Hills is a home to the Pnar (or Synteng or Jaintia) tribe. War Jaintias are also found in this district. Other tribes like Hmar, Bengali, Assamese and Nepalese are also found in the hill. The common dialect in West Jaintia Hills District is Pnar, belonging to the Jaintia language. Other dialects include War Jaintia speaking to the southern part of the district and Hmar/Biate, spoken by approximately 20,000 members of its namesake tribe.

Manipur (and Nagaland) (NH39, NH53, NH102A)

Manipur has a population of 2.72 million as per 2011 census. The Meitei, people of Manipur, is the largest ethnic group. A total of 29 ST are recognized in Manipur. Altogether, they constitutes 35.1% of the total population. The ST population in Manipur is predominantly rural with over 95% of them residing in rural area. The Ukhrul (NH102A), Tamenglong (NH53), Churachandpur and Chandel are predominantly tribal districts with over 90% of the districts population being ST.

While the Sanamahi (Household Deity) belief prevails over majority of the people in the valley of Manipur, particularly among the Meitei's, Christianity are more popular among people inhabiting the hilly districts. Indigenous gods are worshiped by some of the tribal communities, particularly Kabuis and Meiteis. The Meiteis believe to have 108 god in addition to Atiya Sidaba (Sky God), Sanamahi (Household Deity) and Pakhangba (Mangang Ancestor, who later became the originator of all Salais/Clan). Today, Meitei tradition is blended with Hinduism, creating a unique hybrid of Meitei and Hindu, the process referred to as "Meiteinisation of Hinduism".

Kohima (NH39) is the capital of the Nagaland state. Kohima is the land of the Angami Naga tribe. The name, Kohima, was officially given by the British as they could not pronounce the Angami name Kewhima or Kewhira. It is called after the wild flowering plant Kewhi, found in the mountains. As of 2011 census, Kohima has a population of 99,039. The town's population is composed of the 16 tribes of Nagaland. The Angamis and Aos are the largest group among them. English is the official language of Kohima. The tribes have their own dialects which they used for communication among themselves.

Tripura (NH44)

Altogether there are 19 tribes in Tripura. They could be divided into 2 major groups as (i) Ab-original and (ii) Immigrants. Aboriginal tribes are Tripuri, Reang, Jamatia, Noatia, Lushai, Uchai, Chaimal, Halam, Kukis, Garos, Mog and Chakma. Other tribes like Bill, Munda, Orang, Santal, Lepcha, Khasia and Bhutias are the immigrant tribes came and settled here for economic reasons. The Tripuris, who are also called Tripuras or Tipras, are the original inhabitants of Tripura state. They constitute about 16% of the total population and about 57% of the state's tribal population. NH44 passes through Dhalai district and the North Tripura district. North Tripura district is the home to a number of tribes including Chakmas (found in Mizoram), Koloi, Tripuri and Halam.

As per 2011 census, the population of Tripura is 3,671,032. Bengali and Kokborok or Kak-Borak (also known as Tripuri) is the official languages of Tripura. As in the rest of India, English is used for official purpose. The tribal communities have their own dialect for communication. The literacy rate of Tripura in 2011 was 87.8%. Due to heavily influence from the religious doctrine of the neighboring Bengali people in Bangladesh, majority of the Tripuri people follow Hinduism. Muslim, Christianity and Buddhism are also followed in the state.

Assam (and Meghalaya)

Dhubri district is one among the many Muslim majority districts of Assam. About 75% of population is Muslim in Dhubri. The name Dhubri comes from the tale of Chand Sadagar, where the main character of the story Netai Dhubuni used to wash her clothes on the surface of a big stone at bank of the river Brahmaputra. This particular place had a name called "Netai Dhubunir Ghat".

Modern-day Dhubri district was created on 1st July, 1983 when it was split from Goalpara district. Dhubri district occupies an area of 2,838 km2. According to 2011 census Dhubri district has a population of 1,948,632. The district has become one of the most densely populated districts in India with a density of 584 persons per km2 (as per 2001 census). Goalpariya and Bengali are the most widely spoken language in the district, although Assamese is the official language. Most of the people are Deshi (Goalpariya Assamese people which includes the Hindu and Muslim Goalpariya people) people. Only in Dhubri Town more than 50% Bengali people are present.

Phulbari is under the West Garo Hills District in Meghalaya. It is situated in the north western most corner of West Garo Hills District. It is gradually and appreciably developing into township because of its position as a station serving several routes. The River Jingiram which separates Meghalaya from Assam flows by this place. There is a ferry across the Brahmaputra connecting this place with Dhubri, some 22.4 km away. English, Khasi, Garo and A'tong are used in this area. Most of the people are Garos or Achiks, Bengalis, Assamese, Nepalese and members of other ethnic groups such as the Hajong, Rabhas, Koches and Bodo.

11.4.4 Indigenous Knowledge and Management of Natural Resources

Shifting cultivation or locally called Jhum is the most widespread type of cropping system in the North East region and is directly supported by the forest ecosystem. Jhum has been in use for centuries and still remains a major land-use proace despite recent government effort to discourage the practice (e.g. New Land Use Policy of Mizoram) and provides a basis for subsistence farming, maintenance of cultural values and social stability for the people living in low population densities. Challenges associated with jhum are often caused by the high pressure due to local population growth, rather than the inherent problem of the system itself. In recent years, local farmers are responding to the new demands of the market economy and pressure on land by diversifying the cropping patterns. For example, in Meghalaya (NH51, 62, 40), indicating that the traditional practice is not static but dynamic one that continuously evolves with the changes of outside environment. Other unique farming practice identified in the study road include the following:

Khasi tribes of Meghalaya (NH40) practices wet terrace paddy cultivation on hill slopes. This is not rain-fed but irrigated farming practice that uses local skills. Terraces are cut into slopes and carefly flooded using bamboo and locate material as water conduit. In this type of cultivation, suitable terraces are used for short-term fish farming in combination with paddy cultivation during monsoons as shown in Picture below.

Photo 11.1 Fish Pond along NH40

In Jantia hills of Meghalaya (NH40), bamboo drip irrigation is commonly practiced as a tool for water management. It is a low-cost irrigation system using locally available material. Bamboo ducts are laid out at an elevated height supported by wooden props. The practice prevents water percolation in water scarce area. In addition, a variety of water and soil conservation methods are practices in North East region. The below Table shows a set of soil conservation practices identified in the study area.

Table 11.9 Traditional Farming Practices in Study Area

Practice	Advantage	Disadvantage	Location
Bench Terrace	● Effectively control soil and water runoff and erosion ● Trap sediment in the drainage ditch built along the terrace	● Initially disturbs the soil and reduce productivity in the first 2-3 years ● Needs intensive labor, investment and skills for proper construction	NH39 (Nagaland) , NH62
Contour tillage/ planting	● Reduce runoff and soil erosion ● Reduce nutrient loss	● Improperly laid out contour line can increase the risk of erosion ● Maintenance is labor intensive	NH39, NH44, and Assam
Cover Crop	● Improve soil fertility and physical/chemical properties ● Reduce erosion and water loss ● Help to retain moisture in the soil	● May compete for soil moisture and nutrients with the perennial crops ● Involves additional farm labor and inputs ● May result in weed problem	NH51, 62, 40, 54, and 44

Hedgerows	• Reduce soil erosion • Improve fertility and soil moisture • Provide shade for young plants • Serves as a source of fodder, fuel wood and light construction materials	• Loss of land for cultivation due to establishment of contour hedgerow • Competes with food crops planted between the row for light, soil nutrients and moisture • Hedgerow plants may be hosts to pest	NH54, 39
Ridge Terrace	• Effectively control runoff and erosion on moderate slope • Relatively low labor inputs are required • Minimum disturbance of soil	• Less effective in controlling erosion than bench terrace • Need proper maintenance	All over NE region
Diversion Ditches	• Protect cultivated land from hillside runoff • Control gully erosion	• The ditch can overflow onto the farm during heavy rain • Need support structure such as check dam and drops for effective control of erosion • Need continuous repair and de-silting	All over NE region
Drop structure	• Control the upstream water velocities to reduce erosion • Drops the water flow to a lower level and control downstream erosion	• Require skills for construction	All over NE region
Gras strip	• Control soil erosion and runoff • Provide fodder	• Require labor for management of grass strip • Mulching of grass cutting may contribute to weed problem	All over NE region
Soil barriers/traps	• Slow down surface runoff • Retain sediment behind the fences/traps • Prevent widening and deepening of gullies	• Wooded barriers do not usually last for more than 25 years • Construction requires significant labor input • Require continuous maintenance to prevent overtopping during heavy rains	All over NE region
Water harvesting	• Improve food production • Promote conservation and ecological balance • Easy to construct and allow irrigation by gravity	• Require large labor input • High seepage and evaporation is possible • Floating vegetation may infest reservoir	All over NE region

Source: Adopted from the Anthropology of North-East India, edited by T.B. Subba and G.C. Ghosh

11.6 EIA and RAP Study for NH54

As discussed in Section 11.2.1, EIA is not required for widening and improvement of NH54 according to Indian regulation. In line with JICA Guidelines for Environmental and Social Considerations, however, EIA has been prepared and shared with relevant MOEF as well as Mizoram State Government.

11.6.1 Scope of the Project

The targeted section of NH54 starts from Aizawl in Mizoram state to Tuipang with total length of approximately 381km. The study road mainly passes on brow of variegated mountains and alignment of the study road consist of many small horizontal and vertical curves as shown in Figures below.

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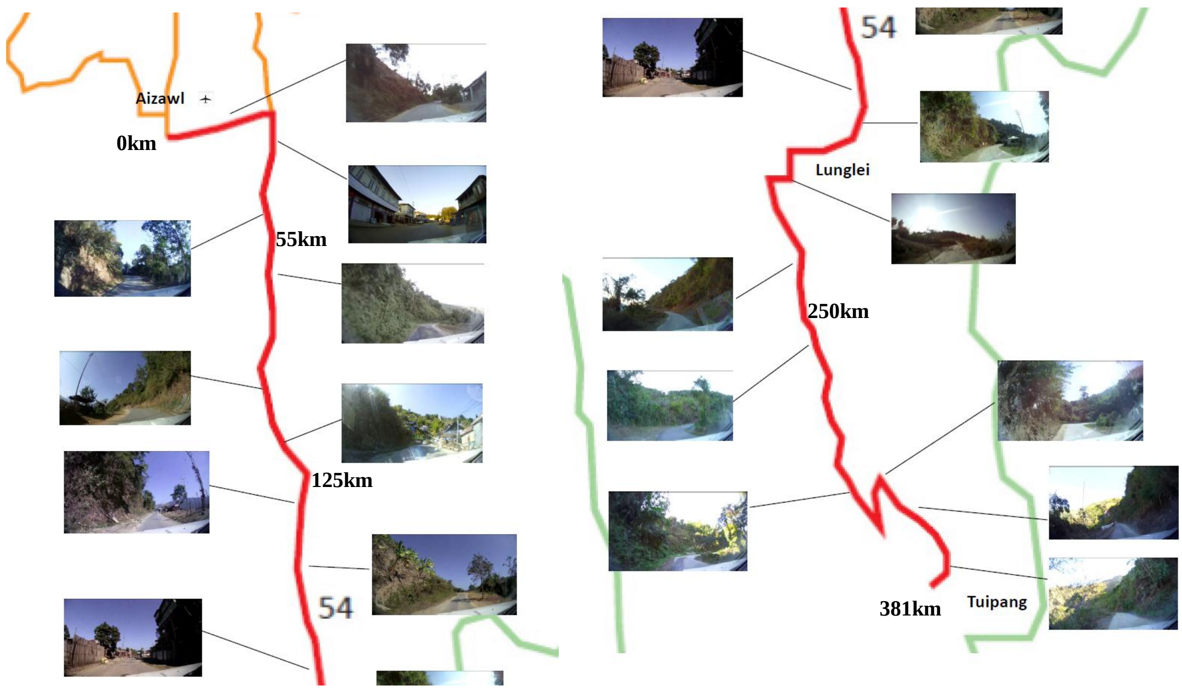


Source: JICA Study Team

Figure 11.7 Road Alignment and Present Road Condition of NH54

The number of lanes is 1.5 lanes for the section near Aizawl and 1.0 lane for other sections. Pavement condition between Aizawl to Lunglei is fair, while section between Lunglei and Tuipang is deteriorated due to inadequate road maintenance. Existing condition of the targeted section of NH54 is shown in Table 12.10. The project involves the widening of existing one-lane road to two-lane roads with installment of proper slope protection and land slide prevention measures, drainage and traffic safety facilities. The total width of the road including carriageway and road shoulder will be 12m except for four sections for which new bypasses are proposed. The details of the proposed improvement, including design of culvert and slope protection measures, are discussed in Chapter 7.

Table 11.10 Present Conditions and Provisional Improvement Cost of NH54

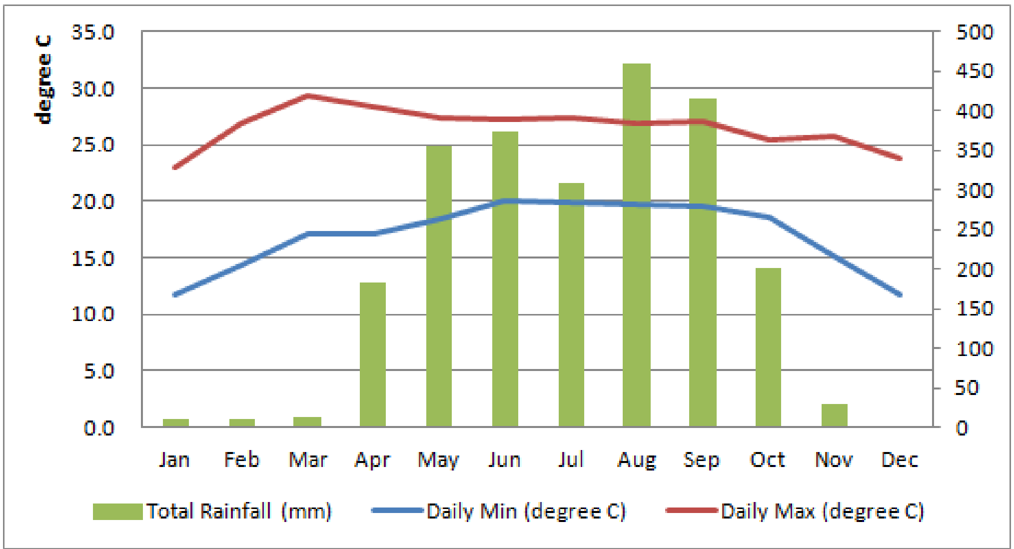
No.	Data Items	Type / Unit		Road			
				NH54 (Upper: KM distance from Aizawl, Lower: KP)			
				0-55	55-125	125-250	250-381
				181-236	236-306	306-431	431-562
1	Number of Lanes	Four (4): Carriageway Width (7m+7m), Double (2): Carriageway Width (7m/10m), Intermediate (1.5): Carriageway Width (5m/5.5m), Single (1): Carriageway Width (3.5m/3.75m) New (0)		1.5	1	1	1
2	Carriageway Width	m		5.5	3.75	3.75	3.75
3	Shoulder Width	Average in section / m		0.4	0.5	0.4	0.45
4	Shoulder Type	Paved or Unpaved		Unpaved	Unpaved	Unpaved	Unpaved
5	Average Altitude	m		714	860	724	853
6	Average Roughness	IRI		4.5	5	6.2	9.1
7	Total Area of Crack	%		6.3	7.5	25	62
8	Ravelled Area	%		6.3	10	5	4
9	No. of Pot Holes	per km		5	5	21	7
10	Edge Break Area	m2/km		50	100	50	20
11	Road Side Friction	%		50	15	10	5
12	Average Travel Speed	km/h		30	26	23	21
13	Road Capacity	PCU – IRC73-1980		5,000	1,000	1,000	1,000
14	Improvement Project Cost (W=12m: Carriageway 3.5mx2+ Shoulder 2.5mx2)	Mountainous (INR crore/km)	9	495	630	1125	1179
		Rolling (INR crore/km)	5.5	0	0	0	0
		Level (INR crore/km)	4	0	0	0	0
		Long Bridge (INR crore/km)	120	0	0	0	0
		Total (INR crore)		495	630	1125	1179

Source: JICA Study Team

11.6.2 Natural Environment

1) Climate

Mizoram has a mild climate, relatively cool in summer 20 to 29 °C (68 to 84 °F) and winter temperatures range from 7 to 22 °C . The region is influenced by monsoon, raining heavily from May to September with little rain in the dry-season. The climate pattern is moist tropical to moist sub-tropical, with average state rainfall 254 centimeters per annum. In the capital Aizawl, rainfall is about 215 centimeters and in Lunglei, another major town of the state, about 350 centimeters.



Source: Mizoram Statistical Handbook 2014

Figure 11.8 Monthly rainfall and daily maximum and minimum temperature in Aizawl (2013-2014)

2) Topography, Geology, and Soil

Mizoram has the most variegated hilly terrain in eastern part of India. Mizoram is mostly covered with hills. The hills are steep and are separated by rivers, which flow either to the north or south, creating deep gorges between the hill ranges. Eastern sector is higher than western sector. Average height of the hills is about 900 meters. The highest peak in Mizoram is the Blue Mountain (Phawngpui) with a height of 2210 meters.

The Geology of Mizoram consists of a repetitive succession of Neogene (Tertiary) arenaceous and argillaceous sediments occurring in a series of approximately North- south trending longitudinal plunging anticlines and synclines. The topography of the area is often a good indication of lithology and argillaceous groups of rocks occur in relatively lower altitudes as compared to arenaceous rocks. The parent materials are predominantly shales and siltstone, with a reasonable percentage of day minerals. As the rocks are relatively impermeable, the dry months provide opportunity of desiccation of the upper topsoil creating some weak bond by geo-chemical processes (laterisation, limonisation, or sometimes kaolinisation). The common rocks found are sandstone, shale, silt, stone, clay stones and slates. The rock system is weak and unstable prone to frequent seismic influence.

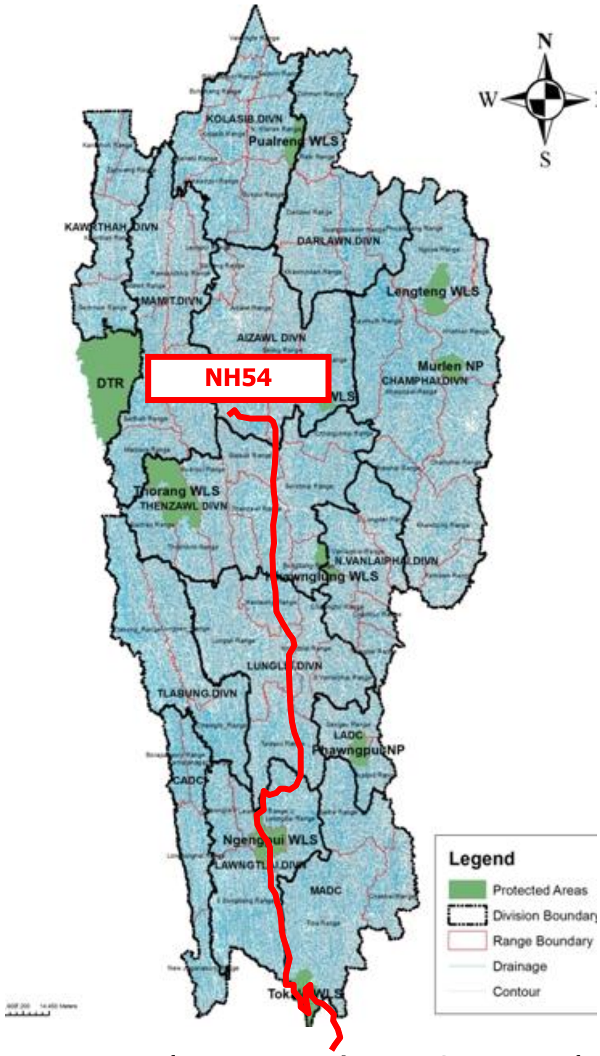
Soil texture, in general, varies from sandy loams, clayey loams to clay. Although the soils are mature, profuse rainy spells in the region coupled with the high gradients have accelerated the problem of leaching of the loose soils. These soils are highly porous with low water holding capacity and this is the main cause of the low water table in Mizoram. The soils of Mizoram are deficient in potassium, phosphorous, nitrogen and humus. The traditional jhum cultivation has adversely affected the productivity. Although superficial greenery is observed owing to the profuse rainfall, the tract is actually in the process of fast degradation. The pH of these soils is acidic to neutral due to excessive leaching. The soil structure of the project area is summarized below.

3) Flora and Fauna

Mizoram is the highest forest cover state in the India, having about 90 % of the total geographical area is under forest (India State Forest Report FSI, 2013). In flora assessment, 57 tree species, 30 shrubs species & 52 herb species recorded from the study area. There is no unique faunal community within the project area, except most common ones like toad, frog, crow, sparrow and myna, Loris, etc. In addition to that some of the insects like moths, stick insects, dragonflies, beetles, cockroaches, grasshoppers were also found. None of the species found in the study area are listed as endangered (EN), threatened (TN) or near threatened (NT) according to IUNC Red List Category.

4) Protected Area and Forest

There are a total of nine protected area (National Park, Wildlife Sanctuary, Tiger Reserve) in Mizoram, but the targeted section of NH54 does not traverse or border with any of them. According to the discussion with the official in State Environment and Forest Department, two Wildlife Sanctuaries, namely Twi WLS and Khawnglung are closest to the road but they are approximately 10km away from the road and project will not cause direct impact to WLS.



Source: Department of Environment and Forests, Government of Mizoram

Figure 11.9Protected Area in Mizoram

Similarly, no reserve forest will be affected by the project. However, the project runs through open forest, jhum land (shifting cultivation) and abandoned jhum area. Given that the forest and forest produces play an important role in local livelihood, efforts are needed to minimize deforestation and to disturbance during construction stage.

11.6.3 Social Environment

Mizoram name derived from Mi (Peoples), Zo (Hills) & Ram (Land) thus Mizoram implies '*land of the hilly peoples*'. The meaning itself shows social structure of the Mizoram state. The Mizos are broadly divided into 5 major tribes and 11 minor tribes. The 5 major tribes are Lushai, Ralte, Hmar, Paite and Pawi. Mizo is the official language and most widely used language for verbal interactions, but English being important for education, administration, formalities and governance, is also widely used. The Duhlian dialect, also known as the Lusei, was the first language of Mizoram and has come to be known as Mizo language. All the tribes still have their own unique dialects which are slightly different from the dominant Mizo (Duhlian), but they can understand each other without problems. As per 2011 census, total population of Mizoram is 1,097,206. Out of these, the number of male and female are 555,339 and 541,867 respectively. The Lushai tribes constituted the majority of the Mizo population. Population density of Mizoram is 52 per km^2. The literacy rate in Mizoram is 91.3% as per 2011 census.

The majority of the Mizo people are Christian. The major Christian denominations are Presbyterian, Baptist, United Pentecostal Church, Roman Catholic, the Salvation Army, Congregational Church of India (Maraland), Seventh-day Adventist, among others. There are other religions like Buddhism, Hinduism, Muslim and Sikh. There are few people who practice Judaism claiming to be one of the lost Judaic tribe group Bnei Menashe and a modernized traditional Mizo religion called Hnam sakhua, which put a particular emphasis on Mizo culture and seeks to revive traditional Mizo values. There are also few tribal religions such as Lalchhungkua, Lalhnam and Nunna Lalchhungkua.

The summary of each district in Mizoram is shown below. Five districts where the targeted section of NH54 passes through are highlighted.

Table 11.11 Snapshot of District in Mizoram

District	Description
Aizawl	Situated between the Tlawng River valley in the West and Tuirial River valley in the East. It is home to the Mizo tribes who are said to have migrated from Myanmar's Chin Hills 300 years ago. Being the capital city of Mizoram it is a political, commercial, educational and cultural hub of the state, housing all important government offices, the State assembly and secretariat, and tourist spots, including some beautiful churches and markets.
Lunglei	It is the biggest district (21.52 % of the total land area) bounded on the north by Mamit and Serchhip Districts, on the south by Lawngtlai and Saiha districts, on the east by Myanmar and on the west by Bangladesh, having dense forest area covering 524.63 sq.kms.
Champhai	Located near the India-Myanmar border, it serves as a gateway of all business activities between India and Myanmar. It is a fast developing venue on the Indo-Myanmar border. The famous Rihdil Lake is only about 50 kms away from the town of Champhai. Champhai valley known as "The Rice bowl of Mizoram" is located towards the base of the town. A chain of green hills encircle luxuriant rice fields, which add to the beauty of this place.
Lawngtlai	Located in the southern most part of Mizoram having common international borders with Bangladesh in the west and Myanmar in the east. It also shares common boundaries with Lunglei and Saiha District in the north and south respectively. Unlike other districts, it has two Autonomous District Councils within the District, namely the Lai Autonomous District Council (LADC) and the Chakma Autonomous District Council (CADC) with their headquarters at Lawngtlai and Kamalanagar respectively, and are administered in accordance with the provisions of the Sixth Schedule of the Constitution of India.
Mamit	Mamit District was created after bifurcation of the erstwhile Aizawl District in 1998. It is bounded on the north by Assam state, on the west by Tripura state and Bangladesh, on the

	south by Lunglei district, and on the east by Kolasib and Aizawl districts. It is 4th largest district in Mizoram in terms of total area. It receives abundant rainfall. The five main big rivers are Tlawng, Tut,Teirei, Langkaih and Khawthlangtuipui. Women Play major role in the society as well as in the family.
Kolasib	The District is bounded by Assam on the north and north west side, on the south and east by Aizawl, and on the south west by Mamit District. The location of the district occupies an important site as it is the main stream of road communication from other state of Mizoram. NH 54 passes through the middle of the district from north to south direction. The only Rail head in the state located at Bairabi. There are some worth visiting sites in and around the district which include Dampa Wildlife Sanctuary and Tlawng River.
Serchhip	Serchhip is located in the central part of the state of Mizoram; adjoined by Champhai District in the East, Aizawl in the North and North West, and Lunglei District in the South. The district has the highest literacy all over India. It lies between the two very important rivers of Mat and Tuikum. While River Tuikum is source for drinking water for Serchhip, River Mat is source for irrigation water for Zawlpui, the rice bowl of Serchhip. Serchhip is also the main producer of cabbages and mustards in Mizoram.
Saiha	Saiha District is situated on the southern-most fringe of the North-eastern region of India and shares border with Myanmar on the eastern and southern side. Administratively, it is divided into two blocks-Saiha and Tuipang. It is the third most developed and also the third most populous town in Mizoram State apart from the state Capital - Aizawl and Lunglei. It is also the capital of the third largest tribe - the Maras in Mizoram.

Source: JICA Study Team

The Net State Domestic Product (NSDP) for the year 2012-13 was about Rs 7,556 Crores, and the Per Capita Income (PCI) during the same period was Rs. 63,413. It has also been observed that during the period 2004-05 to 2012-13 the economy of the state grew at a compound annual growth rate of 9.3%, with Primary Sector growing at 7.6%, Secondary Sector at 7.9% and the Tertiary Sector at 10.3%. During the same period the per capita income of the state grew at 6.8%. The main occupation of the people is agriculture. About 80% of the population are agriculturist. Rice is the main crop of Mizoram and besides rice, maize, potato, ginger, tumeric, black pepper, chilies and a variety of fruits are grown. In Mizoram, the ownership of land is vested with the government, which issues periodic pattas to individual cultivators. The Village Council distributes the plots of land among the villagers for cultivation every year. The agricultural system practiced is of the primitive type of ‘jhum’ or ‘slash and burn’, a practice that has been regarded as detrimental to the top layer of the soil, rendering it to become loose and soft and susceptible to frequent soil erosion. The government is attempting to bring about a change to the practice of ‘jhum’ by introducing ‘terrace cultivation’ which is ideal for the hill slope. The main horticulture crops are fruit crops like Mandarin orange, banana, passion fruit, grapes, hatkora, pineapple, papaya, etc. and flowers like anthurium, bird of paradise, orchid, rose and other subsidiary seasonal flowers. People have also started extensive cultivation of oil palm, medicinal and aromatic plants.

11.6.4 Legal Framework for Environmental Considerations

While Environmental Clearance is not required for this project, various clearance will be required for setting up hot-mix plants, batching plants, etc., under the Air and the Water Acts. Clearance from the State Department of Mining is required for establishing quarries. Clearance from the Sate Ground Water Boards/Authorities is required for establishment of new tube-wells/bore-holes in case they are required during construction work. Also, the provisions as laid down in the Factories Act, 1948, Labor Act, 1988 and the Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 with respect to hygiene and health during the construction stage would apply for this project. With limited possibility, the provisions of the Hazardous Wastes (Management and Handling) Rules, 1989 and the Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996 may also apply during the construction and the operation periods. The applicability of environmental and other relevant rules and acts is shown in Table 11.12 below.

Table 11.12 Clearance Requirements

No.	Activity	Statute	Requirement	Competent Authority	Responsible Agency for Obtaining Clearance	Time Required
Pre-Construction Stage (Responsibility: MORTH)						
2	Road-side tree cutting and clearing forest for resettlement sites and surplus soil dumping	Forest Conservation Act1980 & MOEF Letter Dt.18.02.1998	Permission for Road-side tree cutting	State and Central Government	MORTH	2-3 months
3	Filling of Roadside water bodies (ponds and borrow pits)	State Fisheries Policy Draft Wetlands (Conservation & Management) Rules, 2008	Permission for filling of water bodies	State Irrigation Department State Fisheries Department State Wetlands Conservation Committee	MORT&H	2-3 months
Construction Stage (Responsibility: Contractor)						
1	Establishing stone crusher, hot mix plant, wet mix plant and Diesel Generator Sets	Water Act of 1974, Air Act of 1981, Noise Rules of 2000 and Environmental Protection Action of 1986 and as Amended	Consent-forest abolishment	States Pollution Control Boards for respective section	The Contractor	2-3 months
2	Operating stone	Water Act of 1974, Air Act of	Consent-for operation	States Pollution Control Boards	The Contractor	2-3 months

	crusher, hot mix plant, wet mix plant and Diesel Generator Sets	1981, Noise Rules of 2000 and Environmental Protection Action of 1986 and as Amended		for respective section		
3	Use and storage of explosive for quarry blasting work	India Explosive Act 1984	Explosive licence for use and storage	Chief Controller of Explosives	The Contractor	2-3 months
4	Storage of fueloil, lubricants, diesel etc. at construction camp	Manufacture storage and Import of Hazardous Chemical Rules 1989	Permission for storage of hazardous chemical	States Pollution Control Boards for respective section and or Local Authority (DC)	The Contractor	2-3 months
5	Quarry Operation	State Minor Mineral Concession Rules, The Mines Act of1952, Indian Explosive Act of1984, Air Act of1981 and WaterAct of 1974	Quarry Lease Deed and Quarry License	State Department of Mines and Geology	The Contractor	2-3 months
6	Extraction of ground water	Ground Water Rules of 2002	Permission for extraction of ground water foruse in road construction activities	State Ground Water Board	The Contractor	2-3 months
7	Engagement of labor	Labor Act	Labor license	Labor Commissioner	The Contractor	2-3 months

Mizoram has its own biodiversity rules (Mizoram Biodiversity Rules 2010) and forest act (the Mizoram Forest Act, 1955 and its amendment), but they do not trigger additional requirements in terms of environmental and social considerations other than those already prescribed in national-level legislation.

11.6.5 Institutional Setup

The environmental regulations, legislation, policy guidelines and control that may impact this project, are the responsibility of a variety of government agencies. In all, following agencies would play important roles in this project.

(1) Ministry of Environment and Forests (MOEF)

The primary responsibility for administration and implementation of the Government of India's (GOI) policy with respect to environmental management, conservation, ecologically sustainable development and pollution control rests with the Ministry of Environment and Forests (MOEF). Established in 1985, the MOEF is the agency primarily responsible for the review and approval of EIAs pursuant to GOI legislation.

(2) MOEF Regional Offices

The Ministry of Environment and Forests (MOEF) has set up regional offices, with each region having an office. The office that cover North Eastern zone including Mizoram is located at Shillong, Meghalaya. This office is responsible for collecting and furnishing information relating to EIA of projects, pollution control measures, methodology and status, legal and enforcement measures and environmental protection in special conservation areas such as wetlands, mangroves and biological reserves.

(3) Central Pollution Control Board (CPCB)

Statutory authority attached to the MOEF and located in New Delhi, the main responsibilities include inter alia the following:

- Planning and implementing water and air pollution programs;
- Advising the Central Government on water and air pollution programs;
- Setting air and water standards; and
- Coordinating the various State Pollution Control Boards.

The role of the CPCB, (for this project) will only be in an advisory capacity while the project shall adhere to the norms and standards set up by the Mizoram State Pollution Control Board (MSPCB).

(4) Departments of Environment and Forests (DOEF)

They perform the functions similar to the MOEF at the state level.

(5) Mizoram State Pollution Control Board (M-SPCB)

The M-SPCB has the mandate for environmental management at the state level, with emphasis on air and water quality. The board is responsible for:

- Planning and executing state-level air and water initiatives;
- Advising state government on air, water and industry issues;

- Establishing standards based on National Minimum Standards;
- Enforcing and monitoring of all activities within the State under the Air Act, the Water act and the Cess Act, etc.;
- Conducting and organizing public hearings for projects as defined by the various Acts and as stipulated by the Amendment (April 1997) to the EIA Act; and,
- Issuing No-objection Certificates (NOC) for industrial development defined in such a way as to include road projects as the Third National Highway Project.

(6) Mizoram State Forest Department

The Mizoram State Forest Department is responsible for the protection and managing the forest designated areas within the state. The Forest Department works out Forest Working Plans for the various forest divisions to manage and protect the forest resources. These plans form the basis for managing the forest resources and for chalking out specific plans and policies with respect to the conservation, protection and development of the forest areas. The Forest department will be responsible for granting clearances for forest areas that need to be cleared for the project, according to the provisions of the Forest (Conservation) Act, 1980.

11.6.6 Analysis of Alternatives

The scope for alternative is limited due to hilly nature of the terrain and the nature of the project, which essentially aims to improve and widen existing road. In developing a proposed preliminary road design, three concepts of alternatives have been as shown below.

Table 11.13 Concepts of Alternatives

No.	Option	Contents
0	Zero-Option (without project)	Existing road and slope conditions will persist. Poor pavement condition will lead to more vehicular emissions with detrimental impacts on health and ecosystem. Also, continuation of uncontrolled encroachment will increase the risk of traffic accident in built-up areas. Poor road network continues to be a bottleneck of economic development and also undermine positive benefits of ongoing Kaladan Multimodal Transport Project, which provides additional network from Mizoram to Haldia/Kolkata ports through NH54 and Kaladan River in Myanmar.
1	Applying the same design standard across the whole stretch based on the IRC	The same standard for widening/improvement will be applied across the whole stretch irrespective to geological condition and socio-economic conditions. While the positive impact of widening is significant, the project will trigger significantly more resettlement compared with option 2. Also, geometric improvement of many hair-pin curves will trigger more cutting and filling, increasing impacts on

No.	Option	Contents
		forest and leads to higher project implementation cost. The number of traffic accident will also increase due to the increased speed of vehicles passing through built-up areas.
2	Selective widening considering social impacts	The level of widening will be minimized in heavily built-up area to reduce the scale of resettlement. This option is desirable from socio-economic point of view, but the positive impact in terms of improvement of the road network in the region may be slightly limited compared with option 1.
3	New bypass to avoid densely built-up areas	A new bypass will be constructed in densely built-up areas to avoid resettlement. The option will minimize the scale of resettlement, but the impact on forest and agricultural land (jhum) will be significant as the new road will be constructed in open forest. The bypass will be required in the longer-term to accommodate project increase in traffic demand in the future, but its environmental impact as well as economic feasibility will have to be studied in more details.

Source: JICA Study Team

The illustrative images of widening concepts are shown below.

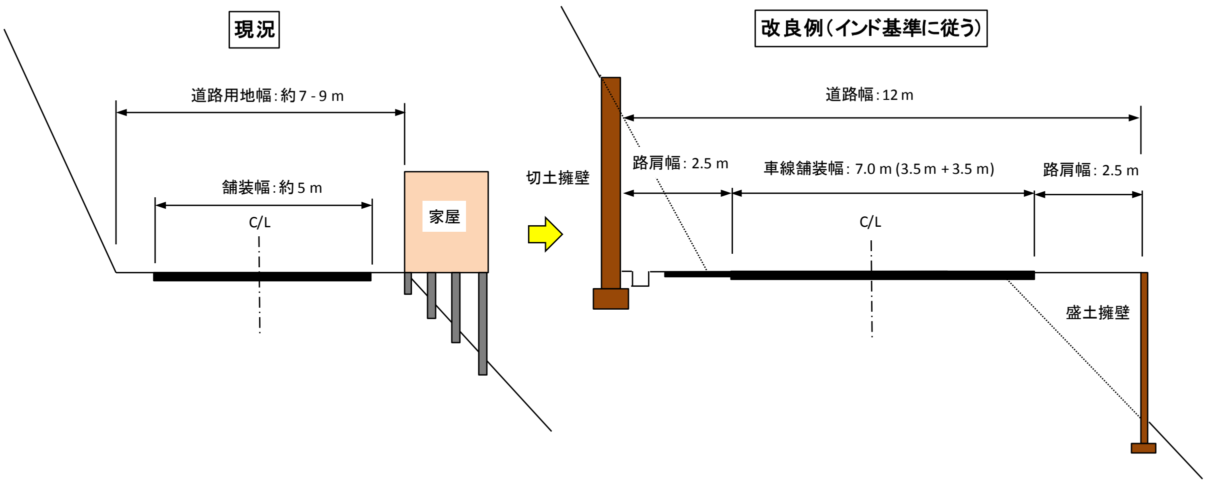


Figure 11.10 Alternative One (Widening based on IRC Standard)

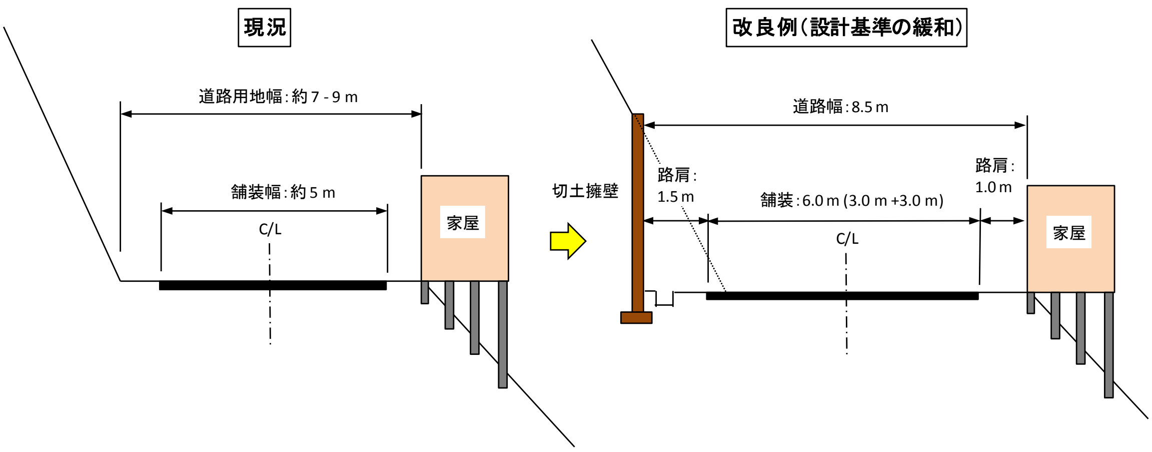


Figure 11.11 Alternative Two (Limited Widening)

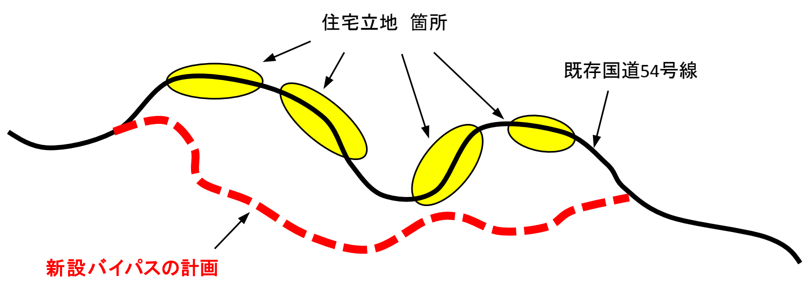


Figure 11.12 Alternative Three (New Bypass)

A comparison of three options is provided in Table 11.14.

Table 11.14 Review of Alternatives

Alternative	Zero Option	One	Two	Three
General Objective	No project. Continue business as usual without intervention.	Follow Indian standard and ensure road capacity will be sufficient over the long-run	Minimize the scale of resettlement	Avoid resettlement
Resettlement	N/A	× Trigger significant resettlement. Preliminary assessment suggest that expansion beyond 15m can result in resettlement of more than 5,000 households.	○ ROW 12m will be adopted in general, except for hair pin curves. Impact will be reduced compared with Option One. 1,937 households will be affected in total.	◎ Minimum impact, but create negative impact on natural environment
Impact on natural environment	△ No immediate impact, but slope failure and soil erosion without proper management will eventually degrade natural environment	◎ Limited impact as the engineering work will be limited in the side of existing road	◎ Limited impact as the engineering work will be limited in the side of existing road	× A more detailed analysis is needed to assess potential impact for new bypass to be constructed in open forest
Pollution	× No immediate impact, but poor road and growing level of congestion will lead to elevated pollution level in the long-run, particularly in built-up area	○ The option leads to least level of congestion and thus least to relatively small increase in vehicular emissions.	△ More congestion will be expected compared with option one, but still leads to better situation compared with without project scenario.	◎ Traffic will not pass through densely built up area and thus the health impact associated with greater vehicular emission will be minimized.
Traffic Safety	× Likely to deteriorate further as no safety measures will be implemented.	○ Proper safety measures inc. traffic signs will be required as the speed of vehicles passing through built-up area is likely to increase.	○ Proper safety measures inc. traffic signs will be required as the speed of vehicles passing through built-up area is likely to increase.	◎ The traffic does not pass through densely built-up area and thus the risk of accident will be reduced.

Alternative	Zero Option	One	Two	Three
Construction cost	N/A	△ Require significant cost associated with land acquisition and resettlement.	◎ The cost associated with land acquisition and resettlement will be less than option one.	× While the cost associated with resettlement will be least among three options, cost of constructing new bypass will be significant.
Overall Evaluation (Ranking in bracket)	**4**	**3**	**1**	**2**
	Given the vulnerability of existing road against landslide and the importance as the key infrastructure in the state, it is not recommended to keep the condition as it is.	The option will trigger significant resettlement. Given the limited availability of open and flat land, preparation of new resettlement site will be necessary.	The scale of widening is compromised in some areas, but this level of widening will be sufficient for caring existing and projected traffic volume in mid-terms.	The scale of resettlement will be minimum, but the high cost associated with bypass construction will undermine economic viability of the project.

Note: ◎: most desirable, best among the option; ○: desirable but better option is available; △: other option is preferable; × should be avoided

Source: JICA Study Team

Option two has been identified as the most viable option for this project. However, considerable expectation for new bypasses has been observed during consultation meetings, particularly from residents in large village in which widening is likely to trigger significant resettlement. Meanwhile, the construction of new bypass requires various additional studies, including topographic survey and environmental assessment, particularly review of forest fauna and flora. After a review of likely resettlement impact, future traffic volume and economic viability of the project in the long-term, and feasibility from engineering g point of view, four major villages with over 4,000 population, namely: Chhiahtlang, Serchhip, Hnathial and Lawngtlai, have been selected for bypass construction. Since the detailed environmental assessment for four bypass options is outside the scope of this EIA, a separate study for proposed bypass sections, including detailed flora and fauna survey, will be carried out. Preliminary drawing of Bypass route is included in Chapter 7.

For sections where bypass is under consideration, it is proposed that the project will only improve existing road (e.g. install new drainage, improve pavement) without widening. One of the main rational of constructing new bypass is to avoid disturbance to local livelihood in densely built-up area. From the traffic demand of point of view, the new bypass will have sufficient capacity to hand additional traffic volume in the future and thus widening (and resettlement associated with it) will not be necessary for section where bypass is proposed. Nevertheless, to improve traffic flow and safety, and increase resilience against natural disaster, improvement, such as installing proper drainage, will be carried out.

11.6.7 Scoping of Environmental Impact

Building on the generic Scoping Matrix (Table 11.4), Scoping Matrix for NH54 widening and improvement has been prepared as below. Items for which larger negative impacts are expected as compared with the generic scoping are highlighted.

Table 11.15 Scoping Matrix for NH54 Widening and Improvement

Sl.	Item	Scoping Result			Rational of Assessment
		P	C	O	
Natural Environment					
1.1	Climate/ Meteorological Phenomena	D	D	D	P: No impact is expected as no engineering work is carried out at this stage.
					C/O: The impacts on micro-climate and micro meteorological phenomena are negligible because the project-related structures will not disturb wind path.
1.2	Topography	D	B-	D	P: No impact is expected as no engineering work is carried out at this stage.

					C: Changes in topographic conditions are expected due to the requirement of cutting filling work. Balancing the volume of cutting and filling is recommended to minimize the volume of spoil soil.
					O: Topographic condition will be stable after the completion of construction work which include slope protection and slope stabilization.
1.3	Geology	D	D	D	P/C/O: No impact is expected as the project does not alter geological condition of the area.
1.4	Soil Erosion	D	B-	B+/B-	P: No impact is expected as no engineering work is carried out at this stage.
					C: Soil erosion is expected particularly during the monsoon period. Construction work should avoid the monsoon period.
					O: Poor condition of drainage causes soil erosion in existing road. The project is expected to improve the condition and thus reduce the risk of soil erosion, but measures for slope protection and stabilization and prevent soil erosion, particularly during the monsoon period, must be in place and regularly monitored.
1.5	Hydrology	D	B-	B-	P: No impact is expected as no engineering work is carried out at this stage.
					C: Construction work may cause minor, temporary impacts on hydrology.
					O: Cutting and/or filling may result in changes in local hydrology. New drainage and culvert will be installed, taking into account the likely water flow in the area.
1.6	Groundwater	D	D	D	P: No impact is expected as no engineering work is carried out at this stage.
					C: The project does not envision the use of groundwater and thus no impact is expected. However, appropriate measures should be undertaken to properly manage effluent during construction.
					O: No impact is expected during the operation stage.
1.7	Ecosystem, Flora, Fauna and Biodiversity	D	B-	B-	P: No impact is expected. No unique/endangered species have been identified during assessment.
					C: The project will not affect pristine ecosystem as the work will be carried out along the existing road. However, construction work will affect mountain ecosystem and local flora and fauna including jhum and plantation.
					O: Increases in traffic volume will have negative impact ecosystem and flora and fauna along the road.
1.8	Protected Areas/Forest	D	B-	B-	P: The targeted section of NH54 does not traverse or border with national parks or protected forest.
					C: By the construction work, some of the forest (including plantation and village forest) area will be affected.
					O: Increases in emissions due to greater traffic volume will negatively affect forest and surrounding ecosystem.
1.9	Coastal Zone	D	D	D	P/C/O: No impacts are expected, because the alignment is far away from the coastal zone and the planned alignment will not pass the tidelands and the mangrove forests which are peculiar to the coastal region.
1.10	Landscape	D	D	B+	P: No impact is expected since the project at this stage does not alter existing condition.

					C: Changes in landscape during the construction work will be minor and temporary. The project should explore possibilities to utilize scenic/view points along the road to strengthen tourism potential in north eastern region of India.
					O: Improved road network facilitates access to scenic places and tourist attractions, thereby positively contributing tourism in the region. Bus bay and other road amenities also help improve aesthetic conditions of the road.
1.11	Natural Disaster	D	B-	B+	P: No impact is expected since the project at this stage does not alter existing condition.
					C: Many areas of the road are prone to landslide and thus appropriate measures should be in place during the construction work to avoid accidents. Construction during the monsoon period is risky and should be avoided.
					O: Slope protection/stabilization measures and drainage are expected to significantly reduce the risk of natural disaster.
Living Environment (Pollution Control)					
2.1	Air Pollution	D	B-	B-	P: No impact is expected since the project at this stage does not alter existing condition.
					C: Some negative impacts are expected due to operation of construction equipment and vehicles. One of these is the dust incidental to earthwork especially during the dry season.
					O: Air pollution is expected to increase due to increase traffic volume on the road.
2.2	Offensive Odor	D	D	D	P/C/O: No impact is expected as the project does not involve the use of chemical and other materials that may cause offensive odor.
2.3	Water Pollution	D	B-	B-	P: No impact is expected since the project at this stage does not alter existing condition.
					C: Turbid water due to the earthworks, bridge pier construction work and wastewater effluents from construction workers' camps/yards are expected to pollute the surrounding rivers/canals to some extent.
					O: Some impacts on water quality in surrounding water bodies are expected due to water discharge from road users and wastewater from maintenance activities.
2.4	Bottom Sediment Contamination	D	B-	D	P: No impact is expected.
					C: The project involves construction of new small bridges. Silt-trap will be used to avoid construction materials such as cement and sand being washed out during construction work.
					O: Some wastewater will be generated from maintenance activities along the road, the impacts on bottom sediment from the wastewater will be negligible.
2.5	Soil Contamination	D	D	D	P: No impact is expected as no engineering activity will be carried out at this stage
					C: Impacts on soil from deposition of pollutants from construction materials in the construction site are expected to be small. Since there is no major industrial activity along the road, it is unlikely that soil along the road is already polluted.
					O: No impact is expected except for the risk of accidental spillage of oil and lubricant, which will be managed by proper safety measures.
2.6	Ground Subsidence	D	D	B+	P/C: No impact is expected as existing conditions will not be altered.
					O: The project will improve subsidence/damaged area of existing road and will install measures to prevent future subsidence.

2.7	Noise/ Vibration	D	B-	B-	P: No impact is expected. C: Noise and vibration are generated by operation of construction equipment and vehicles, although they are temporary. Construction schedule should take into account the location of schools, hospitals and religious facilities that require silence in part of the day. O: Noise and vibration level are likely to increase due to greater traffic volume along the road. Specific measures may be required to minimize impacts on schools, hospitals and religious facilities.
2.8	Sunshine Obstruction	D	D	D	P/C/O: No impact is expected.
2.9	Wastes/Hazardous Materials	D	B-	B-	P: No impact is expected. C: Waste from construction workers' camps are expected to be generated. Waste generated from construction and demolition work may include hazardous materials that must be treated before final disposal. O: Waste will be generated from road users and workers of maintenance works.
Social Environment					
3.1	Involuntary Resettlement	A-	D	D	P: The project will result in large-scale involuntary resettlement, particularly in built-up areas near Tura and Dalu where structures exist in both sides of the road. Minimizing the resettlement should be the priority for road design. C: Resettlement will be completed before construction begins and thus no resettlement is expected during operation O: No impact is expected, as relocation will be completed before construction begins.
3.2	Land Use	A-	A-	D	P: Land acquisition and involuntary resettlement are likely to cause changes in existing land use pattern. C: The project will be carried out along the existing road, and as such, changes in land use associated with construction work are relatively minor, and land clearance for construction yards and workers' camps is temporary. No impact is expected as sufficient slope protection/stabilization measures to protect land use.
3.3	Utilization of Local Resources	D	A-	D	P: No impact is expected. C: Mass-scale use of local resources such as sand and quarrying for the construction activities may obstruct there utilization by the local people for other purposes. O: No impact is expected as use of local resources is not expected during operation.
3.4	General, Regional /City Plans	D	D	D	P: No impact is expected. C: No impact is expected. O: Better infrastructure network may trigger influx of outsiders and economic development in the region.
3.5	Social Institutions and Local Decision-making Institutions	D	D	D	P/C/O: No impact is expected as there will be no change in social institutions and local decision-making institutions such as village councils and women groups
3.6	Social Infrastructure and Services	A-	A-	B+	P: Communal facilities such as public hall may be affected by the project, which negatively affect social infrastructure and services.

					C: Access to social infrastructure and services may be temporarily affected due to construction of construction yard and accommodation for workers as well as traffic jams due to the operation of construction vehicles.
					O: The project is expected to improve access to social infrastructure and services by providing better road network.
3.7	Local Economy and Livelihood	A-	A-	D	P: Loss of income source and livelihood due to involuntary resettlement are expected to negatively affect the local economic and livelihood.
					C: Loss of income source and livelihood due to involuntary resettlement are expected to negatively affect the local economic and livelihood. On the other hand, construction work will have positive impact on local economy by creating employment and business opportunities in the project area.
					O: The project will have positive impact on local economy as improved road network ensures more stable supply of essential goods. In the long-term, this will lead to regional economic development with more job and business opportunities.
3.8	Unequal Distribution of Benefit and Damage	A-	A-	D	P: Land acquisition and involuntary resettlement will lead to unequal distribution of benefits and damage between groups who are directly affected by the project and who are not.
					C: While resettling households bear much of the damage, others may even enjoy benefits from new business opportunities created by construction work, resulting in unequal distribution of benefit and damage.
					O: No impact is expected as the project is an improvement of an existing road and the road will continue as before to accrue benefits to those along the road.
3.9	Local Conflicts of Interest	D	D	D	P/C/O: No impact is expected as the project is an improvement of an existing road and structures/services will be equally restored
3.10	Water Usage, Water Rights and Communal Rights	D	D	D	P/C/O: No impact is expected as rain water is used for both household and agricultural use
3.11	Cultural and Historical Heritage	C-	D	D	P: The targeted roads do not traverse or runs near major ruins and/or cultural heritage.
					C/O: No impact is expected as the project will not affect cultural and historical heritages
3.12	Religious Facilities	A-	A-	D	P: Several memorial stones located along the road may be affected. Small religious facilities in built-up areas may also be affected.
					C: Roadside religious facilities may be affected by noise and vibration during construction and operation due to construction work and greater traffic volume.
					O: No impact is expected as sufficient noise control measures will be implemented.
3.13	Sensitive Facilities (ex. hospital, school, precision machine factory)	B-	B-	D	P: Small community facilities (public halls etc.) may have to be relocated incase road widening is implemented within the built-up area.
					C: Noise and vibration during construction work may affect school and hospitals but the impacts are expected to be minor.
					O: Greater traffic volume is expected to increase noise and vibration level, but adequate mitigation measures will be implemented.

3.14	Poor People	A-	A-	D	P: Given the limited coping capacity of the poor, it is necessary to assess their vulnerability and develop appropriate mitigation measures to be included in rehabilitation plan. C: The poor may bear disproportionally higher burden due to their limited coping capacity, although they can be benefited from employment opportunities during construction work. P: No impact is expected. In the long-term, economic development in the region is likely to benefit the poor.
3.15	Ethnic Minorities/ Indigenous People	A-	A-	D	P/C/O: Tura-Dalu section of NH51 is mainly inhabited by Garo people, registered Scheduled Tribe in India, with distinct culture and language. Preparation of RAP and livelihood restoration plan, therefore, must take into account this factor.
3.16	Gender	D	C-	B+	P: No impact is expected. C: Equal opportunity should be sought for employment during construction work. Prevailing social and cultural norms must be carefully studied to avoid gender-related conflict. O: Better road condition is expected to reduce the burden of girls and women who carry water and fuel wood and improve their safety.
3.17	Children's Rights	D	D	D	P: No impact is expected. C/O：Child labor is unlawful according to article 24 of Indian Constitution. Only adult is eligible for potential employment opportunity created by the project.
3.18	Public Health (sanitation and infectious diseases)	D	B-	B-	P: No impact is expected. C: Influx of construction workers is likely to increase the health risk, particularly that of STD and HIV/AIDS. The risk of malaria should be properly managed in construction work in areas where malaria is prevalent. O: An increase in traffic volume and road users may have negative impact on public health.
3.19	Occupational Health and Safety (OHS)	D	B-	B-	P: No impact is expected. C: Occupational health and safety of construction work should be properly managed through adequate Environment Management Plan. O: Maintenance and repair work should take into account the occupational health and safety of the workers.
Others					
4.1	Accidents	D	B-	B+/B-	P: No impact is expected as the project at this stage does not alter existing condition. C: Increase of risks of accidents associated with construction activities is expected due to the operation of heavy equipment and vehicles. O: Risks of accidents is expected to increase due to greater traffic volume and speed. On the other hand, installment of accident-prevention measures (such as mirrors at curves) will reduce the risk of accidents.
4.2	GHG emissions	D	B-	B+/B-	P: No impact is expected. C: The use of construction machines and operation of vehicles will result in an increase in GHG emissions, though the impact is small and short-term. O: The GHG emission will increase due to an increase in traffic volume. The project is expected to improve the resilience of road against climate change by factoring long-term climate change (changes/increase in precipitation etc.) into the road design.

Note: P: Pre-Construction; C: Construction; and O: Operation

A: Significant impact is expected (+: Positive impact, -: Negative impact),
B: Some impact is expected (+: Positive impact, -: Negative impact),
C: Extent of impact is unknown, further examination will be required (+: Positive impact, -: Negative impact),
D: No impact is expected,

Source: JICA Study Team

11.6.8 Anticipated Environmental Impact and Mitigation Measures

The proposed project will have both positive and negative impacts on the surrounding environment during different stages of the project planning and implementation. For the assessment of impacts, the baseline information has been supplemented by the field visits and the primary surveys of the various environmental components carried out during the study.

Natural Environment

(1) Climate

Pre-Construction and Construction Phase

Since the proposed project is only widening and strengthening to 2 lane road, no change in the macroclimate i.e. precipitation, temperature and wind is envisaged. However, there will be localized, temporary impact due to vegetation removal and the creation of paved surface for road. There may be an increase in daytime temperature around alignment due to loss of vegetation. The impact will be more prominent at locations where the cutting of trees is in clusters.

Operation Phase

During operation phase, increased traffic plying will lead to increase in temperature levels locally along the carriageway though it will be insignificant and temporary.

(2) Topography and geology

Pre-Construction and Construction Phase

The change in topography (that of existing) is envisaged to some extent at various places along the entire length of the road while developing 2 lane standard. The change in topography will also happen due to operation of borrow areas. The construction of material handling yards and labor camps will also alter the existing topography temporarily.

Operation Phase

During the operation phase, there will be probable induced developments in the form of tourism and commercial establishments along the highway. During monsoon, the change in topography will also be visible due to landslide and damage to side slope and breast wall. The benefits in the form of land leveling and tree plantations in the vicinity of the project road shall enhance the local aesthetics.

Mitigation Measures

During construction phase, the existing vegetation including shrubs and grasses along the route (except within the strip directly under embankment or cutting) will be properly maintained. The borrow areas shall be operated and closed as per the specifications for road and bridge construction manual of MORTH. The borrow areas shall be filled with the rejected waste/material, spoil and then finally a layer of topsoil shall be spread over it before carrying out plantation and turfing.

During operation phase, maintenance of embankment will be carried out to avoid soil erosion. The slope protection/ retaining wall if damaged due to land slide will be repaired promptly. The slope protection will also be established/strengthened regularly through plantation of shrubs and vegetation.

(3) Soil Erosion

Pre-Construction and Construction Phase

Site preparation will involve demolition of building, clearing of brushwood, tree removal and temporary re-routing of utilities. This brings risks of erosion to the exposed ground and topsoil. The soil erosion in construction stage may take place at the slope of the embankments, construction sites of cross drainage structures, at borrow areas and at construction sites which will be cleared.

Operation Phase

The soil erosion in operation stage may take place during operation at side slopes of road and near the approaches to bridges and interchanges. The risk is higher during monsoon.

Mitigation Measures

To control roadside soil erosion, turfing with grasses and shrubs will be carried out in accordance with the recommended practice in IRC guidelines. At the locations of steep slopes near crossings of highway with major rivers suitable protection measures such as stone pitching will be adopted. The surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and fill material operations shall be limited to the extent practicable. The contractor will provide immediate permanent erosion control measures to prevent soil erosion that will adversely affect construction operations, damage adjacent properties or cause contamination of nearby streams or other watercourses, village ponds or water bodies etc. The green belt will be developed simultaneously along with construction activities to control the erosion process.

During the operation phase, the slope protection measures like sodding, turfing shall be done and monitored regularly. The green belt will be monitored and replantation for the loss of plants species will be done immediately. The side ditch on road is designed as concrete lined ditch for all section of cut side to prevent damage from water runoff.

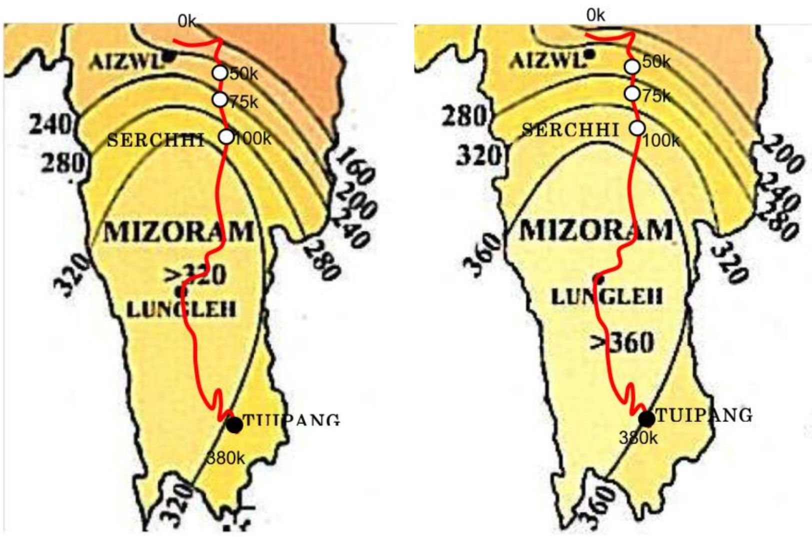
(4) Hydrology

The hydrological study is conducted based on IRC:SP:13 "Guidelines for the design of small bridges and culverts" which is well used technical standard for hydrological study in Indian highway design. The long-term rainfall intensity is modeled as shown below, which have informed the design of drainage and culverts.

Table 11.16 Rainfall Intensity for Each Section of NH54

From	To	25Years- 24hours Rainfall intensity (mm)	50Years- 24hours Rainfall intensity (mm)
Aizawl (SectionA.0k)	Tlungvel (SectionA.50k)	240mm	280mm
Tlungvel (SectionA.50k)	Chhingchhip (SectionA.75k)	280mm	320mm
Chhingchhip (SectionA.75k)	Serchhip (SectionA.100k)	320mm	360mm
Serchhip (SectionA.100k)	Tuipang (SectionD. last)	360mm	400mm

Source: JICA Study Team



Source: ATLAS of Statewise Generalised ISOPLUVIAL (Return Period) Maps of Eastern India (Part – II)

Figure 11.13 Detailed isopluvial map with project location for NH54 for 25 Years (L) and 50 Years (R)

Pre-Construction and Construction Phase

Potential impact on hydrology will be minor, as the project does not involve diversion or re-routing of existing water resources. However, the existing drainage will be slightly obstructed during the construction period, but for a limited period. Hence, change in natural drainage pattern is very insignificant from the present state of the project.

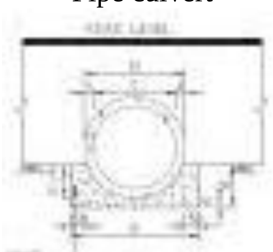
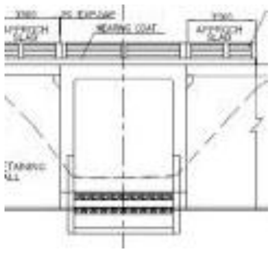
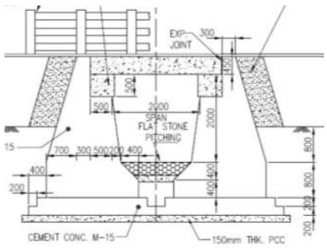
Operation Phase

The projects may marginally lead to increased run-off during operational stages due to increase in impervious surface and sediment will be accumulation in nearby water bodies.

Mitigation Measures

The new drainage system is designed by based on hydrological calculation result. Based on obtained location of water crossing and water discharge, dimension and locations for drainage system are determined. For cross drainage structure, appropriate culvert type is selected by taking account of economy, construction workability, and maintenance ability. Comparison of different culvert types is shown below. In principle, pipe culvert is used where the water discharge is comparably small. BOX culvert is proposed where the water discharge is comparable large. The size is determined to satisfy the water discharge obtained by hydrological calculation.

Table 11.17 Comparison for culver type

	Pipe culvert	BOX culvert	Slab culvert
Layout			
Economy	◎	○	△
East of Construction	◎	○	△
Durability	○	○	△
Capacity	○	◎	◎
Comment	To be applied for small discharge point	To be applied for large discharge point	Not applied

Source: JICA Study Team

(5) Groundwater

No tunnel is proposed in this project and as such, the project will not affect groundwater level or quality in the area. If contractor propose to use water from under surface water source, however, permission from the Water Resource Department and Local Administration is mandatory. The contractor is expected to properly manage effluents and waste water during the construction stage to avoid potential influence to the groundwater.

(6) Ecosystem, Flora, Fauna and Biodiversity

The main impact on flora involves the removal of trees and grubbing of vegetative cover for construction and a clear zone within the Right of Way (ROW) and for spoil bank. Widening of the 1-lane to 2 lanes would have negative impact on plant species by way of cutting the trees and shrubs for construction activities. The types of impacts on flora can be as follows:

- Loss of trees;
- Loss of canopies;
- Compaction of vegetation, and
- Pollution and dust accumulation on vegetation.

Floral/Vegetation assessment has been carried out through quadrate methods; for trees 10mx10m, for shrubs 5mx5m and for Herbs 1m x1m square shaped quadrats were used. Quadrates were laid randomly in the corridors upside and downside of the road. All species in the quadrats were recorded & ecological parameters such as density and frequency were calculated. Faunal species were recorded with the visual observation during site visits, secondary data from the forest department and local information from peoples. There is no unique faunal community within the project area, except most common ones discussed earlier. No endangered or threatened fauna species were reported in the area close to the project highway. In addition to the efforts to minimize the scale of forest clearing and impacts associated with construction activity, following measure will be taken care during construction phase to avoid collision of some wild as well domestic animals:

- It is suggested that regular monitoring by the forest department should be done;
- Anti-poaching measures during construction phase should be strengthened to check violation of existing regulations;
- Side barriers will be provided to avoid collision of animals in forest area; and
- Animal under passes will be provided at various suitable locations to avoid accident.

Mitigation Measures

The tree plantation felled will be replaced and compensated according to the Compensatory Afforestation Policy under the Forest Conservation Act, 1980. Apart from trees earmarked for feeling, no additional tree clearing within the ROW will be allowed. All construction workers should adhere to this rule.

Plantation of shrubs and under trees in the median shall be undertaken to prevent the glare of the vehicles coming in the opposite direction. Construction vehicles, machinery and equipment will move or be stationed in the (ROW) to prevent compaction of vegetation. While operating on temporarily acquired land for traffic detours, storage, material handling or any other construction related or incidental activities, it will be ensured that the trampling of soil will be avoided.

Construction of road will involve removal of topsoil and cutting resulting in clearing of vegetation cover and felling of trees. However such impacts will primarily occur at the project site during initial period of the construction phase and will be minimized through adoption of mitigation measures. It is recommended that the lost trees will be compensated at 1:3 ratio. The site of compensatory afforestation will be specified by the Forest Department during the process of obtaining forest clearance. As per its guidance, the project proponent will plant saplings (types and number to be specified) at designated location (either degraded forest or vacant/abandoned jhum area).

Following measure will be taken during construction phase.

- It is suggested that regular monitoring by the forest department should be done. In keeping view of likely increase in vehicular emissions in the future, the monitoring should include the assessment of impact due to greater air pollution;
- A suitable landscaping plan for the project road has been prepared to enhance the ecological status of the area;
- It was noticed, that the project road did not have tree cover at few locations (Jhum lands) tree plantation at these location will enhance the aesthetics as well as reduce the pollution level of the area; and
- Initiative should be taken to remove the impacted small girth size trees with the help of Forest Department and replanted them at designed place. Though cost involvement against this type of work can be high, it will save the life of growing plants.

(7) Protected Areas/Forest

Pre-Construction and Construction Phase

The project road does not traverse or border with national park, wildlife sanctuary or reserved forest. As discussed above, however, the project will cause deforestation due to removal of trees and grubbing of vegetative cover for construction and a clear zone within ROW. Based on the field survey and satellite data, forest area accounts about 60% of the area to be acquired (or 375 ha out of 625 ha).

Operation Phase

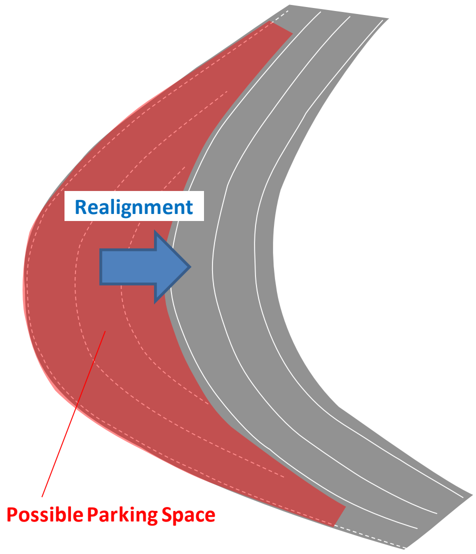
Increases in traffic volume are likely to have negative impact on forest ecosystem.

Mitigation Measures

At the planning stage, efforts to avoid or minimize the number of trees to be cut have been done as part of the design for widening of the road. There will also be measures including replanting the trees at suitable location during the construction stage. Further the plantation at the Jhum lands can also be taken up as a part of plantation program for the loss of tress.

(8) Landscape

For sites where good view can attract tourists, parking spaces/viewpoints can be developed utilizing flat spaces which are produced by improvement of the horizontal alignment to be made especially in sharp curves as illustrated in below Figure. In the preliminary design, about twenty such locations can be developed along NH54.



Source: JICA Study Team

Figure 11.14 Concept for Parking Site/Viewpoints Development

In addition, road and traffic markings to be installed in accordance with IRC:35-1997 will ensure smooth and orderly flow of traffic and contributes to better aesthetic condition of the road by reducing congestion. Buses standing indiscriminately on the carriageway to drop or pick-up passengers can seriously affect capacity of the roadway, besides being a source of accidents. It is, therefore, desirable that on all busy non-urban highways, consideration should be given to the construction of bus lay-byes of suitable design at required locations to ensure orderly movement of the through traffic. For convenience of tourists, it is also proposed that bus bay will be equipped with amenities including public toilets and bazar shed.

Table 11.18 Proposed Bus Bay Locations for NH54

No.	Section	Location	Distance from Aizawl (km)	Section Length (km)	No.	Section	Location	Distance from Aizawl (km)	Section Length (km)
1	1	Aizawl	-		22	2	Dawn	206	16
2	1	Zemabawk	4	4	23	2	Zobawk	219	13
3	1	Tuirial	22	18	24	2	Hrangchalkawn	222	3
4	1	Seling	38	16	25	2	Bualte	231	9
5	1	Thingsulthliah	42	4	26	2	Thualthu	243	12
6	1	Darlawng	53	11	27	3	Tawipui N-II	251	8
7	1	Tlungvel	57	4	28	3	Tawipui N-I	256	5
8	1	Phulmawi	61	4	29	3	Tawipui S	264	8
9	1	Khumtung	63	2	30	3	Thingfal	277	13
10	1	Baktawng	67	4	31	3	Lawngtlai	292	15
11	1	Chhingchhip	77	10	32	3	Saikah	311	19
12	1	Chhiahtlang	97	20	33	3	Paithar	314	3
13	1	Serchhip	107	10	34	3	Chawitlangpui I	316	2
14	2	Keitum	122	15	35	3	Sihtlangpui	319	3
15	2	Bungtlang	130	8	36	3	Kawlchaw	324	5
16	2	Rawpui	135	5	37	3	Zero Point	337	13
17	2	Pangzawl	148	13	38	3	Maubawk	354	17
18	2	Thiltlang	158	10	39	3	Theiva	355	1
19	2	Hnahthial	169	11	40	3	Theiri	363	8
20	2	Leite	182	13	41	3	Tuipang	379	16
21	2	Maudarh	190	8					

Source: JICA Study Team

(9) Natural Disaster

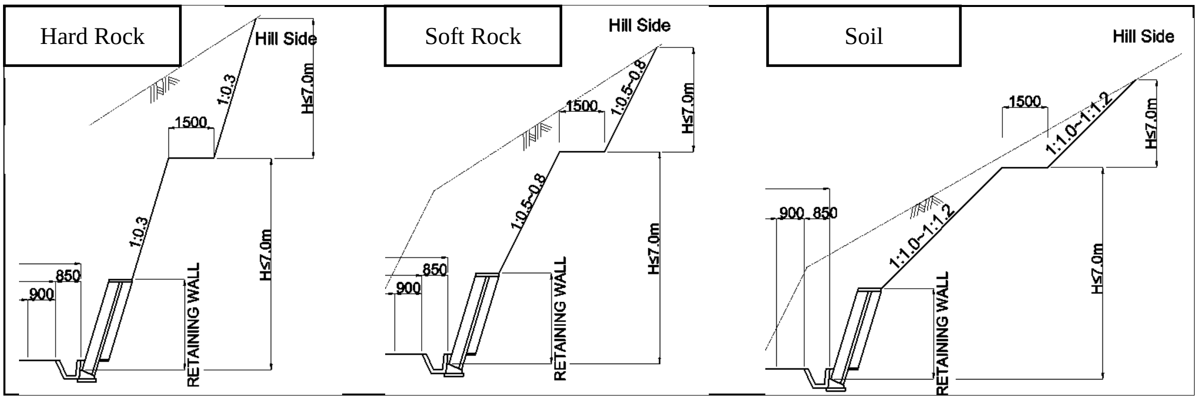
Slope along NH54 is covered by very loose quaternary alluvium. It is concerned that slope failure and erosion have frequently occurred on cut slope along NH54. Therefore, such loose soil slope shall be cut with 1:1.2 gentler than IRC standard for landslide prevention as shown below. The cut slope shall be greened by seeding and mulching consisting of jute netting including seeds which cover all over the slope and prevent erosion by rain water.

Table 11.19 Design Criteria of Cut Slope and Slope Protection Work

<table>
<tr><th colspan="2">IRC Standard*</th><th colspan="3" rowspan="2">JICA Study Team
Rock/Soil Classification</th><th rowspan="2">Cut Grade</th><th rowspan="2">Slope Protection Work</th></tr>
<tr><th>Classification</th><th>Cut Grade</th></tr>
<tr><td rowspan="2">Hard Rock</td><td rowspan="2">80 ~ 90 degree</td><td rowspan="2">Rock</td><td colspan="2">Very Hard</td><td>1:0.2</td><td>No protection work</td></tr>
<tr><td>Hard</td><td>No Risk</td><td>1:0.3</td><td>No protection work</td></tr>
</table>

				Landslide Risk		Crib work
Ordinary Soft Rock	**1:0.25 ~ 1:0.125**		Soft	Non-Dip Slope	**1:0.5**	No protection work
				Dip Slope	**1:0.8**	Hydroseeding (t=5 cm)
Ordinary Soil/ Heavy Soil	**1:1.0 ~ 1:0.5**	Soil	Dense Soil		**1:1.0**	Seeding and Mulching
			Loose Soil		**1:1.2**	Seeding and Mulching

*IRC: SP:48:1948 Clause 7.4
Source: JICA Study Team



Source: JICA Study Team

Figure 11.15 Typical Cross Section of Cut Slope

Frequency and intensity of heavy rain is likely to increase due to climate change. In the project area, an increase of annual rainfall is predicted to be 5-15% for the period from 2021 to 2050. The design of various components of the road (slope protection, drainage etc.) takes into account likely effect of climate change. With increase of the rainfall frequency and intensity, river water and groundwater level are expected to be high, which could cause inundation and damage to the road facilities. Therefore, spring water points have been carefully studied and subsurface drainage is proposed where necessary. Flood marker was checked in site reconnaissance and interview survey for the disaster countermeasure design to inform the road design. The table below shows adaptation measures for climate change taken into consideration in this road design.

Table 11.20 Adaption Measures for Climate Change in NH54

Factor	Design Policy considering Adaptation
Side Slope	· Retaining wall is built all along the road. · Slope protection work is constructed on some weathered and loosen slopes. · Cut slope is covered with vegetation works to prevent erosion and collapse. · Replacement of subgrade and subsurface drainage are planned as countermeasure against sinking.
Embankment	· Drain filter is sandwiched in embankment. · Flood level is confirmed in site reconnaissance and interview survey near river bank in south of NH54.
Bridge & Drainage System	· Rainfall intensity is carefully determined based on the authorized data : ATLAS of Statewise Generalised ISOPLUVIAL MAPs of Eastern India published by Indian Meteorological Department. The isopluvial value from higher edge of counter range is applied.

	· The capacity of all structures is determined to be capable for the discharge of 50 years return period.
Pavement	· Super elevation is installed properly. · Pavement material is examined not to rise over 60 °C on the surface.
Road Sign	· Wind load and visibility is taken into consideration.

Source: JICA Study Team

Living Environment

(1) Air Pollution

Being on hill, towns and villages along NH54 generally have good ambient air quality. The project road alignment also has no polluting industry along it. There is congestion due to traffic in major the built up. This leads to vehicular exhaust emissions and deterioration for which the proposed widening will have positive impact.

During the preparation of Detailed Project Report (DPR) by Indian Consultants, ambient air sampling was carried out in eight locations along the project road in February 2011. The monitoring data for dry season shows that all parameters are under the threshold by CPCB/MOEF. Additional monitoring for pre-monsoon season has been carried out in April 2015 to establish base line ambient air quality in the project area and surroundings. Monitoring was carried out along the project corridor at 15 locations at a frequency of twice in a month, adopting a continuous 24-hours schedule in the month of April 2015 as per guidelines of Central Pollution Control Board and MOEF requirements. The locations of ambient air quality monitoring is shown below.

Table 11.21 Locations Ambient Air Quality Monitoring

Station Code	Location	GPS
AAQ1	Puspak Junction	$23^0$44'23"N $92^0$44'30"E
AAQ2	Tuirial Village	$23^0$43'08"N $92^0$47'56"E
AAQ3	Tiungvel Village	$23^0$36'22"N $92^0$51'14"E
AQ 4	Baktawng	$23^0$32'11"N $92^0$50'57"E
AAQ 5	Chhiahtlang	$23^0$22'39"N $92^0$50'35"E
AAQ 6	Serchhip	$23^0$19'57"N $92^0$51'17"E
AAQ 7	Keitum	$23^0$13'55"N $92^0$54'40"E
AAQ 8	Rawpui	$23^0$08'44"N $92^0$53'52"E
AAQ 9	Thiltlang	$23^0$01'14"N $92^0$55'16"E
AAQ 10	Leite	$23^0$54'06"N $92^0$54'41"E
AAQ 11	S. Tawipui	$22^0$40'22"N

		$92^0$50'43"E
AAQ 12	Thingfal	$22^0$37'08"N $92^0$50'20"E
AAQ 13	Lawngtlai	$22^0$31'33"N $92^0$53'47"E
AAQ 14	Kawlchaw E	$22^0$24'01"N $92^0$57'28"E
AAQ 15	Zero Point	$22^0$27'48"N $92^0$57'27"E

Source: JICA Study Team

The air quality in the project area is less polluted. The AAQ of the project area is given below. The survey results indicate that concentrations of all pollutants are well within the prescribed limits of the National Ambient Air Quality Standards except the particulate matter PM_{10} at Puspak Junction where the figure is slightly higher than permissible limit i.e.118 to 120µg/m^3. The maximum concentration of $PM_{2.5}$ is 52.00µg/m^3 at Puspak Junction while the minimum concentration is 20.80 µg/m^3 at Thingfal. The maximum concentration of SO_2 is 7.30 µg/m^3 recorded at Puspak Junction while minimum concentration is recorded < 4.0 µg/m^3 at various locations. The maximum & minimum concentration of NO_X is 30 µg/m^3& 8.50 µg/m^3 at Puspak Junction and Leite respectively. CO concentration is found to be well below the permissible limit.

Table 11.22 Results of Ambient Air Quality Monitoring

Station Code	Date of Monitoring	Parameters (µg/m^3) & Test Method				
		$PM_{2.5}$	**PM_{10}**	**SO_2**	**NO_X**	**CO**
		Gravimetric Method	Gravimetric Method	Improved West &Gaeke Method	Jacob &Hochheiser Modified Method	NDIR Spectroscopy Method
AQ1	15.04.15 to 16.04.15	52.00	120.50	7.30	30.00	0.6
	22.04.15 to 23.04.15	48.50	118.50	6.80	28.50	0.45
AQ2	15.04.15 to 16.04.15	32.50	65.20	<4.0	15.00	<100
	22.04.15 to 23.04.15	30.00	65.20	<4.0	12.50	<100
AQ3	16.04.15 to 17.04.15	35.00	72.50	<4.0	12.50	<100
	21.04.15 to 22.04.15	31.50	68.10	<4.0	10.00	<100
AQ4	16.04.15 to 17.04.15	38.50	72.50	<4.0	16.50	<100
	21.04.15 to 22.04.15	32.80	68.20	<4.0	15.00	<100
AQ5	17.04.15 to 18.04.15	32.50	72.50	<4.0	15.00	<100
	20.04.15 to 21.04.15	28.50	68.20	<4.0	12.50	<100
AQ6	17.04.15 to 18.04.15	36.80	80.10	5.30	20.10	0.3

Station Code	Date of Monitoring	Parameters (μg/m³) & Test Method				
		$PM_{2.5}$	**PM_{10}**	**SO_2**	**NO_X**	**CO**
		Gravimetric Method	Gravimetric Method	Improved West &Gaeke Method	Jacob &Hochheiser Modified Method	NDIR Spectroscopy Method
	20.04.15 to 21.04.15	32.10	72.50	4.50	15.00	0.2
AQ7	18.04.15 to 19.04.15	28.10	62.10	<4.0	12.50	<100
	19.04.15 to 20.04.15	24.50	58.10	<4.0	10.00	<100
AQ8	18.04.15 to 19.04.15	28.50	58.20	<4.0	12.50	<100
	19.04.15 to 20.04.15	21.50	52.80	<4.0	9.50	<100
AQ9	24.04.15 to 25.04.15	31.50	72.50	<4.0	15.00	<100
	30.04.15 to 01.05.15	28.50	65.20	<4.0	11.50	<100
AQ10	24.04.15 to 25.04.15	23.50	56.20	<4.0	10.00	<100
	30.04.15 to 01.05.15	22.80	51.80	<4.0	8.50	<100
AQ11	25.04.15 to 26.04.15	28.50	56.20	<4.0	12.50	<100
	29.04.15 to 30.04.15	21.80	51.80	<4.0	10.00	<100
AQ12	15.04.15 to 16.04.15	25.10	68.50	<4.0	11.50	<100
	22.04.15 to 23.04.15	20.80	61.40	<4.0	8.50	<100
AQ13	15.04.15 to 16.04.15	36.50	86.50	5.10	20.10	0.35
	22.04.15 to 23.04.15	32.80	76.20	4.50	15.00	0.2
AQ14	15.04.15 to 16.04.15	23.50	52.80	<4.0	11.50	<100
	22.04.15 to 23.04.15	20.10	56.10	<4.0	9.50	<100
AQ15	15.04.15 to 16.04.15	31.20	81.20	4.80	18.50	0.3
	22.04.15 to 23.04.15	28.50	76.50	4.50	16.50	0.25
24 Hourly National Ambient Air Quality (NAAQ) Standards & CO (8 Hourly)		**60**	**100**	**80**	**80**	**2000**

Source: JICA Study Team

Pre-Construction and Construction Phase

The short-term and localized degradation of air quality will occur from dust generation due to procurement and transport of raw materials from quarries and borrow pits, site clearance, use of heavy vehicles, machinery/ equipment, stone crushing handling and storage of aggregates and generation of fine particulate matter (smoke) in asphalt processing. Dust would be generated from haulage of materials and detouring of traffic on non-permanent, temporary pavement etc.

Hot mix plants contribute substantially to the deterioration of air quality due to emissions of oxides of Sulphur, Hydrocarbons and particulate matter. During the construction period, temporary impacts include generation of Odor from construction activities as well as from construction camps. During construction of road, the movement of different types of construction machinery and vehicle will be increased. This in other way increases the fuel consumption.

From the results of the ambient air quality monitoring conducted along the road, it is noticed that the monitoring parameters are within the standards as prescribed by the Central Pollution Control Board The concentration of the air pollutants will further increase during construction period but for limited period only. The impacts on air quality during construction will be mostly localized and concentrated within the ROW. The impacts due to dust generation may felt downwind of the site rather than the site itself due to local wind pattern.

Operation Phase

The project road is mostly passing through the rural areas with alluvial soil. Dust generation due to movement of vehicles is envisaged along the project road, but not in significant amount. Due to increase in speed and volumes of vehicular traffic on the project corridor, marginal increase in the air pollutant levels is expected but not significant. Widening of road will attract larger community to use this corridor which in-turn increase the fuel consumption and has direct impact on national economy and local ecosystem.

Mitigation Measures

The hot mix plants, crushers and the batching plants will be sited at least 500 m in the downwind direction from the nearest settlement. All precautions to reduce the level of dust emissions from the hot mix plants, crushers and batching plants will be taken up. The hot mix plant will be fitted with dust extraction system. Asphalt and concrete plants will be operated in conformity with government pollution control legislation, and located away from the settlements as far as possible. All vehicles, equipment and machinery used for construction will be regularly maintained to ensure that the pollution emission levels conform to the SPCB norms. Regular monitoring of particulate Matter at crusher sites, during the construction, will be conducted. Regular water sprinkling will be done on the cement and earth mixing sites, asphalt mixing site and temporary service and access roads. After compacting the earthwork, water will be sprayed to prevent dust emission. The vehicles delivering construction material will be covered to avoid spilling. Planting of trees/vegetation on the periphery of the construction site will be taken up.

During the operation stage of the project, vehicular emissions of critical pollutants (RSPM, CO, HC, SO_2, and NO_x) will be monitored and roadside tree plantation will be maintained. Over the long-term, projected increase in traffic volume, particularly ones of heavy trucks, may pose health threat in roadside community. The peak hourly estimated traffic volumes for the years 2020 and 2035 have been considered to project future air quality scenarios to provide an indication of long-term variations in air quality. The future level of air pollution, modeled based on the projected increase in traffic volume indicates that the level of pollution (CO and NOx levels) will remain below the standard during the projected period (2035). Nevertheless, mitigation measures such as introducing speed limit and other measures to control congestion in built-up area may be necessary in the longer term. Also, local communities should be well informed of the risk of air pollution. Awareness raising campaign may include distribution of facemask to mitigate risk of air pollution and other information kit.

(2) Water Pollution

The project road traverses through mountainous and steep terrains with several natural drainages such as deep gorges, depressions, etc., where perennial water and rainwater runoff are collected. River Tuirial, Tuichang, Mat, ChimTui Pui and tributaries are located within the study area. Besides, there are many nullahs and stream crossing the project road and many ponds are available near the project road.

Pre-monsoon water quality of the project corridor has been analyzed by collecting water samples along the Project road between April and May in 2015. Meanwhile, the monitoring survey for dry season (winter) was carried out in February 2011 during DPR preparation. In both seasons, parameter such as Iron, Total Coliform Organisms and Faecal Coliform Organisms are beyond permissible limits of Drinking water Standards (IS: 10500) and thus it is not fit for drinking purpose. The surface water quality monitoring location and the analysis results are shown below.

Table 11.23 Surface Water Quality

Parameters	Tuirial river	Tuichang river (Near Keitum village	Mat river (Near Leite village)	ChimTuiPui river (Kalchaw E)	Limits IS: 10500
pH	6.78	6.82	7.17	6.68	6.6 to 8.5
Color (Hazen unit)	1	1	1	1	-
Suspended Solid (mg/l)	11	12	<10	18	-
DO	5.4	5.6	5.6	5.2	-

BOD (mg/l)	23	20	18	25	-
COD (mg/l)	87.48	68.04	68.04	87.48	-
Total Kjeldahl Nitrogen (mg/l)	6.5	4.5	5.5	7.5	-
Total Hardness (mg/l)	40	30	20	30	300
Calcium (mg/l)	8.42	6.41	4.41	7.21	75
Magnesium (mg/l)	4.56	3.36	2.16	2.88	30
Ammonia (mg/l)	2.5	1.8	2	2.8	-
Electric Conductivity	277.7	154.3	107	169.6	-
Chloride (mg/l)	16.97	11.32	11.32	10.37	250
Sulphate (mg/l)	39	5	6	17.5	200
Phosphate (mg/l)	0.8	0.7	0.75	0.9	-
Nitrate (mg/l)	4.8	3.5	5.2	3	45
Fluoride (mg/l)	<0.1	<0.1	<0.1	<0.1	1
Arsenic (mg/l)	<0.01	<0.01	<0.01	<0.01	0.05
Lead (mg/l)	<0.088	<0.088	<0.088	<0.088	-
Mercury (mg/l)	<0.0001	<0.0001	<0.0001	<0.0001	0.05
Phenols (mg/l)	<0.001	<0.001	<0.001	<0.001	-
Cyanides (mg/l)	<0.05	<0.05	<0.05	<0.05	-
Total Dissolved solid (mg/l)	178	99	69	109	500
Iron (mg/l)	0.49	0.31	0.36	4.34	0.3
Total Coliform / 100 ml	1.6×10^3	1.2×10^3	1.5×10^3	1.8×10^3	
Faecal Coliform/ 100 ml	5.1×10^2	4.3×10^2	4.8×10^2	6.2×10^2	

Note: <1 indicate No Colony developed in 1 ml. Sample
<10 indicate No Colony developed in 0.1 ml. Sample
<100 indicate No Colony developed in 0.01 ml. Sample
Source: JICA Study Team

Ground water has been found to be an important source for catering to the local needs of water consumption for various purposes, mainly domestic. Therefore, any kind of deterioration in the quality of ground water owing to the developmental activities will pose threat to the concerned population and attention needs to be paid towards maintaining the quality of water using all possible tools such as monitoring with spontaneous remedial suggestions, if required. Keeping in view the importance of ground water to the local population, monitoring of ground water quality was carried out in five villages along NH54 as shown in Table 4.9.

Analysis of groundwater samples shows that the water is alkaline in nature (pH <8). The total dissolved solids (TDS) in five locations are below the permissible limit (500mg/l). Chloride concentration is well below the desirable limit (250mg/l) in all locations. This is also the case for ground water monitoring during the dry season, undertaken in DPR preparation stage. Sulphate and Nitrate concentrations are low and within the permissible limit and thus indicate low degree of organic pollution. Amongst the cations, Calcium (Ca) and Magnesium (Mg) are below the permissible limit (200mg/l). Concentration of iron is above the desirable limit of 0.3 ml/l in all samples. Groundwater in general is soft in the area and the Hardness is below the permissible limit of 600mg/l.

Groundwater samples are free from heavy metals like cadmium, arsenic, lead, chromium etc. Bacterial quality of groundwater shows all samples are free form faecal coliform and total coliform and hence the water samples are suitable for human consumption after treatment process.

Table 11.24 Ground Water Quality

Parameters	Tuirel village	Keitum village	Thiltlang village	Leite village	Lawngtlai village	Desirable Limit as per BIS 10500	Permissible limit as per BIS 10500 in absence of alternate source
pH	7.02	6.25	6.69	7.34	6	6.5-8.5	No Relaxation
Color (Hazen unit)	1	1	1	1	1	-	-
Odor	Odorless	Odorless	Odorless	Odorless	Odorless	-	-
Electric Conductivity	510.9	170	461	503.1	213.3	-	-
Total Dissolved solid (mg/l)	327	109	295	322	250	500	2000
Bicarbonate (mg/l)	59.78	30.5	51.24	74.42	80	-	-
Total Hardness (mg/l)	45	40	50	60	50	300	600
Calcium (mg/l)	10.02	8.82	11.2	14.03	11.62	-	-
Magnesium (mg/l)	4.8	4.32	5.28	6	5.04	30	100
Chloride (mg/l)	14.14	16.97	17.92	10.37	15.08	250	1000
Sulphate (mg/l)	4.5	5.5	5.5	10	19.5	200	400
Phosphate (mg/l)	0.6	0.8	0.86	0.5	0.8	-	-
Nitrate (mg/l)	4.5	3.8	4	3.5	4	45	100
Fluoride (mg/l)	<0.1	<0.1	<0.1	<0.1	<0.1	1.0	1.50
Arsenic (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
Lead (mg/l)	<0.088	<0.088	<0.088	<0.088	<0.088	0.05	No relaxation
Mercury (mg/l)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-
Phenols (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	-	-
Cyanides (mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	-	-
Iron (mg/l)	7.4	9.74	1.56	4.05	13.82	0.30	1.00
Total Colirom / 100 ml	<100	<100	<100	<100	<100	-	-
Faecal Coliform/ 100	<100	<100	<100	<100	<100	-	-

ml							

Note: <100 indicate No Colony developed in 0.01 ml. Sample
Source: JICA Study Team

In addition to surface water and ground water monitoring, the water samples from three community water tanks have been collected. As shown below, the results indicates that water quality of community water tanks is good and suitable for human consumption.

Table 11.25 Water Quality of Community Water Tank

Parameters	Serchhip	Tawpui village	Zero point	Standard (IS10500)
pH	7.49	7.47	7.38	6.5-8.5
Color (Hazen unit)	1	1	1	5
Odor	Odorless	Odorless	Odorless	Unobjectionable
Electric Conductivity	170.9	408.5	173.6	
Total Dissolved solid (mg/l)	110	262	111	500
Bicarbonate (mg/l)	29.28	50.02	29.28	
Total Hardness (mg/l)	20	30	20	300
Calcium (mg/l)	4.81	7.21	4.01	75
Magnesium (mg/l)	1.92	2.88	2.4	30
Chloride (mg/l)	7.54	7.54	12.26	250
Sulphate (mg/l)	6	30	6.5	150
Phosphate (mg/l)	0.81	0.68	0.86	
Nitrate (mg/l)	1.5	2.8	1.5	45
Fluoride (mg/l)	<0.1	<0.1	<0.1	0.6-1.2
Arsenic (mg/l)	<0.01	<0.01	<0.01	0.05
Lead (mg/l)	<0.088	<0.088	<0.088	0.1
Mercury (mg/l)	<0.0001	<0.0001	<0.0001	0.001
Phenols (mg/l)	<0.001	<0.001	<0.001	0.001
Cyanides (mg/l)	<0.05	<0.05	<0.05	0.05
Iron (mg/l)	0.06	0.15	0.21	0.3
Total Colirom / 100 ml	<100	<100	<100	Must not be detected
Faecal Coliform/ 100 ml	<100	<100	<100	Must not be detected

Note: <100 indicate No Colony developed in 0.01 ml. Sample
Source: JICA Study Team

Pre-Construction and Construction Phase

There are 4 major rivers and numerous streams that cross the NH54 highway alignment under consideration. Road projects may marginally lead to increased run-off during construction stages, which will increase sediment accumulation in nearby water bodies. Though most of the natural watercourses are perennial in nature, the impacts due to the increased run-off would be negligible due to the project road. During construction, the disposal of solid and liquid waste from labor camps, fuel and lubricant spills or leaks from construction vehicles, pollution from fuel storage and distribution sites and that from hot-mix plants is likely to affect water quality unless adequate mitigation measures are designed. The existing drainage will be slightly obstructed during the construction period, but for a limited period. Hence, change in natural drainage pattern is very insignificant from the present state of the project.

Use of water for construction activities such as compaction, suppression, concrete work may pose pressure on local water supplies; the demand would be met from surface water bodies like ponds, canal and rivers. Municipal water supply will be used only for drinking purposes (for construction camps), if available and if permitted by the local municipal authority. No local/municipal water supply would be used for construction purpose.

Operation Stage Impacts

Road projects may marginally lead to increased run-off during operational stages due to increase in impervious surface and sediment will be accumulation in nearby water bodies. Though most of the natural watercourses are non-perennial in nature, the impacts due to the increased run-off would be negligible due to the project road and will be restricted only during monsoon and early part of post-monsoon seasons.

In the operation stage, pollutants from vehicles, and accidental fuel spills may make their way into the receiving environment. The major pollutants of concern are suspended solids, oil and grease, lead etc. All the rivers present at this road section are non-perennial surface water bodies. No adverse direct impact on the water quality (both underground and surface water bodies) is expected during the operation period. The change in natural drainage pattern is very insignificant from the present state of the project.

Mitigation Measures

To avoid contamination of the various water bodies and drainage channels, construction work close to the canals or other water bodies will be avoided, especially during monsoon period. All necessary precautions will be taken to construct temporary or permanent devices to prevent water pollution due to increased siltation and turbidity. All wastes arising from the project will be disposed off, as per the State Pollution Control Board norms, so as not to block the flow of water in the channels. The wastes will be collected, stored and taken to approve disposal sites.

To avoid contamination of the water body and drainage channels from fuel and lubricants, the vehicles and equipment will be properly maintained and re-fuelled only at designated places. The slopes of embankment leading to water bodies will be modified and re-canalized so that contaminants do not enter the water body. Oil and grease traps will be provided at fuelling locations, to prevent contamination of water.

Discharge of oil and grease is most likely from construction vehicle parking area, vehicle repair area and workshops. An oil interceptor shall be provided to ensure that all wastewater flows into the interceptor prior to its discharge. The device has a chamber for separation of oil and water and can handle 200 L/hour of wastewater. The oil float appearing on the surface is removed by periodic cleaning once a week by skimming off the oil film from the surface.

The sewage system (including septic tanks and soak pits) for construction camps will be properly designed and built so that no water pollution takes place to any water body or watercourse. The workplace will have proper medical approval by local medical, health or municipal authorities. The contractor will make arrangements for water required for construction in such a way that the water availability and supply to nearby communities remain unaffected. Due to the non-availability of water required for construction, if a new tube-well is to be bored, prior sanction and approval by the Central Ground Water Board (CGWB) will be obtained. Wastage of water during the construction will be minimized.

(3) Bottom Sediment Contamination

It is proposed that three existing bridge with poor conditions to be replaced with the new ones. During engineering work of the bridges over the rivers, sediment pollution may occur. As one of the mitigation measures, silt fencing will be provided to restrict runoff into the water during construction phase.

(4) Soil Contamination

<u>Pre-Construction and Construction Phase</u>

The contamination of soil during construction stage is primarily due to construction and allied activities. The soil contamination may take place due to solid waste from the labor camps set- up during construction stage. This impact is significant at locations of construction camps; stockyards, hot mix plants, etc. The sites where construction vehicles are parked and serviced are likely to be contaminated because of leakage or spillage of fuel and lubricants. The contamination of soils can also occur at the site of hot-mix plants from leakage or spillage of asphalt or bitumen. At the site of batching plants, because of spillage of cement, leakage of curing agents the soil contamination can occur. The contamination of soil may take place due to dumping of solid waste in unscientific manner, leaching of fuel/oil & grease from workshops, petrol stations and DG sets.

Operation Stage Impacts

During the operation stage, soil pollution due to accidental vehicle spills or leaks is a low probability but potentially disastrous to the receiving environment, should they occur. These impacts can belong term and irreversible depending upon the extent of spill.

Mitigation Measures

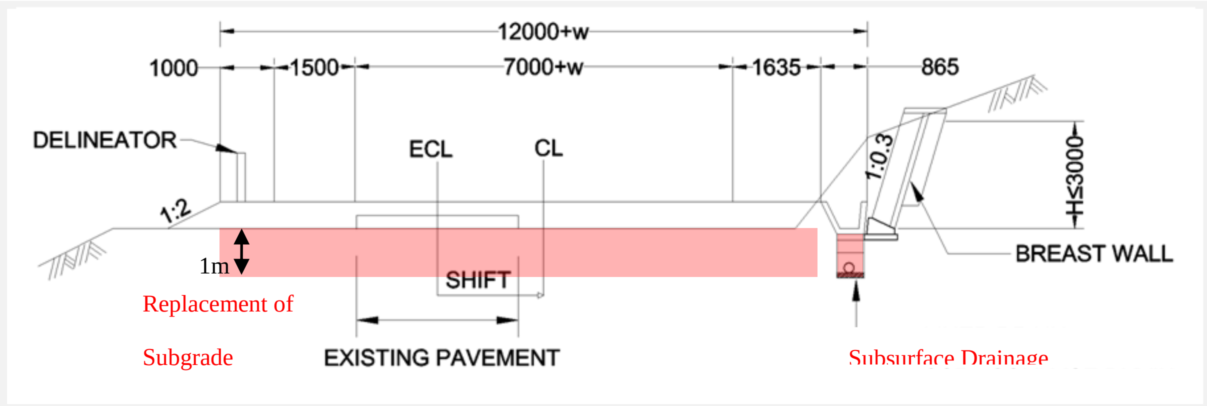
At construction yards, the vehicles/equipment will be maintained and re-fuelled in such a fashion that oil/diesel spillage does not occur and contaminate the surrounding soil. It will be ensured that the fuel storage and re-fuelling sites are kept away from drainage channels and important water bodies. At the washdown and re-fuelling areas, “Oil Water Separators” shall be provided. All spills and discarded petroleum products shall be disposed off in accordance to the Hazardous Waste Management and Handling Rules. Fuel storage and re-fuelling areas will be located at least 500 m from all water bodies near the road alignment. The fuel storage and re-fuelling areas shall not be located on agricultural lands or productive lands to avoid topsoil contamination. The earthwork will be carried out strictly in accordance with the design so that no excess earth is borrowed. The construction waste generated will be reused in the construction of highway.

Bituminous waste will be used after milling and in case bituminous waste is required to be disposed off it shall be disposed in secured way by providing 50 mm tick clay layer. The solid waste generated during construction phase which includes municipal waste both organic & inorganic in nature which shall be stored/treated/disposed off in accordance with Municipal Solid Waste (Management & Handling) Rules. The hazardous waste may include oil waste, biomedical waste, E-waste etc. This shall be disposed off in accordance with the Hazardous Waste (Management, Handling & Transboundary Movement) Rules, Biomedical Waste (Management and Handling) Rules and E-Waste (Management and Handling) Rules respectively.

In the operation stage, the petrol pumps & vehicle washing area located along the ROW will be monitored regularly for any spillages and corrective remedial measures like spread of sand, provision of oil & greases separators for passing wash water of petrol pumps & vehicle washing area before diverting it to water bodies shall be done regularly. The solid waste generated from the way side amenities will include Municipal Waste both organic and inorganic, hazardous waste (like used batteries), will be treated in accordance with Municipal Solid Waste (Management & Handling) Rule and Hazardous Waste (Management, Handling & Transboundary Movement) Rules.

(5) Ground subsidence

Many road subsidence sites have been identified in the slope inventory survey, which was assumed to occur due to consolidation of loosen subsurface soil and high groundwater level except for embankment sliding. Replacement of subgrade with 1.0m thick and subsurface drainage is planned as countermeasures of sinking as shown in below Figure, which will significantly improve the existing condition.



Source: JICA Study Team

Figure 11.16 Typical Cross Section of Countermeasure for Sinking

(6) Noise and vibration

Noise is an important environmental attribute in all road projects because vehicular traffic is a source of noise pollution. During DPR preparation, noise level monitoring was carried out in 19 locations in February 2011 (dry season). For pre-monsoon monitoring, fifteen monitoring sites were identified for to characterize the baseline noise levels in the project area. The results in both seasons shows that the ambient noise level of the project areas in some locations are over the standard prescribed by the Central Pollution Control Board, indicating the need for speed limit and other measures to reduce noise level, particularly in areas near sensitive receptors such as hospitals.

Table 11.26 Ambient Noise Level

Sr. No.	Location	Ambient Noise Level Leq.dB(A)					
		Day Time (07.00 AM to 11.00 PM)			Night Time (10.00 AM to 12.00 PM)		
		L_{min}	L_{max}	L_{eq}	L_{min}	L_{max}	L_{eq}
1	Pushpak Junction	58.4	70.5	66.51	46.2	53.8	48.16

2	Tuirel village	52.5	64.2	60.22	35.1	46.3	35.28
3	Tlungvel village	52	66	61.22	36.8	47.2	38.5
4	Bktawang village	52.9	65.3	60.52	37.8	46.5	40.18
5	Chhiahtlang village	50.4	65.7	60.81	34.2	43.8	36.28
6	Serchhip (NT)	54.6	65.1	60.25	42.3	51.2	46.2
7	Keitum village	56.5	65	61.79	35.2	41.8	36.28
8	Rawpui village	55.8	64.7	61.13	34.2	48.5	38.12
9	Thiltlang village	50.4	60.4	56.78	32.5	41.8	37.5
10	Leite village	45.9	54.8	50.66	34.2	42.6	38.12
11	S. Tawipui village	53	59.1	56.48	32.5	41.5	35.18
12	Thingfal village	51	61.3	57.25	34.8	43.5	37.78
13	Lawngtlai (NT)	54.3	62.4	58.68	46.2	53.2	48.5
14	Zero point village	52.8	64.5	58.88	32.8	43.8	35.12
15	Kawlchaw village	54.8	64.5	59.63	38.5	42.5	40.18

Source: JICA Study Team

Table 11.27 Noise Level Limits of GoI [in LeqdB(A)]

Area/Class	Day Time (6.00 AM to 9.00 PM) Standard	Night Time (9.00 PM to 6.00 AM) Standard
Industrial	75	70
Commercial	65	55
Residential	55	45
Silence	50	40

Source: CPCB

<u>Pre-Construction and Construction Phase</u>

During the construction, the major sources of noise pollution are movement of vehicles transporting the construction material to the construction yard and the noise generating activities at the yard itself. Mixing, casting and material movement are primary noise generating activities in the yard and will be uniformly distributed over the entire construction period. Construction activities are expected to produce noise levels in the range of 80 - 95 dB (A). The major work will be carried out during the daytime. The noise levels in the project area during the construction stage will be intermittent and temporary in nature. Typical noise levels associated with the various construction activities and construction equipment are presented below.

Table 11.28 Typical Noise Levels of Construction Equipment

Construction Equipment	Noise Level dB(A)
Bulldozer	80
Front end loader	72-84
Jack hammer	81-98
Crane with ball	75-87
Crane	75-77
Bulldozer	80

Backhoe	72-93
Front end loader	72-84
Cement & Dump trucks	83-94
Jack hammer	81-98
Scraper	80-93
Welding generator	71-82
Grader	80-93
Roller	73-75
Concrete mixer	74-88
Concrete pump	81-84
Concrete vibrator	76
Paver	86-88
Truck	83-94
Tamper	74-77
Air compressor	74-87
Pneumatic tools	81-98

Source: U.S. Environmental Protection Agency, noise from Construction Equipment and Operations. Building Equipment and Home Appliance. NJID. 300.1. December 31, 1971

At the moment, noise level is within the desired level. The noise level will be increased during construction period, which have significant impact for a limited period on the surrounding environment. The noise levels in the working environment are compared with the standards prescribed by Occupational Safety and Health Administration (OSHA-USA) which in-turn are being enforced by Government of India through Model rules framed under the Factories Act. The acceptable limits for each shift being of 8 hour duration, the equivalent noise level exposure during the shift is 90 dB(A). Hence noise generated due to various activities in the construction camps may affect workers, if equivalent 8 hour exposure is more than the safety limit. ACGIH (American Conference of Government Industrial Hygienists) proposed an 8 hour Leq limit of 85 dB(A). Exposure to impulses or impact noise should not exceed 140 dB(A). The workers in general are likely to be exposed to an equivalent noise level of 80-90 dB(A) in an 8 hour shift for which all statutory precautions as per laws should be taken into consideration.

Operation Stage Impacts

During the operation stage of the project, reduction of vehicular engine noise (as a result of reduced congestion from earlier, smoother flow of traffic due to 2 separate lanes), vehicular body noise (as a result of reduced development roughness) and reduction of blowing of horns will bring the noise levels down, but as volume of traffic, mainly heavy duty traffic will be increase in future due to rapid development and industrialization along the road corridor this may increase noise slightly.

Mitigation Measures

The high noise levels may cause discomfort to local residents and workers. Following mitigation measures shall be adopted to keep the noise and vibration levels under control.

- The plants and equipment used for construction will strictly conform to Central Pollution Control Board (CPCB) noise standards. Vehicles, equipment and construction machinery shall be monitored regularly with particular attention to silencers and mufflers to maintain noise levels to minimum;
- Workers in the vicinity of high noise levels must wear ear plugs, helmets and should be engaged in diversified activities to prevent prolonged exposure to noise levels of more than90dB(A);
- In construction sites within 150 m of human settlements, noisy construction will be stopped between 10 PM and 6 AM except in case of laying of cement concrete pavement for which lower working temperature is a requirement;
- Hot mix plant, batching or aggregate plants shall not be located within 500 m of sensitive land use as schools and hospitals;
- Near to the sensitive receptors such as hospitals and schools, noise barriers such as earth, concrete, wood, metal or double-glazing of windows for façade insulation shall be used;
- Phase demolition, earthmoving and ground-impacting operations so as not to occur in the same time period. Unlike noise, the total vibration level produced could be significantly less when each vibration source operates separately
- Construction machinery will be located away from the settlements;
- Careful planning of machinery operation and scheduling of operations can reduce the noise levels. Use of equipment, emitting noise not greater than 90 dB(A) for the eight-hour operations shift and locating of construction yards at a distance of at least 500 m from any residential areas can be adhered to;
- Use of noise shields to construction machinery and provision of earplugs to the heavy machine operators are some of the mitigation measures, which should be followed by the contractors during the civil works;
- The noise control measures include limitations on allowable grades. Open-graded asphalt and avoidance of surface dressings to reduce tire noise in sensitive areas. Maintenance of proper road surface repairs also helps in reducing noise levels;
- Use of air horns should be minimized on the highway during nighttime. During daytime use of horns should be restricted at few sensitive locations. This can be achieved through the use of sign boards along the roadside;

- Future development along the road should follow correct land use norms so that sensitive receptors are not located along the road, specifically along the bypasses; and
- Development of greenbelt along the main road can also bring about considerable reduction in noise levels. The area available on both sides of the road should be used to develop green belt comprising selected species of trees with high canopy to provide added attenuation of noise

(7) Wastes/Hazardous Materials

Types of construction waste which are expected to be generated include asphalt chunks, chunks of concrete, surplus soil, construction scrap materials and organic waste generated by construction workers. The amount and percentage composition of construction waste will depend on the final design and the schedule of the construction, and thus generic mitigation measures proposed in EMP should be updated once the final ROW drawing is completed. All other construction wastes are also planned to comply with relevant Center or State laws pertaining to waste management.

Table 11.29 Required Volume for Spoil Bank

Highway No.	Sec.	Item	Unit	Volume of Generated Soil	Coefficient of Compation	Volume of Compacted Soil	Required Volume of Spoil Bank
				Cu.m		Cu.m	Cu.m
NH54	S1	Cut Soil	cu.m	3,442,909	0.9	3,098,618	2,400,495
		Fill Soil	cu.m			698,123	
	S2	Cut Soil	cu.m	3,710,629	0.9	3,339,566	2,437,522
		Fill Soil	cu.m			902,044	
	S3	Cut Soil	cu.m	3,560,596	0.9	3,204,536	2,465,129
		Fill Soil	cu.m			739,407	
	Total						7,303,146

Source: JICA Study Team

The volume of surplus soil is estimated as below. Candidate locations with sufficient and necessary conditions for spoil bank construction have been screened with following criteria:

- ❖ To minimize transport of surplus soil, spoil bank should be located at every 5km distance along NH54 with following condition;
  - Ground shape with concavity topography
  - Less ground gradient than 22 degree which is assumed as average angle of spoil bank slope with necessary steps
  - No built-up area
  - No national sanctuary area

- ❖ To be able to construct the spoil bank in less than 30m height

Based on the above criteria, 115 locations in 381 km stretch of NH54 has been identified for spoil bank construction. There are 41, 32 and 42 spoil bank with about 2.43, 2.90 and 2.51 million cu.m capacities in Section I, II and III respectively.

Socio-Economic Environment

(1) Involuntary Resettlement

As per the preliminary ROW design, the project will affect 2,037 households (1,971 households whose houses will be affected and 66 households whose businesses will be affected). The total number of affected people is 8,230. Out of these, 1307 households (1,265 households whose houses will be affected and 42 households whose businesses will be affected) will have to be relocated. Based on the preliminary ROW design, remaining 730 households will be affected but relocation will not be necessary.

(2) Land Use

The project does not lead to large-scale change in land use as the engineering work will be constrained mostly along the existing road. On the other hand, development of resettlement site to accommodate relocated households and construction of spoil bank is likely to cause changes in land use pattern, potentially affecting existing agricultural and plantation activities. Also, jhum cultivation, which is practiced in roadside as in Photo below, will be affected by slope protection/embankment work. The jhum practice directly next to the road is likely to have negative impacts from the road maintenance point of view and thus measures will be developed to shift existing jhum to areas far from the road or transform jhum to other agriculture practice.

(3) Utilization of Local Resources (3.3) and Local Economy and Livelihood

Significant volume of local resources such as sand may be used for construction work. This could cloud out the use of such resources for other purposes in the short-term. In the long-term, the better road network may attract new business, possibly from outside the state with detrimental impact on local business/traders. While the project overall will have significant positive impacts on the local and regional economy, the better transport network may put some groups at risk at least in the short and medium-term. These potential high-risk groups should be identified in the preparation of R&R plan to ensure that they will not be in a disadvantaged position due to the project.

(4) General, Regional /City Plans

The project will create new opportunities for village and district-level development planning. In particular, the construction of spoil bank will create large area of flat land where such surface is a scarce commodity. The development of spoil bank, therefore, should be coordinated with the village/district's development plan so that the land will benefit the community. Similarly, development of resettlement site should be well coordinated with village development plan to ensure proper supply of basic utilities and integration of new sites with the existing village area.

(5) Social Institutions and Local Decision-making Institutions

Except for Lawngtlai and Saiha district where Lai and Hmar population account for the majority of the population respectively, different tribes of Mizo people co-exist across the stretch of NH54 without tribe-rooted conflicts. To minimize potential disturbance and avoid the risk of conflicts, however, the resettlement will be planned within the village where relocation takes place. Being a tribal state, district and village council and traditional community leaders have significant influence on decision-making process in the area. As such, their support and cooperation is critical in smooth implementation of the project, particularly activities related to resettlement. The implementation of EMP as well as RAP/R&R should be built on existing social institutions and will be best guided by local people, rather than outside experts.

(6) Social Infrastructure and Services

For most people residing along NH54, the highway is the only route of access to social infrastructures such as schools and hospitals. Construction activity is likely to cause temporary disturbance to their access to such infrastructure and service and therefore, schedule and timing of the engineering activity should be developed in consultation with the local community. When road blockage is necessary, e.g. for blasting, the local community should be informed in advance so that they can make alternate plan accordingly.

(7) Unequal Distribution of Benefit and Damage (3.8) and Local Conflicts of Interest

Roadside location offers critical advantages for local business (tea stalls, restaurant, petty shops). Resettlement from roadside to inner part o the village may significantly undermine the viability of these businesses, and therefore, business owners to be affected may be worse off compared with farmers to be relocated. Likewise, allocation of plot in resettlement site may become a source of conflicts among affected households who wish to be relocated to more advantageous plots. Sound arbitration and conflict resolution mechanism by local leaders should be in place for smooth implementation of RAP and R&R activity.

(8) Water Usage, Water Rights and Communal Rights

Irrigation is not practiced along the project area and thus water is not likely to become a source of conflicts in the course of project implementation.

(9) Cultural and Historical Heritage

No sites of cultural or historical significance have been identified along the project road.

(10) Religious and Sensitive Facilities

It is expected that the project will affect 8 small churches along the road. Given the importance of religion and religious belief in the project area, the project should explore options avoid/minimize impacts to such facilities during the detailed design once additional topographic data is obtained. Also, access to these facilities, particularly Sunday mass, should not be disturbed by construction activities. Similarly, more stringent standard for noise and vibration and air quality should be adopted where sensitive facilities such as school and hospitals are located.

(11) Poor People

The baseline survey has identified gap between official poverty level and poverty level as reported by the people. R&R activity should take into account the limited coping capacity of the local community and develop measures that leads to sustainable income generation of the affected people, rather than one-off payment of compensation and assistance.

(12) Ethnic Minorities/ Indigenous People

In the state of Mizoram, the tribal (Scheduled Tribe: ST) population constitutes about 95% of the total population. Overwhelming majority of the affected people also belong to ST, and hence they are not minority. While tribal groups in project area holds traditional culture, including shifting cultivation in forest called jhum, they freely interact and share their sources of water, folklore, food, infrastructure and other belongings with the non-ST and other tribal population within and outside community. This is particularly evident in the section between Aizawl and Lunglei where differnet sub-tribe of Mizo, including Lushai, Lai and Mara and non-Mizo people co-exist peacefully without ethnicity-related tensions. Moreover, ST population in project area is not isolated from outside and they are open to new ideas such as family planning and formal education.

(13) Gender

Tribal and non-tribal women in North East States enjoy a relatively higher position in the society than what their non-tribal counterparts do, which is reflected in their high literacy rate. Mizo women are largely involved in household work, collection of forest produce, firewood collection, cultivation and other agricultural activities and thus they will be affected in a way that is different from their male counterpart. In order to ensure that affected women will not be disadvantaged, a dedicated chapter on gender issue is included in women in which options to facilitate women's participation in project implementation and various opportunities to be created by the project is discussed.

(14) Public Health and Occupational Health and Safety (OHS)

The health and safety measures at design, construction and operation phase are given below.

Table 11.30 Health and Safety Measures

Design Stage	
Geometric Correction at Critical Curves	Critical curves have been rectified to maintain project design speed and visibility. (IRC-86-1983 " Geometric Design for Road in Plains")
Construction Stage	
Health hazard to workers due to bad water and sanitation	At every workplace, good and sufficient potable water (as per IS) supply shall be ensured to avoid water-borne diseases and to secure the health of workers. Adequate drainage, sanitation and waste disposal shall be provided at workplaces. Preventive Medical care shall be provided to workers.
Health/ social hazard, sexual harassment to female workers	Segregation of male and female areas in labor camp shall be executed.
Hygiene at Construction Camps	The Contractor during the progress of work will provide, erect and maintain necessary (temporary) living accommodation and ancillary facilities for labour to standards and scales approved by the resident engineer. There shall be provided within the precincts of every workplace, latrines and urinals in an accessible place, and the accommodation, separately for each for these, as per standards set by the Building and other Construction Workers (regulation of Employment and Conditions of Service) Act. Except in workplaces provided with water-flushed latrines connected with a well designed septic tank, all latrines shall be provided with low cost 'Twin Pit Latrine' system. The pit can be closed after the construction is over. There shall be adequate supply of water, close to latrines and urinals. All temporary accommodation must be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking and washing. The sewage system for the camp must be properly designed, built and operated so that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place. Compliance with the relevant legislation must be strictly adhered to. Garbage bins must be provided in the camp and regularly emptied and the garbage disposed off in a lined landfill sites. Construction camps are to be sited away from vulnerable people and adequate health care is to be provided for the work force.

	On completion of the works, the whole of such temporary structures shall be cleared away, all rubbish burnt, excreta or other disposal pits or trenches filled in and effectively sealed off and the whole of the site left clean and tidy, at the Contractor's expense, to the entire satisfaction of the Engineer.
Abandoned Quarry will accumulate water and act as a breeding ground for disease vectors.	Reclamation measure shall be adopted with garland of trees around the periphery. The quarry dust and waste shall be used for refilling. The remaining portion should be covered with trees. If the quarry site is porous, it shall be used by groundwater recharging.
Risk from Operations	The Contractor is required to comply with all the precautions as required for the safety of the workmen as far as those are applicable to this project. The contractor shall supply all necessary safety appliances such as safety goggles, helmets, masks, etc., to the workers and staff. The contractor has to comply with all regulation regarding safe scaffolding, ladders, working platforms, gangway, stairwells, excavations, trenches and safe means of entry and egress.
Risk from Electrical Equipment	Adequate precautions will be taken to prevent danger from electrical equipment. No material or any of the sites will be so stacked or placed as to cause danger or inconvenience to any person or the public. All necessary fencing and lights will be provided to protect the public. All machines to be used in the construction will conform to the relevant Indian Standards (IS) codes, will be free from patent defect, will be kept in good working order, will be regularly inspected and properly maintained as per IS provisions and to the satisfaction of the Engineer.
Risk at Hazardous Activity	All workers employed on mixing asphaltic material, cement, lime mortars, concrete etc., will be provided with protective footwear and protective goggles. Workers, who are engaged in welding works, would be provided with welder's protective eye-shields. Stone-breakers will be provided with protective goggles and clothing and will be seated at sufficiently safe intervals. The use of any herbicide or other toxic chemical shall be strictly in accordance with the manufacturer's instructions. The Engineer shall be given at least 6 working day notice of the proposed use of any herbicide or toxic chemical. A register of all herbicides and other toxic chemicals delivered to the siteshall be kept and maintained up to date by the Contractor. The register shall include the trade name, physical properties and characteristics, chemical ingredients, health and safety hazard information, safe handling and storage procedures, and emergency and first aid procedures for the product.
Risk of Lead Pollution	No man below the age of 18 years and no woman shall be employed on the work of painting with products containing lead in any form. No paint containing lead or lead products will be used except in the form of paste or readymade paint. Face masks will be supplied for use by the workers when paint is applied in the form of spray or a surface having lead paint dry rubbed and scrapped.
Risk caused by Force' Majure	All reasonable precaution will be taken to prevent danger of the workers and the public from fire, flood, drowning, etc. All necessary steps will be taken for prompt first aid treatment of all injuries likely to be sustained during the course of work.
Risk from Explosives	Except as may be provided in the contract or ordered or authorized by the Engineer, the Contractor shall not use explosives. The Contractor shall at all times take every possible precaution and shall comply with appropriate laws and regulations relating to the importation, handling, transportation, storage and use of explosives and shall, at all times when engaged in blasting operations, post sufficient warning flagmen, to the full satisfaction of the Engineer. The Contractor shall at all times make full liaison with and inform well in

	advance and obtain such permission as is required from all Government Authorities, public bodies and private parties whatsoever concerned or affected or likely to be concerned or affected by blasting operations.
Malaria risk	The Contractor shall, at his own expense, conform to all anti-malarial instructions given to him by the Engineer, including filling up any borrow pits which may have been dug by him
Loss of Access	At all times, the Contractor shall provide safe and convenient passage for vehicles, pedestrians and livestock to and from side roads and property accesses connecting the project road. Work that affects the use of side roads and existing accesses shall not be undertaken without providing adequate provisions to the prior satisfaction of the Engineer. The works shall not interfere unnecessarily or improperly with the convenience of public or the access to, use and occupation of public or private roads, railways and any other access footpaths to or of properties whether public or private.
Traffic Jams and Congestion	Detailed Traffic Control Plans shall be prepared and submitted to the Site Engineer/ Project Director for approval 5 days prior to commencement of works on any section of road. The traffic control plans shall contain details of temporary diversions, details of arrangements for construction under traffic and details of traffic arrangement after cessation of work each day. Temporary diversion (including scheme of temporary and acquisition) will be constructed with the approval of the designated Engineer. Special consideration shall be given in the preparation of the traffic control plan to the safety of pedestrians and workers at night. The Contractor shall ensure that the running surface is always properly maintained, particularly during the monsoon so that no disruption to the traffic flow occurs. As far as possible idling of engines shall be avoided to curb pollution. The temporary traffic detours shall be kept free of dust by frequent application of water, if necessary.
Traffic Control and Safety	The Contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as may be required by the Engineer for the information and protection of traffic approaching or passing through the section of the highway under improvement. All signs, barricades, pavement markings shall be as per the MORT&H specification. Before taking up construction on any section of the highway, a traffic control plan shall be devised to the satisfaction of the Engineer. Excavated pits shall be filled to avoid falling of animals/ human beings.
Operation Phase	
Dwellers in settlements may rush to high way and meet accident	Specially design urban section and footpath sections shall be applied to the necessary locations.
Vehicles parked in settlements may lead to narrow carriageway	Specially designed parking areas shall be executed at the required locations.
Fast moving vehicles may threat safety in settlements.	Specially designed pedestrian crossings shall be constructed at required locations.
Accidents involving hazardous materials.	The rules s defined Hazardous waste handling Act shall be compiled. Vehicles delivering hazardous substances shall be printed with appropriate signs. In case of spillage, the report to relevant departments will be made and instructions followed in taking up the contingency measures.
Other Safety Measures	Traffic Management plan shall be developed especially along

	congested locations. Traffic control measures including speed limits will be enforced strictly. Further growth of encroachment and squatting within row shall be discoursed.

Source: JICA Study Team

Other Issues

(1) Accidents

Construction Phase Impacts

The project will improve the road safety through design measures identified during the various road surveys. Road safety will be enhanced in the project through engineering (design), enforcement (safety measures, signage, etc.) and education. The issue of road safety is one of the key issues that may surface in construction stage. During the construction stage, dismantling of structure, cutting of trees, haulage material obstructing vision, spillage of lubricants on road making it slippery is generally the cause of road accidents. Similarly, in operation stage, increase in traffic and increase in speed would tend to increase in accidents. In spite of these, the social benefits from the project are quite significant.

It is likely that there will be some concern of safety for highway users during construction period, as haulage of material and other equipment would restrict movement of vehicles. Highway patrolling system with ambulance facility and crane will render assistance to users in distress and disabled vehicles which in-turn will improve the safety level.

Operation Phase Impacts

The proposed project implementation would improve the road safety for the highway users as well as locals living by the side of the road. In operation stage, increase in traffic and increase in speed would tend to increase in accidents. In-spite of these, the social benefits from the project are quite significant. In operation phase, increase in vehicle speed may cause thereof to the safety of pedestrians and for cattle for crossing road.

Mitigation Measures

Street furniture known as road studs, blinker or cat's eye include equipment installed on road or roadside to assist visibility of road alignment/structures. They are retro-reflective safety devices used in road marking. Generally, it consists of two pairs of reflective glass spheres set into a white rubber dome, mounted in a cast-iron housing. This is the kind that marks the center of the road, with one pair of devices showing in each direction. A single-ended form has become widely used in other colors at road margins and as lane dividers.

Since the NH54 is located in mountainous region, hair-pin bends are unavoidable from the viewpoint of cost and environmental impact. Design speed of 20km/h is applied for hair-pin bends, while design speed of 30km/h is adopted in general. Small horizontal curves such as R20m-R25m are used in steep terrain to avoid large-scale earthwork and/or demolition of houses. At those sub-standard sections, securing traffic safety by applying combination of facilities shall be considered.

In hair-pin bends, it is difficult to secure overtaking sight distance and thus, the section shall be designated as no-overtaking section. In order to inform that to drivers, the double centre line with marking of pair of solid lines is applied. Cats eyes to delineate road alignment are to be installed on the centre line and lane edges so that drivers will be able to identify the direction he should go before entering into the curve. Furthermore, traffic signs and guard rails shall be properly equipped to avoid hazardous accidents. The Figure below shows an example of combined traffic safety facilities to be installed at hair-pin bends.

In the locations where the existing bridges are to be utilized with rehabilitation works, carriageway width becomes narrower than that of earthwork sections due to the difference in shoulder width. It is, therefore, proposed to install facilities that notify drivers the decrease in carriageway width and existence of concrete curb.

The project road passes through 48 villages and there are a lot of buildings, shops or houses at roadside as well as pedestrians going along the sidewalk and crossing the road. Furthermore, more road facilities such as bus stops are necessary than rural sections. Therefore, drivers have to handle much information on roads/traffic and decide their maneuvers in a short time at built-up areas. In order to assist road users in obtaining information, appropriate traffic signs and road markings shall be provided properly.

(2) GHG emissions

There is a possibility of increased GHG emission due to the operation of heavy vehicles as well as traffic jams incidental to the construction works, this impact will be temporary. On the other hand, it is expected that the GHG emission will be increase due to increase traffic volume. The increase will be mitigated by keeping good road conditions which will reduce consumption of extra fuel and congestion, thereby mitigating GHG emissions over time.

11.6.9 Environment Management Plan

Based on the assessment above, environment mitigation and enhancement measures during different stages of the project have been developed as shown below.

Table 11.31 Environmental Management Plan for Pre-Construction Stage

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
P1	Relocation of Project Affected Persons (PAP) and	• All requirements of the RAP shall be complete before start of construction stage. The activities broadly include acquisition of land and structures, relocation of utilities, payment of compensation and provision assistance[7]	All areas	Before construction begins	NGOs, , NHIDCL, Village Council, District Revenue authorities,	PIU, SC
P2	Removal of vegetation	• Minimize the scale of vegetation clearing by factoring vegetation/forest cover in the final design of the road alignment process • Removal of trees to be carried out after forest clearance is obtained • Reforestation/replantation of trees at a term as instructed by the Forest Dept. • Activity shall be supervised to avoid poaching of animals	All areas	Before construction begins	PIU, Contractor	PIU, SC

7 More details to be found in RAP report.

P3	Setting up construction camps	• Camps shall be located at least 500m away from the nearest built-up area. • Sewage system for a construction laborer's camp shall be designed, built and operated so that no pollution to ground or adjacent water bodies/ watercourses takes place. Garbage bins shall be provided in the camps and regularly emptied and the garbage disposed off in a hygienic manner, to the satisfaction of the relevant norms and the Engineer. • In relation to underground water resources, the contractor shall take all necessary precaution to prevent interference with such water resources. • All relevant provisions of the Factories Act, 1948 and the Building and other Construction Workers (regulation of Employment and Conditions of Service) Act, 1996 shall be adhered to.	All construction campsite identified by the contractor and approved by SC	During Establishment, Operation and Dismantling of Such Camps.	Contractor	PIU, SC
P4	Setting up hot mix plants	• Hot mix plants and batching plants shall be located sufficiently away from habitation and agricultural operations. • Where possible such plants will be located at least 1000m away from the nearest habitation.	All hot-mix and batching plants	During Erection, Testing, Operation and Dismantling of Such Plants.	Contractor	PIU, SC
P5	Finalizing sites for surplus soil dumping	• Location of dumping sites shall be finalized. The sites shall meet following conditions: i) dumping does not impact natural drainage courses; ii) no endangered/rare flora is impacted by such dumping	All areas identified as potential dumping sites	During mobilization	Contractor	PIU, SC

P6	Identification of hazard-prone locations	• The contractor shall identify locations sensitive to landslides (in addition to the ones that area already identified) and shall duly report these to the Supervision Consultant (SC) and to PIU/PWD.	All area	During mobilization	Contractor	PIU, SC

Source: JICA Study Team

Table 11.32 Environmental Management Plan for Construction Stage

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
Soil						
C1	Soil Erosion in Borrow Pits	• The depth of borrow pits shall be restricted so that sides of the excavation shall have a slope not steeper than 1:4, from the edge of the final section of the bank.	On approved locations of borrow pits.	Construction Stage	Contractor and Supervision Consultant	PIU
C2	Loss of top soil in Borrow pits	• Agricultural fields or productive land shall be avoided for borrowing earth. If unavoidable topsoil shall be preserved and used for tree plantation.	On approved locations of borrow pits.	Construction Stage	Contractor and Supervision Consultant	PIU
C3	Compaction of Soil	• Construction equipment and vehicles shall be restricted to move only within designated area to avoid compaction of productive soil.	Throughout corridor.	Construction Stage	Contractor and Supervision Consultant	PIU
C4	Soil erosion in embankments	• Pitching shall be done for slope stabilization as per the IRC guidelines	At the places of embankments	Construction Stage	Contractor and Supervision Consultant	PIU

C5	Contamination of soil from fuel and lubricants	• Construction vehicles and equipment shall be operated and maintained in such a manner so that soil contamination due to its spillage shall be minimum. • Fuel storage shall only be done on wasteland and will be kept away from drainage channels and natural water bodies.	Near Labor camp and sites of installation of Construction machineries.	Construction Stage	Contractor and Supervision Consultant	PIU
C6	Contamination of land from construction waste and quarry materials	• Debris generated due to the dismantling of the existing pavement structure and the cutting of the hillside for the widening shall be suitably reused in the proposed construction, such as for fill materials for embankments. • Debris and other material obtained from existing embankment shall be dumped in approved landfill site already identified by concerned agency. All spoils shall be disposed off as desired and the site shall be fully cleaned before handing over. • Construction waste including non-bituminous and bituminous waste shall be dumped in approved landfill site identified by State Pollution Control Board (SPCB). All spoils shall be disposed off as desired and the site shall be fully cleaned before handing over.	Solid waste dump Site identified and approved by SPCB. Throughout the area	Construction Stage	Contractor and Supervision Consultant	PIU
C7	Loss of top soil in land acquisition	• Topsoil shall be stripped, stored and shall be laid on ground for landscaping purpose.	Throughout the area	Construction Stage	Contractor and Supervision Consultant	PIU
Water						

C8	Contamination of water by fuel/ oil spillage of vehicle	• Construction vehicles / equipment shall be operated and maintained in such a manner to avoid contamination of water bodies due to oil spillage. • Fuel storage shall only be done on wasteland and will be kept away from drainage channels and natural water bodies.	Near labor camp and sites of installation of Construction machineries.	Construction Stage	Contractor and Supervision Consultant	PIU
C9	Contamination of stagnant water body by fecal matters from labor camp.	• Labor camp shall not be allowed near any of the water bodies. • The proper sanitation facilities shall be provided.	Preapproved locations away from the water bodies.	Construction Stage	Contractor and Supervision Consultant	PIU
C10	Deposition of dust in open wells near construction site	• The mouth/opening of the well shall be covered with suitable material during any of the construction activity so as to prevent dust entering in the well.	All the wells along the project corridor.	Construction Stage	Contractor and Supervision Consultant	PIU
C11	Using drinking water for construction purpose	• The contractor shall make arrangements for water required for construction in such a way that water availability and supply to nearby community is unaffected. • Wastage of water shall be kept minimum during construction.	At respective planned construction sites	Construction Stage	Contractor and Supervision Consultant	PIU
C12	Hand pump close to road may get affected in widening	• All the Hand pumps shall be relocated to suitable alternate place.	At the respective locations	Construction Stage	Contractor and Supervision Consultant	PIU
C13	Well may get affected in widening	• All the Wells shall be relocated at alternate site.	At the respective locations	Construction Stage	Contractor and Supervision Consultant	PIU
C14	Altering flow of Natural drains	• Drain shall be channelized with Slope protection - Gabion Structure.	At the respective locations	Construction Stage	Contractor and Supervision Consultant	PIU

C15	Sanitation of waste disposal in construction camps	• The construction of camps will be done with sufficient buffer from habitation. • At construction sites and labor camps sufficient no of latrines will be provided. • The sewage generated from the camps will be properly disposed off so that it does not affect water bodies	Wherever labor camp is located	Construction Stage	Contractor and Supervision Consultant	PIU
Air						
C16	Emission from construction vehicles and machinery.	• All vehicles, equipment and machinery shall be selected to meet recognized international and national standards for emissions and shall be maintained and operated in a manner that ensures relevant air, noise and discharge rules. • Only unleaded petrol and low sulphur diesel or sulphur free diesel shall be used as fuel for vehicles, equipment and machinery.	Wherever the hot mix plant and batching plant is setup.	Construction Stage	Contractor and Supervision Consultant	PIU
C17	Air pollution from various plants affecting settlements	• The asphalt plants, crushers and batching plants shall not be sited at least 500 m in leeward direction from nearest human settlement	Locations near Settlement	Construction Stage	Contractor and Supervision Consultant	PIU
C18	Air pollution may exceed the limits prescribed by Central Pollution Control Board.	• Regular monitoring or air quality parameters during the construction period as envisaged in the Environmental Monitoring Plan.	Locations given in Environmental Monitoring Plan.	Construction Stage	Contractor and Supervision Consultant	PIU
C19	Vehicles will generate dust and suspended particles.	• The dust generated by vehicles on site shall be arrested using a water tanker fitted with sprinkler capable of applying water uniformly with a controllable rate of flow to variable widths of surface but without any flooding.	Wherever the plants are setup and sensitive locations as suggested in monitoring plan.	Construction Stage	Contractor and Supervision Consultant	PIU
Noise						

C20	Noise levels from vehicles. Asphalt plants and equipment	• The plants and equipments used for construction shall confirm to CPCB norms. • Vehicles and equipments used shall be fitted with silencer. • Any vehicle and machinery shall be kept in good working order and engines turned off when not in use. • All equipments and plants shall strictly be placed away from educational institutes and hospitals. • Regular monitoring of noise parameters (Leq) during the construction period as envisaged in the Environmental Monitoring Plan.	Wherever the plants are setup.	Construction Stage	Contractor and Supervision Consultant	PIU
C21	Noise from blasting operations	• Blasting as per Indian Explosives act will be carried out. • People living near such blasting operation sites shall be informed before the operational hours. • Workers at blasting sites shall be provided with earplugs.	At the sites where the blasting is required and in quarry sites	Construction Stage	Contractor and Supervision Consultant	PIU
C22	Noise barriers	• Construction of noise barriers in the form of walls and vegetation at Sensitive locations.	All along the corridor wherever the sensitive locations like schools, hospitals and other community places are located.	Construction Stage	Contractor and Supervision Consultant	PIU
Flora and Fauna						

C23	Tree cutting for widening	• Three trees shall replace each tree cut for the purpose. • The Engineer shall approve such felling only when the NHIDCL receives a "clearance" for such felling from the DOF, as applicable. • Trees felled shall be replaced as per the compensatory afforestation criteria in accordance with the Forests (Conservation) Act, 1980.	Throughout the project area	Construction Stage	Contractor and Supervision Consultant	PIU
C24	Damage or Loss of Important Flora	• During construction, at any point of time, if a rare/ threatened/endangered flora species is found, it shall be conserved in a suitable manner in consultation with authorities. The Engineer shall approve detailed conservation processes, plans and designs as well as associated modification in the project design.	Throughout the project area.	Construction Stage	Contractor and Supervision Consultant	PIU
Health and Hygiene						
C25	Health hazard to workers due to bad water and sanitation	• At every workplace, good and sufficient potable water (as per IS 10500) supply shall be ensured to avoid water-borne diseases and to secure the health of workers. • Adequate drainage, sanitation and waste disposal shall be provided at workplaces. • Preventive Medical care shall be provided to workers.	Wherever labor camp is setup	Construction Stage	Contractor and Supervision Consultant	PIU
C26	Health hazard to workers by various construction activity	• Personal protective equipment shall be provided to worker as per the Factories Act.	Throughout the project area	Construction Stage	Contractor and Supervision Consultant	PIU
C27	Health/ social hazard, sexual harassment to female workers	• Segregation of male and female areas in labor camp shall be executed.	Wherever labor camp is setup	Construction Stage	Contractor and Supervision Consultant	PIU

C28	Hygiene at Construction Camps	• The Contractor during the progress of work will provide, erect and maintain necessary (temporary) living accommodation and ancillary facilities for labor to standards and scales approved by the resident engineer. • These shall be provided within the precincts of every workplace, latrines and urinals in an accessible place, and the accommodation, separately for each for these, as per standards set by the Building and other Construction Workers (regulation of Employment and Conditions of Service) Act, 1996. There shall be adequate supply of water, close to latrines and urinals. • All temporary accommodation must be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking and washing. The sewage system for the camp must be properly designed, built and operated so that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place. Compliance with the relevant legislation must be strictly adhered to. Garbage bins must be provided in the camp and regularly emptied and the garbage disposed off in a lined landfill sites. Construction camps are to be sited away from vulnerable people and adequate health care is to be provided for the work force.	Wherever labor camp is setup	Construction Stage	Contractor and Supervision Consultant	PIU

C29		• On completion of the works, the whole of such temporary structures shall be cleared away, all rubbish burnt, excreta or other disposal pits or trenches filled in and effectively sealed off and the whole of the site left clean and tidy, at the Contractor's expense, to the entire satisfaction of the Engineer.				
C30	Abandoned Quarry will accumulate water and act as a breading ground for disease vectors.	• Reclamation measure shall be adopted with garland of trees around the periphery. The quarry dust and waste shall be used for refilling. The remaining portion should be covered with trees.	All quarry locations.	Construction Stage	Contractor and Supervision Consultant	PIU
Safety						
C31	Safety of vehicles plying on road while the construction activity is going on.	• Prior arrangement/traffic diversion for safe passage of vehicles shall be made with proper direction and signage at the construction site. • Detailed Traffic Control Plans shall be prepared and submitted to the Site Engineer/ Project Director for approval 5 days prior to commencement of works on any section of road. The traffic control plans shall contain details of temporary diversions, details of arrangements for construction under traffic and details of traffic arrangement after cessation of work each day.	Throughout the project area	Construction stage	Contractor and Supervision Consultant	PIU

C32	Risk from Operations	• The Contractor is required to comply with all the precautions as required for the safety of the workmen as far as those are applicable to this contract. • The contractor shall supply all necessary safety appliances such as safety goggles, helmets, masks, etc., to the workers and staff. The contractor has to comply with all regulation regarding safe scaffolding, ladders, working platforms, gangway, stairwells, excavations, trenches and safe means of entry and egress.	All construction sites	Construction stage	Contractor and Supervision Consultant	PIU
C33	Risk from Electrical Equipment	• Adequate precautions will be taken to prevent danger from electrical equipment. No material or any of the sites will be so stacked or placed as to cause danger or inconvenience to any person or the public. • All necessary fencing and lights will be provided to protect the public. All machines to be used in the construction will conform to the relevant Indian Standards (IS) codes, will be free from patent defect, will be kept in good working order, will be regularly inspected and properly maintained as per IS provisions and to the satisfaction of the Engineer.	All construction Site	Construction stage	Contractor and Supervision Consultant	PIU

C34	Risk at Hazardous Activity	• All workers employed on mixing asphaltic material, cement, lime mortars, concrete etc., will be provided with protective footwear and protective goggles. Workers, who are engaged in welding works, would be provided with welder's protective eye-shields. Stone-breakers will be provided with protective goggles and clothing and will be seated at sufficiently safe intervals. • The use of any herbicide or other toxic chemical shall be strictly in accordance with the manufacturer's instructions. The Engineer shall be given at least 6 working day's notice of the proposed use of any herbicide or toxic chemical. A register of all herbicides and other toxic chemicals delivered to the site shall be kept and maintained up to date by the Contractor. The register shall include the trade name, physical properties and characteristics, chemical ingredients, health and safety hazard information, safe handling and storage procedures, and emergency and first aid procedures for the product. This should comply with Hazardous Material Act.	All construction sites	Construction stage	Contractor and Supervision Consultant	PIU

C35	Risk of Lead Pollution	• Nobody below the age of 18 years and no woman shall be employed on the work of painting with products containing lead in any form. No paint containing lead or lead products will be used except in the form of paste or readymade paint. • Facemasks will be supplied for use by the workers when paint is applied in the form of spray or a surface having lead paint dry rubbed and scrapped	All construction sites	Construction stage	Contractor and Supervision Consultant	PIU
C36	Risk caused by Force' Majure	• All reasonable precaution will be taken to prevent danger of the workers and the public from fire, flood, drowning, etc. All necessary steps will be taken for prompt first aid treatment of all injuries likely to be sustained during the course of work.	All construction Site	Construction stage	Contractor and Supervision Consultant	PIU

C37	Risk from Explosives	• Except as may be provided in the contract or ordered or authorized by the Engineer, the Contractor shall not use explosives. Where the use of explosives is so provided or ordered or authorized, the Contractor shall comply with the requirements of the following Sub-Clauses of this Clause besides the law of the land as applicable. • The Contractor shall at all times take every possible precaution and shall comply with appropriate laws and regulations relating to the importation, handling, transportation, storage and use of explosives and shall, at all times when engaged in blasting operations, post sufficient warning flagmen, to the full satisfaction of the Engineer. • The Contractor shall at all times make full liaison with and inform well in advance and obtain such permission as is required from all Government Authorities, public bodies and private parties whatsoever concerned or affected or likely to be concerned or affected by blasting operations.	Place of use of Explosives	Construction stage	Contractor and Supervision Consultant	PIU
C38	Malarial risk	• The Contractor shall, at his own expense, conform to all anti-malarial instructions given to him by the Engineer, including filling up any borrow pits which may have been dug by him	All construction sites, particularly beyond Lunglei district	Construction stage	Contractor and Supervision Consultant	PIU

C39	First Aid	• At every workplace, a readily available first aid unit including an adequate supply of sterilized dressing material and appliances will be provided.	At the construction site /labor camp	Construction stage	Contractor	PIU
Disruption to Users						
C40	Loss of Access	• At all times, the Contractor shall provide safe and convenient passage for vehicles, pedestrians and livestock to and from side roads and property accesses connecting the project road. Work that affects the use of side roads and existing accesses shall not be undertaken without providing adequate provisions to the prior satisfaction of the Engineer. • The works shall not interfere unnecessarily or improperly with the convenience of public or the access to, use and occupation of public or private roads, railways and any other access footpaths to or of properties whether public or private.	Throughout the project area, particularly in built-up areas	During Construction.	Contractor	Engineer

C41	Traffic Jams and Congestion	• Detailed Traffic Control Plans shall be prepared and submitted to the Site Engineer/ Project Director for approval 5 days prior to commencement of works on any section of road. The traffic control plans shall contain details of temporary diversions, details of arrangements for construction under traffic and details of traffic arrangement after cessation of work each day. • Temporary diversion (including scheme of temporary and acquisition) will be constructed with the approval of the designated Engineer. While approving temporary diversion construction, the Engineer will seek endorsement from the PIU. • Special consideration shall be given in the preparation of the traffic control plan to the safety of pedestrians and workers at night. • The Contractor shall ensure that the running surface is always properly maintained, particularly during the monsoon so that no disruption to the traffic flow occurs. As far as possible idling of engines shall be avoided to curb pollution. • The temporary traffic detours shall be kept free of dust by frequent application of water, if necessary.	Throughout Corridor	During Construction.	Contractor	Engineer

C42	Traffic Control and Safety	• The Contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as may be required by the Engineer for the information and protection of traffic approaching or passing through the section of the highway under improvement. • All signs, barricades, pavement markings shall be as per the MORTH specification. Before taking up construction on any section of the highway, a traffic control plan shall be devised to the satisfaction of the Engineer as per EMP. Excavated pits shall be filled to avoid falling of animals/ human beings.	Throughout the project area	During Construction.	Contractor	Engineer
Environment Enhancement						
C43	Hand pumps enhancement/relocation for ground water recharging	• Hand pumps within Right of Way shall be enhanced/relocated.	At the respective locations along the corridor.	Construction Stage	Contractor and Supervision Consultant	PIU
C44	Roadside landscape development	• Avenue plantation of foliage trees mixed with flowering trees, shrubs and aromatic plants shall be carried out where ever land is available between ditches and Right of Way.	Throughout the corridor	Construction Stage	Contractor and Supervision Consultant	PIU
C45	Providing better bus bays	• Bus shelters shall be provided at given locations	As per traffic plan	Construction Stage	Contractor and Supervision Consultant	PIU
C46	Better sitting arrangements where small space is available	• Designed sitting arrangements shall be provided.	As per the design	Construction Stage	Contractor and Supervision Consultant	PIU
C47	Landscaping of junctions	• All rotary junctions shall be landscaped suitably	As per landscape design at the respective locations	Construction Stage	Contractor and Supervision Consultant	PIU

C48	Abandoned Quarry will accumulate water and act as a breeding ground for disease vectors.	• The abandoned quarry locations shall be planted suitably as the plan	Wherever quarries are located and abandoned	Construction Stage	Contractor and Supervision Consultant	PIU
C49	Erosion of embankments, shoulders, side slopes, and pavement leading to deterioration and affecting stability and integrity of road	• Earth works specifications will include provision for stable slope construction, compacting and laying out turf including watering until ground cover is fully established • Proper construction of Breast wall and retaining wall at the locations identified by the design team to avoid soil erosion • The measures proposed for slope stabilization are: Discharge zones of drainage structures (culverts and minor bridges) provided with riprap • Construction in erosion and flood prone areas will not be in monsoon /season. • Side slopes will be kept flatter wherever possible, and in case of steeper slopes it will be supported by the retaining wall. • In order to avoid soil erosion from uphill side the drain along the breast wall will be constructed in the entire length. The breast wall will be constructed at the chainages identified by the design team.	At the respective locations throughout the project area.	Construction Stage	Contractor and Supervision Consultant	PIU

Source: JICA Study Team

Table 11.33 Environmental Management Plan for Operation Stage

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
O1	Water quality degradation due to road-run-off	• Silt fencing, oil & grease traps, etc. shall be provided at sensitive water bodies to ensure that the water quality is not impaired due to contaminants from road run-off • Monitoring shall be carried out as specified in the Monitoring plan	As specified in the monitoring plan	As per monitoring plan	PIU, SPCB	PIU
O2	Soil and water contamination from accidental spills	• Contingency plans to be in place for cleaning up of spills of oil, fuel and toxic chemicals	All area	Plan to be developed at state/district level by early operation stage	PIU, Local Government Bodies	PIU
O3	Traffic safety	• Traffic control measures including speed limits to be enforced strictly. • Local government bodies and development authorities will be encouraged to control building development along the highway.	All area	Throughout operation stage	PIU, Local Government Bodies	PIU

O4	Accidents involving hazardous materials	• Compliance with the Hazardous Wastes (Management and Handling) Rules, 1989 including: • For delivery of hazardous substances, permit license, driving license and guidance license will be required. • These vehicles will only be harbored at designated parking lots. • In case of spill of hazardous materials, the relevant departments will be notified at once to deal with it with the spill contingency plan.	All area	Manual/guideline to be prepared during early operation stage	PIU	PIU
O5	Roadside tree plantation	• Trees planted along the corridor shall be maintained for a period of three years. Maintenance works include, watering of the saplings, replacement of the bamboo fence every year for 3 years and all necessary measures for survival of the sapling.	All area	Immediately from the planting of sapling	NGO	PIU

Source: JICA Study Team

11.6.10 EMP Implementation Cost

Based on the above, the cost for implementation of EMP is estimated as below.

Table 11.34 Budget for EMP Implementation

Item	Detail	Unit	Unit	Quantity	Total (Rs)
I. Monitoring					
Air	Monitoring near hot mix plant locations approved by the Engineer as per NAAQS ,2009 CPCB	No.	5,000	80	400,000
Water	At locations specified in the monitoring plan as per IS 10,500 & IS 2296	No.	5,000	60	300,000
Noise	At equipment yards as directed by Engineer as per CPCB guideline 1989	No.	2,000	80	160,000
Flora and Fauna	Monitoring of impact on biodiversity	No.	50,000	24	1,200,000
Sub-Total (I)					2,060,000
II. Afforestation	Compensatory afforestation, in accordance with Forest Conservation Act (1980) as per guideline provided in EMP	No.	200	50,000	10,000,000
Sub-Total (II)					10,000,000
III. Institutional Cost					
Expert fees	Lump sum				6,000,000
Staff training	Lump sum				1,500,000
Ext. monitoring	Lump sum				2,000,000
Information disclosure	Lump sum				500,000
Sub-Total (III)					10,000,000
Sub-Total (I+II+III)					22,060,000
Contingency (10%)					2,206,000
Total					**24,226,000**

Source: JICA Study Team

11.6.11 Environment Monitoring Plan

To ensure effective implementation of the EMP, it is essential that an effective monitoring plan be designed and carried out. The environmental monitoring plan provides such information on which management decision may be taken during construction and operational phases. It provides basis for evaluating the efficiency of mitigation and enhancement measures and suggest further actions that need to be taken to achieve the desired effect. The monitoring includes: i) Visual observations; ii)

Selection of environmental parameters at specific locations; and iii) Sampling and regular testing of these parameters.

Monitoring methodology covers the following key aspects: Components to be monitored; parameters for monitoring of the above components; monitoring frequency; monitoring standards; responsibilities for monitoring; direct responsibility, overall responsibility; and monitoring costs. Environmental monitoring of the parameters involved and the threshold limits specified are discussed below.

Ambient air quality

Ambient air quality parameters recommended for monitoring road transportation developments are PM10, PM 2.5, Carbon Monoxide (CO), Oxides of Nitrogen (NO_X), Sulphur Dioxide (SO_2) and Lead (Pb). These will be monitored at designated locations starting from the commencement of construction activity. Data should be generated at all identified locations in accordance to the National Ambient Air Quality Standards, 2009. The location, duration and the pollution parameters will be monitored and the responsible institutional arrangements are detailed out in the Monitoring Plan.

Water quality

The physical and chemical parameters recommended for analysis of water quality relevant to road development projects are pH, total solids, total dissolved solids, total suspended solids, oil and grease, COD, chloride, lead, zinc and cadmium. The location, duration and the pollution parameters to be monitored and the responsible institutional arrangements are detailed in the Environmental Monitoring Plan. The monitoring of the water quality is to be carried out at all identified locations in accordance to the Indian Standard Drinking Water Specification – IS 10500: 1991.

Noise

The measurements for monitoring noise levels would be carried out at all designated locations in accordance to the Ambient Noise Standards formulated by Central Pollution Control Board (CPCB) in 1989. Noise should be recorded at an “A” weighted frequency using a “slow time response mode” of the measuring instrument. The location, duration and the noise pollution parameters to be monitored and the responsible institutional arrangements are detailed in the Environmental Monitoring Plan

The monitoring plan for the various performance indicators of the project in the construction and operation stages is summarized below.

Table 11.35 Environmental Monitoring Plan

Sl. No	Item	Project Stage	Parameters	Guidance	Standards	Location	Frequency	Duration	Responsibility	
									Implementation	Supervision
M1	Air	Construction	SPM, RSMP, SO_2, NOx, CO, HC	• Dust sampler to be located 50m from the plan in the downwind direction. • Use method specified by CPCB for analysis	Air (P&CP) Rules, CPCB, 1994	Hot mix plant/ batching plant	Twice a year for three years	Continuous 24 hours	Contractor through approved monitoring agency	PIU
M2		Construction	SPM, RSPM	• Dust sampler to be located 50m from the earthworks site downwind direction. Follow CPCD method for analysis	Air (P&CP) Rules, CPCB, 1994	Stretch of road where construction is underway	Twice a year for three years	Continuous 24 hours	Contractor through approved monitoring agency	PIU
M3		Operation	SPM, RSMP, SO_2, NOx, CO, HC	• Use method specified by CPCB for analysis	Air (P&CP) Rules, CPCB, 1994	Sampling location specified in EIA report	Twice a year for one year	Continuous 24 hours	PIU	PIU
M4	Water	Construction	pH, BOD, COD, TDS, TSS, DO, Oil & Grease and Pb	• Sample collected from source and analyze as per Standard Methods for Examination of Water and Wastewater	Water quality standards by CPCB	Sampling locations specified in EIA report	Twice a year for three years		Contractor through approved monitoring agency	PIU
M5		Operation	pH, BOD, COD, TDS, TSS, DO, Oil & Grease and Pb	• Grab sample collected • from source and analyze as per Standard Methods for Examination of Water • and Wastewater	Water quality standards by CPCB	Sampling locations specified in EIA report	Twice a year for one year		PIU	PIU
M6		Operation	Cleaning of drains and water bodies	• Choked drains, water bodies undergoing siltation and subject to debris disposal should be monitored under cleaning operations	To the satisfaction of the engineer (PWD)	All area	Post-monsoon		PIU	PIU

M7	Noise	Construction	Noise levels on dB (A) scale	• Free field at 1m from the equipment whose noise levels are being determined	Noise standards by CPCB	At equipment yard	Once every 3 Month (max) for three years, as required by the engineer	Reading to be taken at 15 seconds interval for 15 minutes every hour and then averaged	Contractor through approved monitoring agency	PIU
M8		Operation	Noise levels on dB (A) scale	• Equivalent Noise levels using an integrated noise level meter kept at a distance of 15 m from edge of Pavement	Noise standards by CPCB	At maximum 15 locations listed in EIA report for noise monitoring locations	Thrice a year for 1 years	Readings to be taken at 15 seconds interval for 15 minutes every hour and then averaged.	PIU	PIU
M9	Soil erosion	Construction	Turbidity in Storm water; Silt load in ponds, water courses	• Visual observations during site visits	As specified by the engineer / Water quality standards	At locations of stream crossings and at locations of retaining wall and breast wall	Pre-monsoon and post-monsoon for three years		Contractor	PIU
M10		Operation	Turbidity in Storm water; Silt load in ponds, water courses	• Visual observations during site visits	As specified by the engineer / Water quality standards	As directed by the engineer	Pre-monsoon and post-monsoon for one year		PIU	PIU
M11	Construction camp	Construction	Monitoring of: 1.Storage Area; 2. Drainage Arrangement 3. Sanitation in Camps	• Visual Observations and as directed by the engineer	To the satisfaction of the engineer and Water quality standards	At storage area and construction workers' camp	Quarterly during construction stage		PIU	PIU

M12	Afforestation	Construction and operation	Plant survival	• The success of tree planting. Monitor the rate of survival after six months, one year and 18 months in relation to total numbers of trees planted		All area	Minimum three years after planting		NGO, PIU	PIU

Source: JICA Study Team

11.6.12 Land Acquisition and Resettlement

The project requires land acquisition for proposed widening and other work including slope protection and stabilization. For a project involving involuntary displacement of 400 or more families en masse in plain areas, or 200 or more families en masse in tribal or hilly areas, the National Rehabilitation and Resettlement Policy 2007 (NRRP, 2007) requires the administrator for Rehabilitation and Resettlement (R&R) to undertake a Baseline Survey and Census for identification of the persons and families likely to be affected (Sec.6.2). This will be carried out by the State Government, who is responsible for rehabilitation once the final ROW is determined based on the additional topographic survey. Meanwhile, this RAP report has been prepared based on the preliminary design with the aim of informing the R&R related discussion between State Government and NHIDCL to ensure that land acquisition and involuntary resettlement for this project be carried out in a manner that is consistent with the JICA Guidelines for Environmental and Social Considerations.

In the state of Mizoram, the tribal (Scheduled Tribe: ST) population constitutes about 95% of the total population. While tribal groups in project area holds traditional culture, including shifting cultivation in forest called jhum, they freely interact and share their sources of water, folklore, food, infrastructure and other belongings with the non-ST and other tribal population within and outside community. This is particularly evident in the section between Aizawl and Lunglei where differnet sub-tribe of Mizo, including Lushai, Lai and Mara and non-Mizo people co-exist peacefully without ethnicity-related tensions. Moreover, ST population in project area is not isolated from outside and they are open to new ideas such as family planning and formal education. Given that the mainstream population of the area is tribal, elements of an Indigenous People Plan (IPP) as described in the World Bank OP4.10 have been incorporated into this report. No separate IPP has been prepared for this project.

11.6.13 Legal Framework for Land Acquisition and Resettlement

The Land Acquisition Act 1894 has so far served as the base policy document on which the State Government passes resolution to acquire land for different projects. This act is superseded by new act (Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013), which took effect on January 1st, 2014. However, the State Government of Mizoram issued Notification (No. H. 11018/8/2010-REV, dated January 5th, 2015) stating that the new Act will not be used in Mizoram on the ground that being under the Sixth Schedule of the Constitution, land in the State belongs to the individuals and not the Government. The Government is in the process of developing its own rule and has drafted the Draft Mizoram (Land Acquisition, Rehabilitation and Resettlement) Bill, 2015. However, this has not yet finalized as of August 2015. The proposed Bill generally follows the LARR 2013 but there are differences in terms of the additional benefits to rural area and solatium to be added to the compensation. In keeping view of the requirement under JICA Guidelines, the resettlement policy and entitlement proposed in a RAP report will be adopted in this project. Applicable acts, notifications, and policies relevant in the context of the project are discussed below.

Table 11.36 Applicable Acts and Policies

No.	Acts, Notifications, Policies	Relevance and Applicability to the Project
1	Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (LARR 2013)	Provides for enhanced compensation and assistances measures and adopts a more consultative and participatory approach in dealing with the Project Affected Persons (PAPs). The Act took effect in January 2014, however, State of Meghalaya opposes to the provisions on the ground that being under the Sixth Schedule of the Constitution, land in the State belongs to the individuals and not the Government.
2	National Rehabilitation & Resettlement Policy, 2007 ((NRRP 2007)	Provides limited benefits to affected family (an ex-gratia payment of not less than Rs. 20,000/- and in case land-holder becoming landless or small or marginal farmer in such cases other rehabilitation benefits as applicable.
3	The National Tribal Policy, 2006	Provides an environment conducive to the preservation of traditional and customary systems and regime of rights and concessions enjoyed by different ST communities.
4	The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006	Provides for recognition of forest rights to Scheduled Tribes in occupation of the forest land prior to 13.12.2005 and to other traditional forest dwellers who are in occupation of the forest land for at least 3 generations i.e. 75 years, up to maximum of 4 hectares. These rights are heritable but not alienable or transferable.
5	The Right to Information Act, 2005	Provides for setting out the practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, the constitution of a Central Information Commission and State Information Commissions and for matters connected therewith or incidental thereto.
6	World Bank OP 4.12 – Involuntary Resettlement	The project requires additional land area for widening and strengthening, junction improvements, realignments, safety provisions, etc. It will also affect structures mainly used for residences, business units, cattle sheds and livelihood of people. Some of them are without any valid pass/permit. All affected under the project, irrespective of a valid pass/permit shall be supported under the project to improve their quality of life or at least restore to pre-project standards.

7	OP 4.10 – Indigenous Peoples	Over 90% of the population in the State belongs to Tribal community, and almost all affected households belong to ST. While a separate IPP report is not prepared, the issues discussed in RAP takes into account this fact and address issues related to indigenous peoples in the RAP. The project shall ensure broad community support for the project based on free prior and informed consultation.
8	JICA Guidelines for Environmental and Social Considerations	See Box 3.1 below

Source: JICA Study Team

The LARR 2013 exempted 13 laws, including the National Highways Act from its purview. However, the LARR 2013 required that the compensation, rehabilitation, and resettlement provisions of these 13 laws be brought in consonance with the LARR 2013 within a year of its enactment (that is, by January 1, 2015), through a notification. The Bill brings the compensation, rehabilitation, and resettlement provisions of these 13 laws in consonance with the LARR Act, 2013. The Bill creates five special categories of land use: (i) defence, (ii) rural infrastructure, (iii) affordable housing, (iv) industrial corridors, and (v) infrastructure projects including Public Private Partnership (PPP) projects where the central government owns the land. The LARR 2013 requires that the consent of 80% of landowners is obtained for private projects and that the consent of 70% of landowners be obtained for PPP projects. The proposed amendment to the Bill, currently under the parliamentary discussion, exempts the five categories mentioned above from this provision of the Act. Being a rural infrastructure project, the above requirement does not technically apply to this project. As per the proposed amendment, projects that belong to five categories do not require social impact assessment. The amendment has not yet passed, but regardless the passage of the amendment, the project has sought to obtain support from the affected community in keeping with JICA Guidelines for Environmental and Social Guidelines. The key principle of JICA Guidelines in terms of land acquisition and involuntary resettlement is shown in Box below.

Box 11.1 Principle of JICA Policies on Involuntary Resettlement Right

The key principle of JICA policies on involuntary resettlement is summarized below.

I. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.

II. When, population displacement is unavoidable, effective measures to minimize the impact and to compensate for losses should be taken.

III. People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.

IV. Compensation must be based on the full replacement cost as much as possible.

V. Compensation and other kinds of assistance must be provided prior to displacement.

VI. For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy,

VII. In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.

VIII. Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.

IX. Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

Above principles are complemented by World Bank OP 4.12, since it is stated in JICA Guideline that "JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies". Additional key principle based on World Bank OP 4.12 is as follows.

X. Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits.

XI. Eligibility of Benefits include, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying.

XII. Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.

XIII. Provide support for the transition period (between displacement and livelihood restoration.

XIV. Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.

XV. For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared.

XVI. In addition to the above core principles on the JICA policy, it also laid emphasis on a detailed resettlement policy inclusive of all the above points; project specific resettlement plan; institutional framework for implementation; monitoring and evaluation mechanism; time schedule for implementation; and, detailed Financial Plan etc.

Source: JICA Guidelines for Environmental and Social Considerations, 2010

The following table summarizes key deviations between the two sets of legal and policy frameworks i.e. JICA policies and the existing Indian policies relevant to this project. The table also makes recommendations for measures to plug these gaps.

Table 11.37 Key Gaps between JICA and Indian Regulations

Sl. No.	JICA Guidelines (2010)	Applicable Policy (LARR and NRRP)	Gaps Between JICA's Guidelines and LARR and NRRP	Proposed Gap Filling Measures
1	Involuntary resettlement should be avoided wherever possible.	Stated aim to minimize large scale displacement. Encourages projects to be set up on waste land, degraded land, Un-irrigated land. (NRRP 2007, #1.4, Chap 1)	No	-
2	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken.	If unavoidable, Govt. to consider different alternatives to minimize displacement, total land acquired and total agricultural land acquired for non agricultural use (NRRP 2007, #1.4, Chap 1), LARR has provision for compensation for losses incurred.	No	-
3	People who must be settled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre0project levels.	Provisions made for R&R benefits to all; but subject to condition that non titleholders must be residing or drawing livelihood in the affected area for a period not less than 3 years preceding date of declaration of the affected area. (NRRP, #3.1.b.iii)	Yes, Non titleholders need to be residing continuously or drawing livelihood from the affected area for a period not less than 3 years preceding the date of declaration. LARR silent on compensation rights of Non Titleholders for loss of land (illegally occupied), structures. R&R benefits such as housing improvement, development benefits, loss of crops, trees, transitional support etc to be provided only if residing/ drawing livelihood for a continuous 3 year period in the area, preceding declaration of 'affected area'	Recognize claims of Non Title holders (as identified by census survey and irrespective of their residing period status) and in respect of – - Compensation for structures, trees - Structure transfer assistance - Structure reconstruction assistance - Shifting assistance for residential house owner - Tenant shifting allowance Assistance to be provided at par with similar R&R support extended to titleholder familiar
4	Compensation must be based on the full	Compensation made on market rate as	Yes, Market rate as calculated by	Compensation to be provided at full

Sl. No.	JICA Guidelines (2010)	Applicable Policy (LARR and NRRP)	Gaps Between JICA's Guidelines and LARR and NRRP	Proposed Gap Filling Measures
	replacement cost as much as possible	determined or recognized by state	government is usually far below the actual prevailing market rates.	replacement cost based on prevailing market rates and additional allowances
5	Compensation and other kinds of assistance must be provided prior to displacement	Provisions exist in NRRP		-
6	For projects that entails large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public.	Requirement for RAP is mentioned subject to number of displaced exceeding 400 families in plains or 200 in hilly/tribal areas or Desert Development Programme (DDP) blocks.	Yes, numerical condition (400 in plain area, 200 in tribal, hilly or DDP blocks) attached. JICA requires this to be implemented if PAH number is higher than 50.	RAP to be prepared for this project.
7	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance.	Specific mention provided in NRRP	No	-
8	When consultation held, explanation must be given in a form, manner, and language that are understandable to the affected people	Provision made	No	-
9	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans	Specified	No	-
10	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities	Specified	Yes, R&R Committee to be set up only if in the project area more 400 families (in plains) or 200 in tibal/hilly areas are to be displaced	- GRM to be set up. Should be accessible to PAHs- to be constituted at district level for issues around land acquisition R&R benefits. Similar body to exist at state level for

Sl. No.	JICA Guidelines (2010)	Applicable Policy (LARR and NRRP)	Gaps Between JICA's Guidelines and LARR and NRRP	Proposed Gap Filling Measures
				monitoring and supervision - R&R implementing NGO/Consultant to have presence in each project affected district and facilitate and inform PAHs about GRM and its processes.
11	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socio-economic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advantage of such benefit.	Specified under NRRP for identification of all affected persons	No	-
12	Eligibility of benefits includes, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under la), the PAPs who do not have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying	Specified- R&R benefits to non titleholders provisioned by subject to them residing/ drawing livelihood for period not less than 3 years in the project affected area (from the date formal declaration)	Yes, Non titleholders if residing or drawing livelihood for a period less than 3 years are not eligible for R&R benefits	- All non-titleholders (as identified on the date of census survey) will also be eligible for R&R benefits
13	Preference should be given to land –based resettlement strategies for displaced persons whose livelihoods are	Specified	No	-

Sl. No.	JICA Guidelines (2010)	Applicable Policy (LARR and NRRP)	Gaps Between JICA's Guidelines and LARR and NRRP	Proposed Gap Filling Measures
	land-based.			
14	Provide support for the transition period (between displacement and livelihood restoration)	Specified	Yes, no such benefits provision for non titleholder residing/drawing livelihood for a period less than 3 years	- Transition benefits to be provided to all non titleholders (displaced and livelihoods impacted) who have been identified as per census survey.
15	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.	Mentioned for vulnerable groups as defined under NRRP. Specific mention of additional provisions for SC and ST community mentioned under #7.21 of the NRRP. Requirement of a separate tribal development plan to be prepared if number of tribal displaced families exceeds 200 families.	No	- Special R&R assistance to SC community. - Special attention to be made by the R&R implementing NGO, the vulnerable PAH/persons receive R&R support as made out for them in the RAP.

Source: JICA Study Team

11.6.14 Scale of Land Acquisition and Resettlement

(1) Demographic Profile

The project road stretching over 381km passes through 48 villages in 5 districts. The number of villages per district are the following (Aizawl: 11, Serchhip: 8, Lunglei: 17, Lawngtlai: 6 and Saiha: 6). In these villages, the baseline survey has identified and surveyed 2,037 households (1,971 households whose houses will be affected and 66 households whose businesses will be affected). The total number of affected people is 8,230. The average household size is 4.1, which is below the State average of 4.8. Out of these, 1307 households (1,265 households whose houses will be affected and 42 households whose businesses will be affected) will have to be relocated. Based on the preliminary ROW design, remaining 730 households will be affected but relocation will not be necessary.

The social categories of affected households per five districts are shown below. Overwhelming majority of the affected population are Mizo.

Table 11.38 District-wise Social Category of Affected Households

District	ST	SC	OBC	General	Prefer not to answer	Total
Aizawl	421	0	0	0	215	**636**
Serchhip	244	0	1	1	238	**484**
Lunglei	415	0	0	0	252	**667**
Lawngtlai	40	0	0	0	49	**89**
Saiha	119	0	0	0	42	**161**
Total	**1,239**	**0**	**1**	**1**	**796**	**2,037**

Source: Baseline Survey

The result of religious affiliation overlaps closely with the respondents' social category. The result confirms that Christianity is the dominant religious belief among Mizo.

Table 11.39 District-wise Religious Affiliation of Affected Households

District	Christian	Hindu	Muslim	Buddhist	Other	Prefer not to answer	Total
Aizawl	419	2	0	0	0	215	**636**
Serchhip	246	0	0	0	0	238	**484**
Lunglei	413	1	0	0	1	252	**667**
Lawngtlai	40	0	0	0	0	49	**89**
Saiha	119	0	0	0	0	42	**161**
Total	**1,237**	**3**	**0**	**0**	**1**	**796**	**2,037**

Source: Baseline Survey

Educational Attainment of household heads is shown below.

Table 11.40 Educational Attainment of Household Heads

Educational Attainment	Aizawl	Serchhip	Lunglei	Lawngtlai	Saiha	Total
No Education	30	16	43	3	13	**105**
Below Elementary	138	92	191	13	24	**458**
Completed Elementary	64	35	45	10	20	**174**
Below High School	136	70	72	5	27	**310**
Completed High School	27	16	27	6	17	**93**
Not completed college	8	9	12	2	10	**41**
Finished College (graduate or higher)	18	8	25	1	8	**60**
No Answer	215	238	252	49	42	**796**
Total	**636**	**484**	**667**	**89**	**161**	**2,037**

Source: Baseline Survey

(2) Vulnerability

According to Reserve Bank of India, the share of the poor in Mizoram is 23% in rural area and 7.9% in urban area in 2012[8]. However, the survey found that over 40% of respondents or 446 households consider themselves as BPL household, which may reflect their real coping capacity against negative impacts. Also, the project should take into account the fact that over 230 households are headed by women when the details of the Rehabilitation Plan is developed to ensure women's participation.

Table 11.41 Vulnerability Status of Affected Households

District	Women-headed HH	HH head over 50	Widow in HH	Poverty Line*		
				Below Poverty Line	Above Poverty Line	Don't know / Not Aware
Aizawl	77	155	14	145	240	36
Serchhip	46	131	24	81	162	3
Lunglei	84	204	21	147	256	12
Lawngtlai	11	18	0	17	21	2
Saiha	15	54	7	56	62	1

8 Number and Percentage of Population Below Poverty Line, Reserve Bank of India, Sep 16, 2013 (accessed August 11, 2015), https://www.rbi.org.in/scripts/PublicationsView.aspx?id=15283

Total	233	562	66	446	741	54

Note: BPL figure is based on self-judgment of respondents and may not be accurate.
Source: Baseline Survey

(3) Land Ownership Status of Affected Households

Land ownership in North East States including Mizoram can be broadly classified into following categories:

- Private Land with Land settlement certificates (LSC): Land holding of the owners is certified with Land Settlement Certificate;
- Periodic Patta: A prescribed Land Settlement document setting agricultural land periodically whereby an individual has entered an agreement with the Government to pay land revenue and taxes at the rate legally assessed or imposed in respect of the land so leased out;
- Village Council Pass (or Garden Pass): Issued by Village Council which have traditionally acted as certificates of land ownership for agricultural purposes within the Council's territory; and
- Government Land: land owned by Government

The land ownership status of affected households is shown below.

Table 11.42 Land Ownership Status of Affected Household

Ownership Status	Aizawl	Serchhip	Lunglei	Lawngtlai	Saiha	Total
LSC	272	140	262	27	99	**800**
Periodic Patta	49	15	39	7	6	**116**
Home Site	18	36	5	1	1	**61**
Village Council Pass	82	55	108	4	13	**262**
Government Land	0	0	1	1	0	**2**
No Answer	215	238	252	49	42	**796**
Total	**636**	**484**	**667**	**89**	**161**	**2,037**

Source: Baseline Survey

It has been observed that majority of the affected households has been living in the project areas for a period 11 to 30 years. This is in line with the fact that land transfer is not common in Mizoram, which should be taken into account in the calculation of solatium.

(4) Occupation and Income of Affected Households

Table 11.43 Primary Occupation of Household Heads

Primary Occupation	Aizawl	Serchhip	Lunglei	Lawngtlai	Saiha	Total
Agriculture	73	42	117	5	1	**238**
Allied Agriculture	54	6	10	0	0	**70**
Dairy	2	4	20	0	4	**30**
Forestry	5	15	20	0	5	**45**
Household/Cottage Industry	1	3	3	1	1	**9**
Business/Trader/Shop Owner	108	40	36	4	4	**192**
Skilled Profession	74	36	32	4	6	**152**
Unskilled Labor	38	38	91	14	59	**240**
Pvt. Service	19	6	12	4	3	**44**
Govt. Service	32	20	47	5	29	**133**
Retired/Pensioner	13	17	18	2	5	**55**
Unemployed but capable to work	0	17	2	0	2	**21**

Too Young to work/disabled/Student	1	0	3	1	0	**5**
Other	1	2	2	0	0	**5**
Total	**421**	**246**	**413**	**40**	**119**	**1,239**

Source: Baseline Survey

Monthly income of affected households has been summarized below. About 40% of the surveyed households has monthly income between Rs.5,000 and 10,000 while about 23% of them has monthly income less than Rs5,000.

Table 11.44 Month Household Income

District	Average Monthly Income (Rs.)
Aizawl	9,879
Serchhip	12,791
Lunglei	14,024
Lawngtlai	15,515
Saiha	12,736
Average	**12,989**

Source: Baseline Survey

The baseline survey has identified gap between official poverty level and poverty level as reported by the people. R&R activity should take into account the limited coping capacity of the local community and develop measures that leads to sustainable income generation of the affected people, rather than one-off payment of compensation and assistance.

(5) Gender

Tribal and non-tribal women in North East States enjoy a relatively higher position in the society than what their non-tribal counterparts do, which is reflected in their high literacy rate. Mizo women are largely involved in household work, collection of forest produce, firewood collection, cultivation and other agricultural activities and thus they will be affected in a way that is different from their male counterpart. In order to ensure that affected women will not be disadvantaged, a dedicated chapter on gender issue is included in the RAP (Chapter 10) in which options to facilitate women's participation in project implementation and various opportunities to be created by the project is discussed.

(6) Cut-off Date

The preliminary cut-off date for land acquisition is May 14th 2015, which is the completion date of the baseline survey, and was informed to the project affected households during the survey. Formal cut-off date for the Project will be announced to project affected villages/households through Notification during the final inventory survey after the final ROW drawing is developed.

(7) Impact on Affected Households and Structures

Out of 1971 households, 1,265 households will have to be resettled while 706 households will be partially affected. Meanwhile, 42 business structures will have to be relocated whereas 24 such structures will be partially affected9. Types of affected structures per block are shown below.

9 This is based on the preliminary ROW design and will have to be verified once the final ROW drawing is established.

Table 11.45 Type of Affected Structures per District

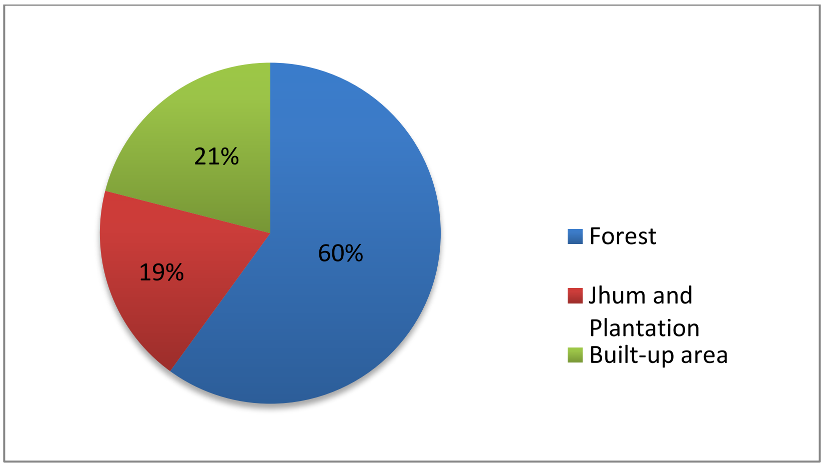
District	Housing	Shop[1]	Public Bldg.	Religious Str	Utilities[2]	Total
Aizawl	602	34	29	2	35	**702**
Serchhip	473	11	19	2	19	**524**
Lunglei	658	9	25	2	45	**739**
Lawngtlai	86	3	3	1	5	**98**
Saiha	152	9	6	1	20	**188**
Total[2]	**1,971**	**66**	**82**	**8**	**124**	**2,251**

Note: [1] Tea stall, restaurant, petty shop; [2] Well and Toilet
Source: Baseline Survey

Based on the baseline survey, all households are considered as titleholder (i.e. in possession of (LSC, periodic patta, village council pass) except for two households (one in Lunglei and the other in Lawngtlai) who reside on government land10.

(8) Impact on Land

The project requires additional land area of 624.6 ha, out of which 435.5 ha is required for widening and improvement work. In addition, 160.3 ha is needed for disposing surplus soil and 28.8 ha for construction of resettlement sites. The candidate locations for surplus soil disposal have been identified during the preliminary design and the budget for disposal, including measures to prevent soil erosion, have been included in the project cost. However, the sites will have to be verified after the additional topographic survey and in consultation with affected community as well as State/District Government. The breakdown of land to be acquired by type based on the field survey and satellite data is shown below.



Source: JICA Study Team

Figure 11.17 Breakdown of Affected Land to by Type

Proper disposal of surplus soil is critical to avoid soil erosion and damage to productive land and forest. At the same time, the disposal sites must be located near the sites where surplus soil is generated so as to transport cost and related emissions/noise. The candidate sites that satisfies following conditions:

a) Ground shape with concavity topography
b) Ground gradient less than 22 degree which is assumed as average angle of spoil bank slope

10 For those who did not answer land-holding status, they are assumed to be title-holders based on the land-holding conditions of their neighbor.

with necessary steps, and the height is less than 30m

c) Not close to built-up area

Along the 381km stretch, a total of 115 such locations have been identified with the enough capacity to handle surplus soil generated from this project. The distance between each site is less than 5km.

(9) Impact on Trees and Crops

Jhum land and bamboo plantations as well as wild trees along the road will be affected by the project. Fruit bearing trees (Banana, Mango, Jackfruit, other citrus fruit, etc.) will also be affected. Since the ROW drawing for the widening and improvement is yet to be finalized, the counting exercise of affected trees has not been carried out at this stage. Indeed the rational of counting exercise should be reviewed again given the widespread of jhum practice along the road. Forest area immediately after the burning (for jhum) will be without tree and if counting will be used as the basis of compensation, trees in jhum area will not be compensated. Should counting exercise be carried out in the detailed design stage, it should take into account the cycle of jhum to avoid such underestimation. Meanwhile, the budget for compensating trees and crops has been provisionally estimated based on the affected area (approximately 125 ha. Social Impact based on the estimate shown in section 5.3) and weighted average price11 of trees/crops identified during the survey.

11.6.15 Resettlement Policy

World Bank-funded Regional Transport Connectivity Project, a RAP report targeting State Highway in Lunglei and Lawngtlai districts was prepared in 2014. This RAP was prepared as per World Bank's Safeguard Policy, and as such, broadly in line with the requirements of JICA. The resettlement policy and entitlement matrix proposed in this RAP builds on the RAP for WB-funded project with revisions/updates based on changes/differences in socio-economic conditions and new provisions laid out in LARR 2013.

In this backdrop, the resettlement policy framework aims to:

- Update the resettlement policy that was followed in the previous project in Meghalaya/West Garo Hills in line with provisions of new relevant Acts and Rules, and other projects being implemented with financial support from multilateral funding agencies with safeguard policies comparable to that of JICA;
- Bring together and build upon the previous experiences and good project implementation practices;
- Enhance institutional capacity at the Project level for implementation of RAP and livelihood restoration activities; and
- Establish mechanism and processes for fair grievances redress with respect to land acquisition and compensation and any other matters associated with the RAP

For above objectives, the policy framework builds on following principles:

- Involuntary resettlement shall be avoided to the extent possible or minimized where feasible, exploring all viable alternative project designs and also take due precautions to minimize disturbance to habitations, and places of cultural and religious significance;
- Where displacement is unavoidable, people losing assets, livelihood or other resources shall be assisted in improving or at a minimum regaining their former status of living at no cost to

11 Weighted average price of tree/crops is derived as follows. 1) derive average price of tree/crop based on the Basic Schedule Rate. (e.g. Cashew: 1,000-2,000; Teak: 3,000-6,000, Rubber: 1,500-3,000; Banana: 100-200) 2) estimate the average number of such trees/crops per ha.

themselves; Ensure that the socio-economic conditions of the Project Affected Persons (PAPs) actually improve after implementation of the project;

- Share information, consult and involve PAPs and local persons from preparation stage in issues of land acquisition, loss of livelihood and in identifying social issues likely to arise during project implementation;
- Ascertain broad community support based on free, prior and informed consultation;
- Pay special attention to marginalized and vulnerable groups and secure their participation;
- Ensure payment of compensation and assistance to PAPs at replacement cost, prior to any displacement or start of civil works;
- The common property resources will be replaced as far as feasible and assistance will be provided at replacement value to the group;
- All land acquisition will be carried out after issuance of notifications for harvesting of crops;
- Ensure that project does not involve any kind of activities involving child labor; and
- Ensure equal opportunities and wage to women/female workers

11.6.16 Entitlement Matrix

The Entitlement Matrix has been developed in accordance with the principles adopted and analysis of initial identification of project impacts. The Entitlement Matrix recognizes and lists various types of losses associated with the project and provides the basic tools and guidelines for preparation of compensation and resettlement packages.

Table 11.46 Entitlement Matrix

Type of Loss	Occupant of Property	Unit of Entitlement	Entitlement	Details of Entitlement
Agricultural land	Titleholder	Household	Compensation at Replacement value and Assistance	a) Land for land, as much as possible. Or cash compensation for the land at replacement cost, which will be determined by District Collector. b) If the compensation amount is less than the replacement cost mentioned above, the difference amount will be paid as Assistance. c) If the residual land is unviable for agriculture, PAPs hall have the following three options: ● Compensation for affected land and continue on the remaining unaffected plot of land; or ● If eligible person surrenders the residual plot, then compensation and assistance given for the entire plot of land; or ● Replacement land, if so wished by eligible persons, subject to availability of land that is at least equally productive d) Resettlement allowance of Rs. 50,000/- will be provided to those who do not get land for land, irrespective of the size of land. e) Subsistence Grant equivalent to Rs. 3000 (MAW: Minimum Agricultural Wage) per month for 6 months. f) In case of severance of cultivable land, an additional grant of 10% shall be paid over and above the amount paid for land acquisition. g) Four (4) months' notice to harvest standing crops shall be given. However, if notice cannot be given then compensation for these crops shall be paid at market value
	Periodic Patta Holder/ Temporary Village Pass Holder		Assistance	a) Land for land, if available; if not, replacement value of land as determined by District Collector shall be given to land owners/holders. b) Resettlement allowance of Rs. 50,000/- will be provided to those who do not get land for land, irrespective of the size of land. c) Subsistence grant equivalent to Rs. 3,000.00 per month (MAW) for 6 months. d) Four (4) months' notice to harvest standing crops shall be given. However, if notice cannot be given then compensation for these crops shall be paid at market value.

Non- agricultural vacant land (Homestead, Commercial and others)	Titleholder	Household	Compensation for structure at Replacement Cost plus assistances	a) Replacement cost for structure at latest Basic Schedule of Rates (BSR) without depreciation with a minimum of Rs. 1,50,000.00 b) Two (2) months' notice for removal of structure c) In case of partially affected structures and the remaining structure continues to be viable, in such case an additional assistance equivalent 25% of replacement cost will be paid towards repair/restoration of Structure d) Right to salvage materials from the demolished structure e) For the displaced eligible persons whose remaining structure is unviable, the following shall be payable ● Subsistence grant of Rs. 3,000/- per month for a period of twelve (12) months from the date of displacement ● One time resettlement allowance of Rs.50,000/- ● Transportation cost of Rs. 50,000.00 for shifting family, building materials, domesticated animals etc. ● Lumpsum Assistance amount of Rs. 7,500/- for re-establishing other basic facilities such as electricity connection, water supply pipeline ● All fees, taxes and other registration charges incurred for the replacement structure f) Compensation in the form of residential / commercial plot at resettlement site if so opted by 15 or more PAPs on payment and free of cost for vulnerable groups will be provided. The size of the plots will be equal to the area lost or minimum of 35 m^2 for house and 15 m^2 for shop.
	Periodic Patta Holder/ Temporary Village Pass Holder			For land ● Subsistence grant equivalent to Rs. 3,000.00 per month of MAW for 6 months. ● Four (4) months' notice to harvest standing crops/trees shall be given. However, if notice cannot be given then compensation for these crops shall be paid at market value For structure ● Replacement cost for structure at latest Basic Schedule of Rates (BSR) without depreciation with a minimum of Rs. 1,50,000.00 ● Two (2) months' notice for removal of structure ● Right to salvage materials ● Lump sum Transportation cost of Rs.50,000

Loss of Plants/Trees	Owner/Occupant	Household	Compensation	Revenue Department or Special Committee to determine the current cost. For perennial fruit bearing trees such as Pineapples, Jackfruits, etc.), average productivity of such trees will be taken as 20 years.
Loss of Cattle shed, poultry shed or any other shed for domestic animals	Owner/Occupant	Household	Compensation	Rs. 600 per m^2 for Thatched roof and Rs. 1000 per m^2 for GCI sheet roof (to be paid as per revised/latest available updated basic schedule of rates for buildings). In case of non-revision, 10% premium per year will be added to the latest rate available.
Loss of residence/ commercial unit	Tenant	Household	Assistance	a) The amount of deposit or advance paid by the tenant to the landlord or the remaining amount at the time of expropriation (this will be deducted from the payment to the landlord) b) Subsistence grant of Rs. 3,000/- per month for a period of twelve (12) months from the date of displacement c) Lump sum shifting allowance of Rs. 15000/-
Loss of kiosk	Owner/occupant	Household	Assistance	a) Lump sum shifting allowance of Rs. 7500/- b) Right to salvage materials from the existing structure
Loss of employment	Wage earner	Household	Assistance	a) Economic Rehabilitation Grant equivalent to twenty-five (25) days of Minimum Agricultural Wages (MAW) per month for a period of three months. b) Priority work opportunities in the project construction work c) Rs. 20,000/- towards vocational/skill improvement as per choice.
Loss of Livelihood (losing commercial unit, losing agricultural land and with balance land below MEH)	Titleholder/ Periodic Patta holder/ Village Pass holder	Household	Assistance	d) Priority work opportunities in the project construction works. e) Rs. 20,000/- towards vocational/skill improvement as per choice. The amount will cover daily stipend equivalent to MAWfor the duration of training and shall also cover costs towards boarding, lodging, transportation, etc.

Additional support to vulnerable groups	Titleholder/ Periodic Patta holder/ Village Pass holder	Household	Assistance	One time additional financial assistance of Rs. 25,000/- as Economic Rehabilitation Grant towards income generation
Loss of Jhum /Fallow land)	Village	Village	Compensation at 'replacement value'	Replacement value for the common property transferred/acquired shall be paid to Village Council and the amount will be utilized through participatory planning by the villagers within 6 months from date of release of payment. PIU shall monitor its utilization
Loss of Common Property Resources	Village	Village	Enhancement of community resources	Replacement /Restoration or augmentation of existing infrastructure and provision of additional infrastructure facilities based on identified need
Loss of Access	Village	Village	Alternate access	Provision of access path(s), steps, footpaths at identified locations in consultations with community
Temporary and unforeseen impacts.	Affected entity	Household	Mitigation measures in line with principles of resettlement policy framework	Unforeseen and temporary impacts during construction will be documented and dealt with on case by case basis through the GRM in accordance with the principles laid down in the resettlement policy framework

11.6.17 Grievance Redress Mechanism (GMS)

The Grievance Redress Mechanism (GMS) involves formation of Grievance Redress Committee (GRC). The main objective is to provide a step-by-step process of registering and addressing the grievances with respect to land acquisition. It is expected that this mechanism will ensure redress of disputes through participative process. The mechanism and principles of GMS builds on the provisions laid out in the Right to Information Act, 2005 (see Box 11.2 below).

> **Box 11.2 The Right to Information Act, 2005**
>
> The Right to Information Act, 2005 provides for setting out the practical regime of right to information for citizens. Under the provisions of the Act, any citizen may request information from a "public authority" (a body of Government or "instrumentality of State") which is required to reply expeditiously or within thirty (30) days.
>
> The Act also requires every public authority to computerize their records for wide dissemination and to proactively publish certain categories of information so that the citizens need minimum recourse to request for information formally. Thus under the Act, citizens have right to seek information from concerned agencies by following the set procedures.
>
> Source: the Right to Information Act, 2005

The first tier of GMS takes place at village/block level and involves physical verification and certification upon receipt of any grievance such as inaccurate measurement of impacted asset, loss of access, damage to structures and/or crops during construction. The verification and certification will be carried out by the RAP implementation agency, Nokma and/or members of Village Council in presence of PAPs who file the grievance, and appropriate documentation would be done. Response would be provided to the concerned PAP within 7-10 days of receipt of grievance. Financial implications of any changes would be presented to the GRC for consideration and approval.

The second tier of resolution will be undertaken by the GRC. A district-level GRC will be formed by the Project Authority within one month from the date of mobilization of RAP implementation agency at site. The GRC will comprise Project Director, NHIDCL; PWD; Deputy Commissioner of West Garo Hills; representatives of the concerned Village Council or his/her authorized representative, PAPs and RAP implementation agency. Grievances of PAPs in writing will be brought to GRC for redress by the RAP implementation agency. The RAP implementation agency will provide necessary assistance to PAPs in presenting his/her case before the GRC. The GRC will respond to the grievance within 7 days. The GRC will meet once in 15 days but may meet more frequently, depending upon the number of such cases. However, after convening the first GRC meeting, it will not hold any meeting till such time any grievance is brought to the GRC for redressal. Grievances brought to the GRC shall be redressed within a time period of one month (30 days) from the date of receipt of grievance. The decision of the GRC will not be binding to PAPs. In other words, decision of the GRC does not bar PAPs taking recourse to court of law.

11.6.18 Institutional Arrangement for RAP Implementation

As per Indian regulatory framework, activities related to resettlement and rehabilitation will be carried out by the State Government. Given the autonomous characteristics of Mizoram and its District, however, it is proposed that the district as well as village council and traditional village leaders also play a major role in implementing RAP. At the moment, NHIDCL has regional offices in Guwahati, Assam, and for this project, it is expected that a project office (Project Implementation Unit: PIU) to be set up in Tura. A dedicated NHIDCL staff (or expert hired by NHIDCL) will work closely with State and district/village officials to ensure that implementation of RAP is in line with JICA Guidelines for Environmental and Social Considerations. Institutional arrangement includes provisions to strengthen the capacity of PIU and PWD with regard to land acquisition and implementation of RAP and management of other social issues. The project institutional arrangement is shown below.

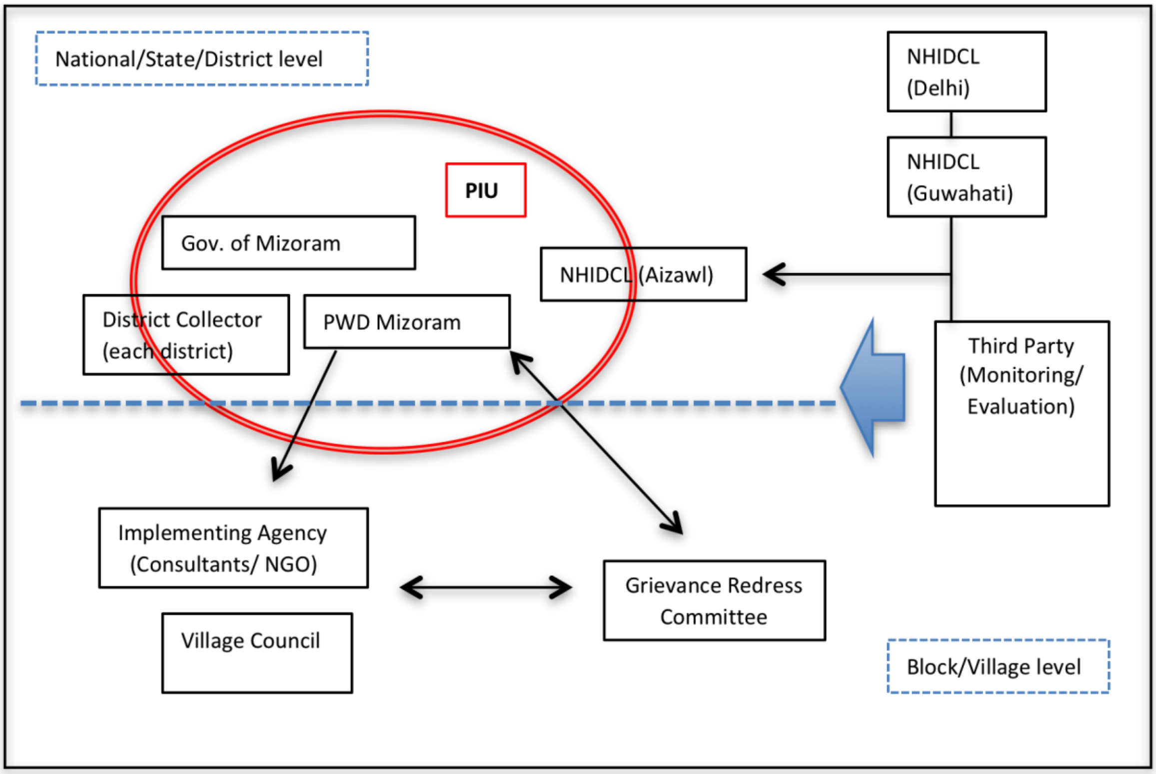


Figure 11.18 Institutional Arrangement for RAP Implementation

11.6.19 RAP Monitoring and Evaluation

Monitoring and evaluation are important activities of any infrastructure development project, and even more so for projects involving involuntary resettlement. It helps make suitable changes, if required during the course of RAP implementation and also to resolve problems faced by the PAPs. Monitoring is periodical checking of planned activities and provides midway inputs, facilitates changes, if necessary, and provides feedback to project authority for better management of the project activities. On the other hand, evaluation assesses the resettlement effectiveness, impact and sustainability. In other words, evaluation is an activity aimed at assessing whether the activities have actually achieved their intended goals and purposes. Thus monitoring and evaluation of RAP implementation are critical in order to measure the project performance and fulfillment of project objectives.

Table 11.47 Summary of Monitoring Activity

Type	Frequency	Prepared by	For	Report Contents
Internal RAP Monitoring	Quarterly	PIU	NHIDCL/ State Government	10-15 page report (plus supporting documentation) summarizing progress against the RAP; outline of any issues and agreed related actions; summary schedule of grievance status; minutes of any stakeholder or affected people consultations or meetings
External Monitoring	Harf-yearly	Expert Panel	NHIDCL/ State Government	25-35 page report (plus supporting documentation) summarizing assessment of progress towards living standard restoration, livelihood restoration; compliance of JICA Guidelines; discussions of any RAP issues of concern; identification of any areas of non-compliance and agreed corrective actions; and summary or resettlement status.
Completion Audit	One-off	Expert Panel	NHIDCL/ State Government	RAP Completion Audit to verify NHIDCL has complied with undertakings defined by the RAP and that land acquisition and compensation has been completed in accordance with JICA Guidelines

Source: JICA Study Team

11.6.20 Rehabilitation Plan

(1) Options for Rehabilitation/Income Restoration

The socio-economic survey of the PAPs (see details in chapter 4) indicates that the main sources of income in the project influence area are agriculture and small business enterprises. The population has limited capacity to benefit from the livelihood opportunities created under the development projects or any government sponsored program. One of the key principle of the RAP is to ensure that the livelihood of PAPs will be improved, or at least restored compared with pre-project level. The project will provide income restoration opportunities by way of skill development training and linkage with the on-ongoing government schemes for this purpose. The Rehabilitation Plan will therefore aim to support PAPs to regain their previous living standards by creating income generation opportunities as well as improving PAPs capacity to benefit from the various economic opportunities developed by the project. The Rehabilitation Plan will be developed and implemented by State Government in the course of this project, and the detail of the plan should be tailored with inputs from stakeholders in a later stage of the project. Keeping JICA and World Bank policies in perspective, however, following options and principle are proposed for inclusion to the Rehabilitation Plan.

Shared market place

While the road widening and improvement proposed under the project are expected to facilitate trade across borders, these roads also may have the potential to boost local level trade and improving linkages of the villages in the interiors with the local and regional markets. At the same time, relocation is likely to cause negative impact on households along the road who have benefited from the roadside location suitable for business. It is recommended that project creates benefit sharing arrangements with communities along the project roads and build capacity for increasing the production and trade potential, for example, through construction of common market place in a convenient location along the road where community members can buy and sell agricultural goods and engage in small businesses.

Backyard Poultry

Many households rear chicken for their own consumption but rarely doing it commercially. Small marketing effort may work to the benefit of the producer.

Support for expanding plantation

Insufficient supply of saplings is a barrier for initiative towards better methods of farming. Productivity of cashew, rubber and other plantations along NH54 can be enhanced through supply of quality saplings.

(2) Identification and Development of Resettlement Site

Being hilly state, vacant land suitable for relocation is limited in Mizoram, and hence, cash compensation is not likely to lead long-term solution. The baseline survey found that the affected people prefer land-for-land compensation, particularly land in the same village, which in many cases, does not exist today. From the social point of view, relocation within the same village is also desirable, as it will avoid fragmentation of the community. In this background, it is proposed that resettlement site with basic utilities such as water and electricity to be developed in villages where available land will not be sufficient to accommodate affected households. The exact location of such site shall be elaborated during detailed design stage with village/district officials in consultation with community, but it is envisaged that 1km (on average) of new access road deviating from NH54 per village will be suffice for this purpose. The provisional cost for developing such land is included in the budget estimate.

11.6.21 Resettlement Budget

The resettlement budget comprise estimated value of compensation for land, structures, trees, various resettlement assistances, cost of CPRs, institutional cost, contingency, hiring of RAP implementation agency, HIV/AIDS awareness generation, capacity building, external monitoring and evaluation consultant, among others. The total resettlement cost for the project road is estimated at about Rs. 3,889,710,000.

The resettlement and rehabilitation budget has been estimated based on the information, data collected from field and other secondary sources. The budget shall be updated and adjusted as per the market rate of various items as the project continues. The compensation amount for assets shall be determined by the land acquisition officer of the project to be hired for the implementation of RAP. The breakdown of budget for different components is provided in Table below.

Table 11.48 Resettlement Budget

Item	Unit	Unit Cost	Quantity	Total (Rs)
I. Compensation				
Land (construction)	ha.	700,000	435	304,500,000
Land (surplus soil)	ha.	500,000	160.3	80,150,000
Land (resettlement site)	ha.	-	-	Included in III
Rural area multiplier	*the land price will be double for compensation of rural area land			384,650,000
Structure	Sq. m	7,500	20,000	150,000,000
Public toilet, water point	No.	50,000	20	1,000,000
Crops	No.			90,000,000
Solatium	*100% of compensation as per LARR 2013			940,300,000
Sub-Total (I)				1,880,600,000
II. Allowance				
Moving allowance	Household	50,000	1500	75,000,000
Subsistence allowance	Household	18,000	2000	36,000,000

Assistance to vulnerable	Household	20,000	1000	20,000,000
Training	Household	20,000	2000	40,000,000
Sub-Total (II)				171,000,000
III. Resettlement Site				
Sub-total (III)	Village	30,000,000	48	1,440,000,000
IV. Implementation				
Expert fees	Lump sum			20,000,000
Staff training	Lump sum			3,000,000
External monitoring	Lump sum			5,000,000
Information disclosure	Lump sum			1,500,000
Livelihood restoration	Lump sum			15,000,000
Sub-Total (IV)				44,500,000
Sub-Total (I+II+III+IV)				3,536,100,000
Contingency (10%)				353,610,000
Total				**3,889,710,000**

Source: JICA Study Team
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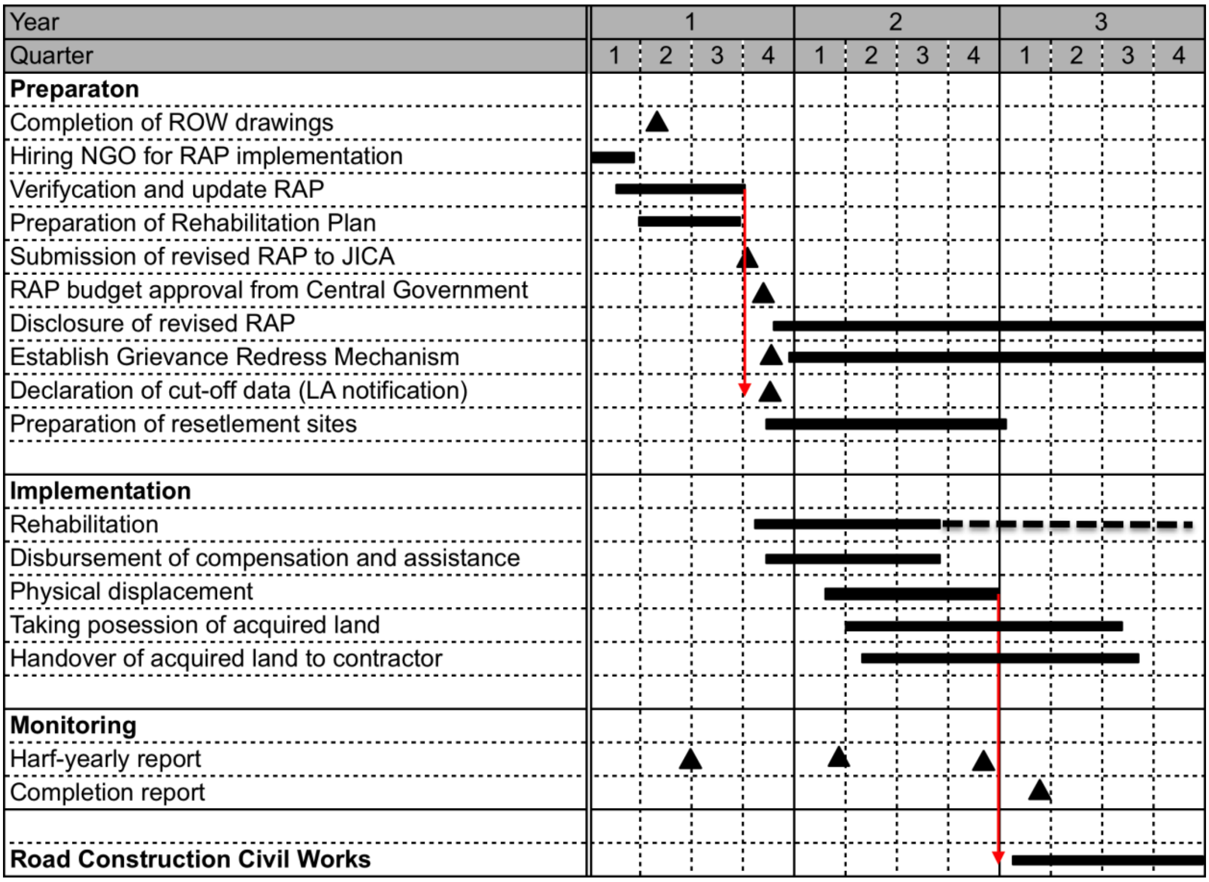
11.6.22 Resettlement Schedule

The implementation of RAP consists of following major activities:

- Deployment of required staffs (at PIU and village/block level);
- Information dissemination activities by holding consultations, distributing leaflets containing salient features of resettlement policy and entitlement matrix in Garo language;
- Verify and update the list of PAPs and their status through Detailed Measurement Survey (DMS), list and measure all property and assets affected and their estimation;
- Preparation of micro plan (RAP implementation at village/block level);
- Disburse of R&R assistance to PAPs, which may include preparation and distribution of identity card and opening of back account;
- Relocation and rehabilitation of CPRs; and
- Preparation for relocation of PAPs

Considering the long rainy season prevalent in the project area and whole state, approximately a period of 5-6 months (May - October) is not available for construction works. The RAP implementation period is proposed to be 24 months, but this needs to be scheduled in a manner so that initial activities such as verification, measurement etc. can be completed during the dry period. The other activities such as preparation of micro plan, approval, disbursement and other necessary documentation can be completed during the rainy season. RAP implementation activities to be carried and respective agencies likely to be involved for each activity are presented in Table below.

Table 11.49 Resettlement Schedule



Source: JICA Study Team

11.6.23 Stakeholder Consultations

Stakeholder consultation is an important method of involving various stakeholders particularly, local community with reference to the proposed development initiatives. Consultations provide a platform to participants to express their views, concerns and apprehensions that might affect them positively or negatively. This process is of particular importance for this project given the high ST share among the affected population. The World Bank OP 4.10 on Indigenous Peoples emphasizes “a process of free, prior, and informed consultation (FPIC) with the affected Indigenous People’s communities at each stage of the project, and particularly during project preparation, to fully identify their views and ascertain their broad community support for the project." Consultations for this project adopted the following framework to ensure a process of FPIC.

a) Conduct appropriate gender and intergenerationally inclusive consultations with the Project Affected Peoples' communities, the Affected Peoples' Organizations (village council, women's groups, etc.), and other local civil society organizations (NGOs) identified by the Affected Peoples' communities;

b) Use consultation methods appropriate to the social and cultural values of the Affected Peoples' communities and their local conditions (including using local languages, allowing time for consensus building, and selecting appropriate venues) and give special attention to the concerns of women and their access to development opportunities and benefits; and

c) Provide the Affected Peoples' communities with all relevant information about the project (including an assessment of potential adverse effects of the project) in a culturally appropriate manner.

The purpose of consultations was to inform people about the project, take note of their issues, concerns and preferences, and allow them to make meaningful choices. It ensured participation of potential project affected persons (PAPs), local community and other stakeholders. People in general were informed in advance through invitation letter and phone calls, and allowed to participate in a free and fair manner. During these consultations, PAPs were informed about the project, likely scale of resettlement, its resettlement policy, including compensation based on full replacement cost, resettlement assistance, schedule, and grievance mechanism. Consultations provided meaningful contributions with regard to appropriate compensation, sufficient allowance for resettlement, livelihood restoration, reducing adverse impacts, address safety issues, etc. Most stakeholders expressed their needs for compensation at a full replacement cost and some stakeholders expressed their concerns regarding assistance for relocation; however, no objections were raised concerning the implementation of the project and to compensations based on replacement cost during both stakeholder consultations and door-to-door census surveys. The following sections present details of the consultations.

(1) 1st Round Consultations with Communities

The first round of district level meetings was held in all the 5 districts. It witnessed participation from project affected persons, representatives from district level line departments, elected representatives, civil society, local NGOs and other opinion leaders. These consultations/meetings were used as the platform for dissemination and disclosure of key information about the project, key components, alignment, affected villages, applicable laws and policies related to environmental and social considerations etc. It also sought to capture participants' perception about project, concerns and suggestions with respect to proposed alignment and existing policies and practices for management of environmental issues. The type and number of participants to each meeting is shown below. To ensure sufficient participation of PAP during consultation, village representatives who attended from each affected village agreed to shared the meeting contents with other members in the village and share their feedback, if any.

Table 11.50 Participation Details of 1st Round of Consultation

District	Date	Total No. of Participants			Representation (No.) from					
		Total	M	F	Govt. Dept.	Village Council	NGO	MCHP*	District Taxi Union	Affected HHs
Aizawl	14-May-15	25	22	3	4	3	3	3	1	11
Serchhip	08-May-15	90	75	15	6	12	14	8	2	48
Lunglei	05-May-15	144	110	34	7	25	22	19	2	69
Lawngtlai	16-Apr-15	46	40	6	2	11	10	6	1	16
Saiha	13-Apr-15	58	42	16	3	8	7	12	1	27

Note: * Mizo Hmeichhe Inswikhawm Pawl (MHIP) is the women groups present across Mizoram.
Source: JICA Study Team

(2) 2nd Round Consultations with Communities

The second round of district level meetings was held in all the 5 districts. Reflecting the number of villages in Lunglei district, two meetings were held in Lunglei this time. The type and number of participants to each meeting is shown below.

Table 11.51 Participation Details of 2nd Round of Consultation

District	Date	Total No. of Participants			Representation (No.) from					
		Total	M	F	Govt. Dept.	Village Council	NGO	MCHP*	District Taxi Union	Affected HHs
Aizawl	26-Aug-15	37	34	3	2	13	9	6	2	15
Serchhip	24-Aug-15	85	60	25	3	26	22	14	1	32

Lunglei	13-Aug-15	78	55	23	4	28	19	10	2	34
	17-Aug-15	90	64	26	1	31	28	22	1	38
Lawngtlai	16-Aug-15	56	40	16	2	18	18	8	2	18
Saiha	20-Aug-15	52	39	13	3	19	14	6	1	16

Note: * Mizo Hmeichhe Inswikhawm Pawl (MHIP) is the women groups present across Mizoram.
Source: JICA Study Team

(3) Outcome of Consultations

The summary of discussion outcomes from district level stakeholder consultation/meetings is presented in the section following.

Table 11.52 Summary of District-level Consultations

Districts	Key Outcomes/Concerns/Suggestions from Meeting	Response
Aizawl	*General: About Project, alignment, components and its significance*	
	• Participants, specifically line department officials present in the meeting underscored the significance of the project and advantages that will come with widening and improvement of existing highway.	
	• A public representative suggested that the road widening should not be uniform across the entire length, and it should also consider the habitation pattern and its density and designed accordingly.	The degree of widening will be modified depending of geographical conditions and development status of the area.
	• A public VC representative from Tlangnuam, extended support of the community, despite this affecting the several houses, if it was for the benefit of the society and the state.	
	• Another representative from Tuirial, opined that the state will any way be providing compensation for losses, so it is better that the residents prepare themselves for impacts, positive or negative. The sentiment found echo from the representatives from Tlangnuam who believed that community should also join in with their support for the project if it desires for development.	
	Project Concerns and Issues: On Land Acquisition, R&R processes and Impacts	
	• Some of the participants, from among the potentially affected households, cited challenges they would face if their houses are to be demolished because of the project. A widow pointed out that she alone to fend for herself and	Vulnerable groups such as widow will be entitled to receive additional support, inc. allowance and assistance in

	that it will be difficult for her to construct a new house on her own. Few others suggested that affected people's consent should necessarily be acquired before government decides on the project and that such decisions should be in the interest of the property owners. • One of the participants suggested that for every village there should be a group of people identified for coordination of project activities and that one of them be appointed as public relation officer (and with some honorarium attached for his/her role functions). • Some of the participants also shared their expectation that the compensation should be made at market/replacement cost. • Few others suggested that there should first be a public hearing in each of the villages before commencement of the project execution. *Others* • A representative from local drivers' union suggested that there should be coordination committee set up for the execution of the project that will also keep away greedy and opportunistic elements away from siphoning of the benefits of the project. The union will be in full support of the project. • Recognizing the benefits of the project, participants highlighted the need for awareness campaign as part of community mobilization and preparedness for the project, to make them aware about the project and its benefits. This would require rounds of public meetings and consultations, and also a sound compensation award system. In summary, the project finds a positive response from the people with broad suggestions being around engaging with local affected community, their representatives, compensation at market value, and efforts to minimize environmental impact. The affected otherwise are willing to cooperate and support the infrastructure development project.	income restoration and rehabilitation. The consent of local community will be secured before the project approval To be reflected in implementation of RAP The compensation will be made in the replacement cost Village-level consultation will be held in preparation of final RAP and R&R plan
Serchhip	*General: About Project, alignment, components and its significance* • Public representatives in general appreciated the project and significance it will have in people's life. Similar sentiments were made by other participants and specifically in the context of Serchhip town, for which they wanted it to be	Four bypasses are proposed to avoid densely built-up area

	diverted away from the main town area. *Project Concerns and Issues: On Land Acquisition, R&R processes and Impacts* • One of the participants (from YMA) pointed out at 'Compensation' as the major challenge for projects of this nature. He suggested that to get over this, the project should consider of bypassing the major settlement areas which will also reduce compensation costs. • Another YMA representative highlighted the need for adequate awareness generation among people. He also cautioned against unwanted political and bureaucratic hurdles/ vested interest that sometimes come in the way of development projects. He therefore suggested the project proponents to work towards earning goodwill and trust among people for this project. • VC representatives present in the meeting too shared the opinions expressed by YMA around engaging with people. And more importantly the need to be fair and diligent in compensation awards, identification of award beneficiaries. • Further on the issue of compensation, village representatives wanted the award to be completed before commencement of physical works as people will have time to resettle to new location. • Participants also suggested for a public meeting in each village that will also enable amicable resolution, if any, that will arise and related to the project. • Participants from Darlawng, too highlighted the need for public hearing as 2-3 villages in their vicinity will be affected because of the project. • Meeting also discussed the need for a fair and reasonable compensation while efforts should be made to minimize property and land loss. *Others* • Participants in general suggested for public meeting in village to know about their opinion, concerns and suggestions related to alignment. They also wanted the alignment to minimize blind curves by construction of bridges or cutting. However, as the bottom line they also want minimal damage to environment and the ecology in their villages.	including Serchhip. Local community will be informed of throughout the preparation and implementation of the project Community engagement will continue through the preparation of final RAP and R&R plan Award of compensation will be made before construction work begins Village-level consultation will be held in preparation of final RAP and R&R plan The preliminary ROW drawing makes the best effort to avoid impact on existing structures

	In summary, the project is expected to find support among the people. Suggestions include the need to have public meeting in each village, need for fair compensation policy and practice and ensuring minimal damage to environment.	
Lunglei	*General: About Project, alignment, components and its significance* • Representatives from YMA while sharing their opinion recognized the importance of the project but at the same shared their belief that the project is being executed as part country's strategic defense policy. *Project Concerns and Issues: On Land Acquisition, R&R processes and Impacts* • Highlighting the critical issue of compensation, the YMA representative wanted the compensation award estimation to factor in actual loss to people, keeping in mind that each house will have different internal furnishing and hence the amount cannot be decided just on the basis of super structure. This issue will crop up as major hurdle and that there should be no vested interest or partisan politics played by the state on these aspects.	
	• Representatives from a women organization while welcoming the project for its development benefits, also cautioned on associated risks that it will bring primarily because of increased traffic and influx of outside element that may damage the culture and environment of the area.	Appropriate safety measures will be implemented.
	• For a student representative, present in the meeting, it was difficult to imagine the project impacts. He however, suggested that widening the road uniformally may cause extensive damage and hence it may be reduced a little, considering the topography of the region. Related suggestion from few others was that the widening should be done only outside the village (settlement) peripheries and not within.	The degree of widening will be modified depending of geographical conditions and development status of the area.
	• Issue of compensation and need for fairness in amount of compensation and award process was raised by few participants. Participants wanted award to be made in cash and the amount to be acceptable to affected households. While few other participants suggested that the government should buy some unaffected private land where affected households can be relocated.	The compensation will be made in the replacement cost. The project will prepare resettlement site, but PAPs can take cash compensation should they choose so.
	• Participants also wanted the R&R policy be designed in view of large number of households	R&R will be developed in consultation with local

	that will affected. *Others* • Forest department representative also highlighted that the road construction needs to be of good quality and should use stone chips brought from other states as the soil and the rock type in the state is very soft in texture and strength and not suitable for construction. He cited the example one such road constructed by Tantia group in the recent past. He further suggested that adding asphalt to construction materials would add to the strength and life of the road constructed. • An ex MLA expressed his apprehension emanating from corruption that may hit the quality aspects of the project though the project in itself is about the good of people. Similar sentiments were expressed by some other participants as well, mainly identifying state administration for this practice. Participants were visibly unhappy about the road condition in the state especially when compared with the road quality in some of other Indian states. Meeting discussion suggested for over all approval and appreciation for the project. However, corruption and compensation were two major discussion points. Further, concerns around landslide, dumping of excavated soil etc too were raised by the participants. Width of road was another item discussed in the meeting and suggestions made on the necessity of widening it by 12 m unifomally across the length of the road.	community.
Lawngtalai	*General: About Project, alignment, components and its significance* • Participants in general shared positive opinion during the discussion. They nonetheless had some concerns about compensation and environmental and health hazard (mentioned below). *Project Concerns and Issues: On Land Acquisition, R&R processes and Impacts* • One of the major discussion points was around widening of the road within the town area of Lawngtlai. Some of the public representatives shared the opinion that the NH54 may have a diversion from AOC (using MMTP road) and connecting directly to Nalkawn, thereby bypassing the core town area. • Another suggestion in this regard from another participant was that the diversion should be from	A bypass will be constructed to avoid impact in Lawngtlai

	AOC2, western side of circuit house via power house to tourist lodge. • One of participants also shared his concern around compensation issue and shared the experience from MMTP road constructed in the past. As per him, more than 100 affected families have not received compensation till date and that this project should have system in place to avoid such incidences. Similar delays were also experienced by few families when NH54 was being constructed in the 70's. • Another participant (a public representative) while supporting the project mentioned that the implementing agency should assign good public relation officer or grievance cell and should not repeat the mistakes and the practice done the past MMTP & World Bank project. He also suggested for entrusting the revenue department instead of the line department like PWD for compensation and R&R activities. • Queries were made regarding types and extent of help that the state will provide the affected households in R&R. Participants broadly have positive view about the project and its significance. They however have bad experiences regarding compensation award process from similar projects in the past. This was the major discussion point during the meeting.	Compensation will be paid before construction work begins. A dedicated grievance redress mechanism will be established for this project.
Saiha	*General: About Project, alignment, components and its significance* • Meeting proceedings began with some of the public representatives exhorting all present to extend support to the project. Almost all participants expressed their opinion in support of the project, particularly in view of the poor condition of the existing road. *Project Concerns and Issues: On Land Acquisition, R&R processes and Impacts* • Expressing his support for the project, a representative from VC, Theiva, shared concern over loss of 55 houses, besides other basic amenities, if road is to be widened as proposed. • Participants from Kawlchaw, too shared similar situation where there are more than 60 houses along the road and a newly constructed church that will be affected because of road widening.	The preliminary ROW drawing (and final ROW to be prepared) tries to minimize the impact as much as possible.

	• One of the participants wanted to know about the stand of the government if some of the families would not want to relocate. • Participants also shared that some of the households may not have legally recognized document but are actual occupants of the houses. Such families should be provided such legal documents before determining claimant status for compensation award purposes. • Participants in general requested for implementing agency to provide and construct all basic amenities like water sources etc as part of R&R activities. Overall, the participants had very positive opinion about the project, particularly in view of the bad condition of the existing road.	Affected households are eligible for assistance irrespective to their land-holding status. Basic utilities will be equipped with at the resettlement site.

Note: The consultation was carried out with hypothetical widening of 15m for both sides (since the 1st round of consultation was carried out without the development of preliminary design), and hence the likely impact of resettlement discussed above tend to be higher than the one associated with the proposed ROW design.
Source: JICA Study Team

Stakeholder Meeting in Aizwal

Stakeholder Meeting in Serchip

Stakeholder Meeting in Lunglei

Stakeholder Meeting in Lawngtlai

Photo 9.1 Selected Picture of Consultation Meetings

11.7 EIA and RAP Study for NH51

As discussed in Section 11.2.1, EIA is not required for widening and improvement of NH51 according to Indian regulation. In line with JICA Guidelines for Environmental and Social Considerations, however, EIA has been prepared and shared with relevant MOEF as well as Meghalaya State Government.

11.7.1 Scope of the Project

The study road of NH51 starts from Tura to Dalu in Meghalaya state with the total length of approximately 54km. The study road passes mostly on rolling terrain, and alignment of the study road consists of combination of medium horizontal and vertical curves as shown below. The number of existing lane is one for the entire section. Pavement condition is rather deteriorated in the whole section due to inadequate road maintenance. The project aims to improve the road network by widening and improvement of the targeted section of NH51 and thereby contributing to the accelerated economic growth and poverty reduction in the region.

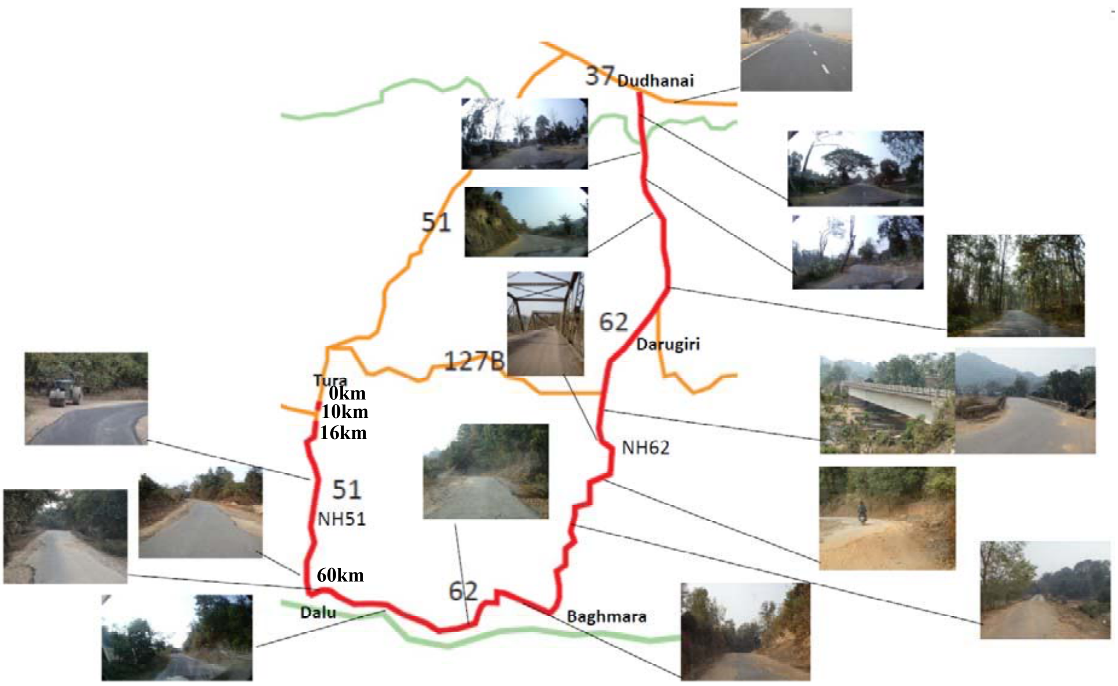


Figure 11.19 Road Alignment and Present Condition of NH51

Existing condition of the targeted section of NH51 is shown below. The project involves the widening of existing one-lane road to two-lane roads with installment of proper slope protection and land slide prevention measures, drainage and traffic safety facilities. The total width of the road including carriageway and road shoulder will be 12m.

Table 11.53 Present Conditions and Provisional Improvement Cost of NH51

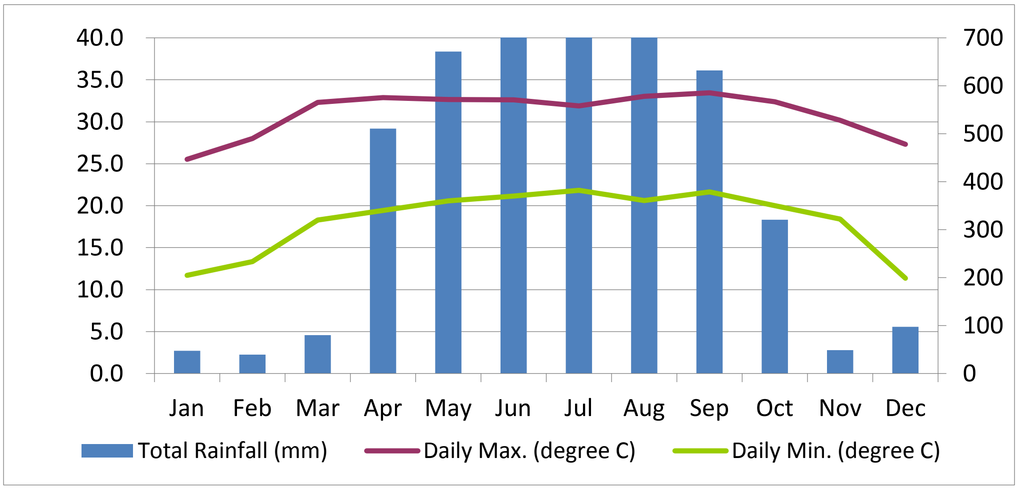
No.	Data Items	Type / Unit		Road	
				NH51 (Upper: KM distance from Tura, Lower: KP)	
				0-10	16-60
				85-95	101-145
1	Number of Lanes	Four (4): Carriageway Width (7m+7m), Double (2): Carriageway Width (7m/10m), Intermediate (1.5): Carriageway Width (5m/5.5m), Single (1): Carriageway Width (3.5m/3.75m) New (0)		1	1
2	Carriageway Width	m		3.75	3.75
3	Shoulder Width	Average in section / m		1	1
4	Shoulder Type	Paved or Unpaved		Unpaved	Unpaved
5	Average Altitude	m		258	110
6	Average Roughness	IRI		5.2	6.5
7	Total Area of Crack	%		25	32
8	Ravelled Area	%		1.5	2
9	No. of Pot Holes	per km		30	24
10	Edge Break Area	m2/km		162	162
11	Road Side Friction	%		40	27
12	Average Travel Speed	km/h		21	36
13	Road Capacity	PCU – IRC73-1980		1,000	1,000
14	Improvement Project Cost (W=12m: Carriageway 3.5mx2+ Shoulder 2.5mx2)	Mountainous (INR crore/km)	9	0	0
		Rolling (INR crore/km)	5.5	55	242
		Level (INR crore/km)	4	0	0
		Long Bridge (INR crore/km)	120	0	0
		Total (INR crore)		55	242

Source: JICA Study Team

11.7.2 Natural Environment

1) Climate

Meghalaya experiences tropical monsoon climate, which varies from western to eastern parts of the plateau. The Garo Hills District, which lies in the western part of the state has tropical climate characterized by high rainfall and humidity, generally warm summer and moderately cold winter. For the entire state, the mean summer temperature is 26° C and the mean winter temperature is 9° C. The mean annual rainfall varies from 2,000-4,000 mm with most rainfall occur during May to September. Maximum rainfall of 12,000 mm has been recorded in the southern slope of Khasi Hills along the Cherrapunjee-Mawsynram belt. The monthly total rainfall and maximum/minimum temperature of Tura is presented below.



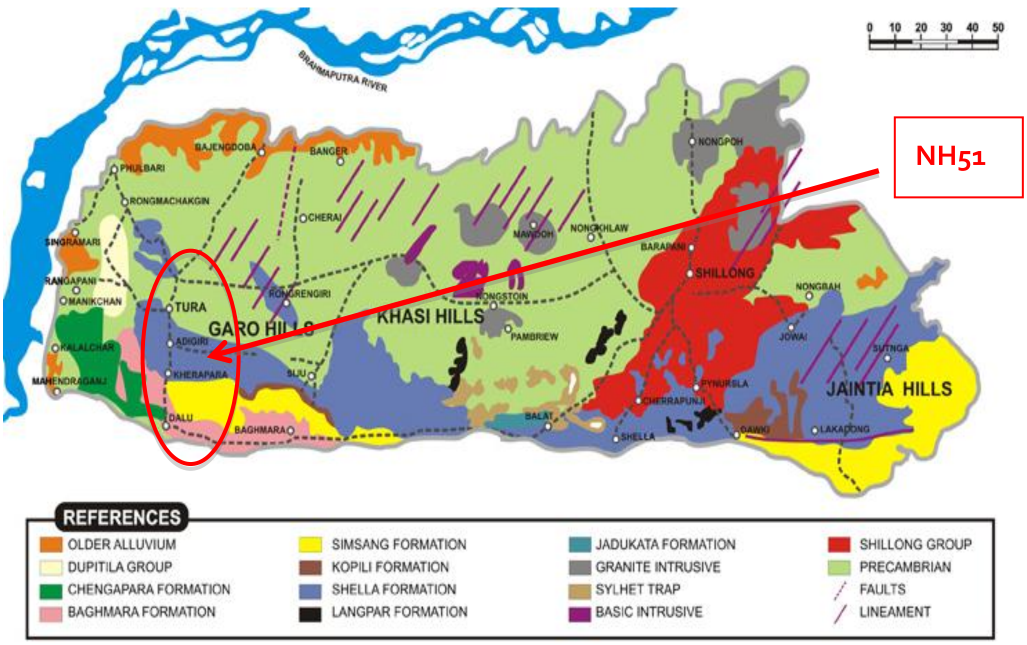
Source: West Garo Hills District Statistical Handbook 2015

Figure 11.20 Monthly rainfall and daily maximum and minimum temperature in Tura (2011-2013)

2) Topography, Geology, and Soil

The geology of Meghalaya consists of older and stable rock types, which are resistant to weathering, mostly belonging to Periods of Archean Gnessic complex, Shillong Groups of rocks, Lower Gondwana rocks, Sylhet Traps and Cretaceous-Tertiary sediments. The layers of land surface in the project area mainly comprises of Schist, Gneisses, Quartzite, sand stone, Shale, Lime Stone, Granite, Granodiorite and Pegmatite.

West Garo Hills District shows different types of soil as the provenance differs. Red Gravelly Soil and Red Sandy Loam in the hilly slopes and Clayey Loam in the plans are the common soil types in the project area. The soils are acidic in nature and comparatively rich in organic matter and nitrogen but poor in phosphorous. Tura, the district capital, is a valley located at the foothills of the Tura Hills and right below the Tura Peak. The elevation of Tura is approximately 350m. It is filled with small rivulets and green valleys all around. Meanwhile, Dalu, located 33 km North-east of Tura at the end of NH51 and NH62, has the elevation of about 20m. The geological map of Meghalaya is shown below.



Source: Department of Mining and Geology, Government of Meghalaya

Figure 11.21 Geological Map of Meghalaya

3) Flora and Fauna

Community/village forest along the targeted section of NH51 is home to various flora and fauna. The Meghalaya Government records show the following flora and fauna. Floral/vegetation assessment carried out through quadrate methods: for trees 10mx10m, for shrubs 5mx5m and for Herbs 1m x1m square shaped quadrats were used. Quadrates were laid randomly in the corridors upside and downside of the road. All species in the quadrats were recorded & ecological parameters including density, frequency were calculated. Faunal species were recorded with the visual observation during site visits, secondary data from the Environment and Forest department and local information from local community.

FLORA

1) Mammalian Fauna

Hoolock gibbon, Stump-tailed macaque, Rhesus macaque, Assamese macaque, Slow loris, Golden langur, Capped langur, Common monkey, Golden cat, Leopard cat, Jungle cat, Large Indian civet, Masked Palm civet, Indian Grey mongoose, Indian fox, Himalayan Black bear, Yellow Throated marten, Yellow-Bellied weasel, Indian flying squirrel, Malayan Giant squirrel, Bandicoot rat, Indian Crested porcupine, Lesser Bamboo rat, different species of Bat etc.

2) Avian Fauna

Indian black baza, Barred jungle owlet, Peafowl, Red jungle-fowl, Thick-billed green pigeon, Blue throated barbet, Long-tailed broadbill, Grey-headed myna, Jungle myna, Green magpie, Indian house crow, Red winged crested cuckoo, Large green-billed malkoha, Crow pheasant, Red headed trogon, Redwattled lapwing, Burmese roller etc

3) Reptile Fauna

Different varieties of lizards, snakes, turtle/tortoises, geckos are recorded. Different species of snakes include Blind snakes, Indian Gamma, Checkered Keelback, Red necked Keelback and others. Important poisonous species include Indian Cobra and Vipers.

FLORA

1) Tall trees

Schima wallichii, Terminalia belirilia, Engelhardtia spicata, Aesculus assamica, Aporusa wallichii, Bridelia retusa, Cryptocarya andersonii, Talauma hodgsonii, Lagerstroemia parviflora, Gmelina arborea, Shorea robusta etc.

2) Lower canopy

Miliusa velutina, Hibiscus macrocarpus, Zizyphus rugosa, Helicia robusta, Engelhardtia spicata var. Colebrooliana and Ficus prostrata etc.

3) Shrubby species

Capparis zeylanica, Garcinia lancifolia, Bauhinia acuminata, Mimosa himalayayana, Mussaenda roxburghii, Eupatorium modiflorum, Solanum kurzii and Phlogacanthus tubiflorus etc.

4) Intertwining trees

Dysolobium grande, Mucuna bracteata, Fissistigma wallichii, Paederia scanders, Solena heterophylla and Aristolocjia saccata.

5) Epiphytic climbers

Rhaphidophora spp., members of Loranthaceae, Cuscuta reflexa and few species of epiphytic orchids like Rhynchostylis retusa, Cleisostoma simondii are also present.

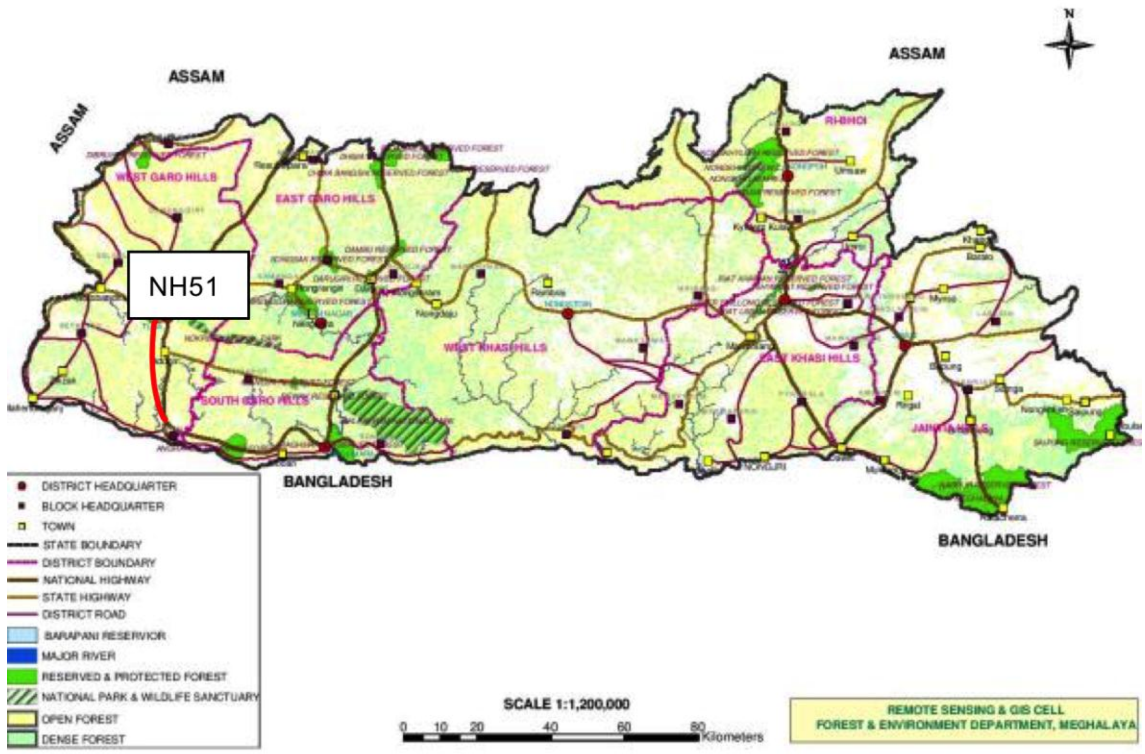
6) Herbaceous plants

Acanthaceae, Aneilema scaberrimum, Anemone spp Burmania Sp., Coiictyospermum, Dictyospermum, Coix sp. Cyprus spp., Ericcaulon, Fabaceae, Oxalis corniculate, Poaceae etc are noticed. Ferns and fern-allies, liverworts and mosses etc. are also seen on old tree trunks and stones etc. near water sources, in shady places.

4) Protected Area and Forest

Forest of Western Garo Hills can be broadly classified into tropical, subtropical and temperate forests. The Indian Institute of Remote Sensing has classified vegetation of Meghalaya into following categories: tropical evergreen, tropical semi-evergreen, tropical mosit deciduous, subtropical broad leaved, subtropical pine and temperate forest types, grasslands and savanna.

As shown below, the target section of NH51 does not pass through or border with existing National Park, Wildlife Sanctuary and Protected/Reserved Forest. Being a sixth schedule state, the forest area is under the village Council and is known as community forest/village forest. The targeted section of NH51 passes through forest and plantation (teak, rubber and cashews) for which appropriate measures to mitigate negative impacts due to road widening will be required.



Source: Forest and Environment Department, Meghalaya

Figure 11.22 Map of Protected/Reserved Forest and National Park & Wildlife Sanctuary

11.7.3 Social Environment

According to the 2011 Census, the population of Meghalaya is 2,967,000. Out of those, 86% belong to scheduled tribe. A total of 17 notified STs are recognised in the state with the Khasi, Garo and Jaintia12 being the three major tribes. The Khasi constitutes more than half of the total ST population of the state (56.4%), and Garo accounts for 34.6%. Altogether, they constitute more than 90% of the total ST population. The Khasi, Garo and Jaintia had their own kingdoms until they came under British administration in the 19th century. Other tribes include the Koch, the Biate of Saipung Constituency and Jowai, the related Rajbongshi, Boro, Hajong, Dimasa, Hmar, Paite, Kuki, Lakhar,

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12 Jaintia (Synteng or Pnar) is listed both as a sub-tribe under Khasi and as a separate ST.

Karbi, Rabha and Nepali. All of them were generally known as “hill tribes” by the British. English is the official and widely spoken language of the state. Other principal languages are Khasi, Pnar and Garo. Hindi and Bengali are also widely spoken in the state.

West Garo Hills is one of the largest districts of Meghalaya located in the western part of the State. The Garo Hills district was divided into two district, vis-à-vis West Garo Hills District and East Garo Hills District in October 1976. West Garo Hills District was further divided into West and South Garo Hills on June 1992. West Garo Hills District is headquartered in Tura, which, with the population of 74,858 people as per 2011 Census, is the second largest town in Meghalaya after Shillong. The proposed project falls in three blocks, namely Rongram, Dalu and Gambegre Development Blocks. Block-wise population data as per 2011 Census is shown below.

Table 11.54 Block-wise Population of West Garo Hills District per Gender

Block	Male	Female	Total
Rongram	67,114	66,642	1,33,756
Selsella	88,349	86,857	1,75,206
Dalu	27,351	26,744	54,095
Dadenggre	20,842	20753	41,595
Betasing	36,340	35,763	72,103
Zikzak	37,867	36,735	74,602
Tikrikilla	29,267	29,121	58,388
Gambegre	17,029	16,517	33,546
Total	**3,24,159**	**3,19,132**	**6,43,291**

Noted: Blocks where the project road is located are heighted.
Source: District Statistical Handbook 2015

Table 11.55 Block-wise Population of West Garo Hills District per Caste

Block	ST	SC	Other	Total
Rongram	106987	2701	24068	133756
Selsella	78715	3046	93445	175206
Dalu	47108	464	6523	54095
Dadenggre	40351	41	1203	41595
Betasing	65776	305	6022	72103
Zikzak	49862	1703	23037	74602
Tikrikilla	52729	507	5152	58388
Gambegre	32484	43	1019	33546
Total	**474012**	**8810**	**1604**	**643291**

Source: District Statistical Handbook 2015

Meghalaya is primarily a rural-agrarian economy with 80% of the population residing in rural areas and around 62.8% of the working population engaging in agriculture and allied activities.

11.7.4 Legal Framework for Environmental Considerations

No State-level policy and regulations trigger additional requirements in terms of environmental and social considerations other than those already prescribed in national-level legislation. As such, legal framework for environmental consideration of NH51 project will be the same as NH54 project discussed in 11.5.4.

11.7.5 Institutional Setup

Institutional setup for environmental consideration of NH51 is also the same as NH54, except that State Government of Meghalaya and its departments instead of Mizoram, will be in charge of various state-level responsibilities.

11.7.6 Analysis of Alternative for NH51

The scope for alternative is limited due to hilly nature of the terrain and the nature of the project, which essentially aims to improve and widen existing road. In this study, two alternative options (without project scenario (zero option)) and another widening/improvement option based on a different concept) have been reviewed and compared with the proposed option.

1. Without Project (Zero Option)

The existing road has roadside settlements, particularly in and around two major built-up areas – Tura and Dalu. The traffic flow is impacted by conflicts between the local and through traffic, which is further compounded by various land use conflicts including uncontrolled development along the highway and encroachment. Given the current level of population growth and economic development, traffic volume is likely to expand further, adding more pressure to already constrained road capacity.

The without project scenario entails that existing road and slope conditions will persist. Poor pavement condition will lead to more vehicular emissions with detrimental impacts on health and ecosystem. Also, continuation of uncontrolled encroachment will increase the risk of traffic accident in built-up areas, particularly in Dalu where street vendors market daily goods on the road today. In addition, landslide will be more frequent in this scenario, depriving the local population along NH51 from supply of essential commodities and undermine the potential of economic growth. In particular, NH51 serves as one of the major trade routes connecting Meghalaya and Bangladesh and as such, blockage of NH51 will negatively affect the potential of mineral and horticultural product exports to Bangladesh.

2. Widening and improvement Option 1 (as proposed in DPR)

A design proposal for widening and improvement for NH51 is proposed in DPR prepared by Indian Consultants. While the project is expected to bring positive benefits, the design proposed in DPR is likely to cause significant environmental impacts which can be avoided or mitigated. Some of the issues include:

- Widening is proposed only toward hill side, resulting in higher volume of cut soil;
- Proposal of re-installing all existing culverts is made without hydrological analysis. Drainage without proper runoff estimate can cause soil erosion and damage the road; and
- Re-construction was proposed for one minor bridge and rehabilitation was proposed for ten minor bridges without information about damage condition and specific details of rehabilitation.

Comparison of with and without project scenario is provided below.

Table 11.56 Comparison of Alternatives

Component	Without Project	DPR	Proposed Design
Social Impact	No change in the short-term, but congestion and poor road quality will undermine the road utility over the long-term	30m ROW is proposed and thus more than double the land is required compared with the proposed design. Three churches and one policy station, one fire station will be affected.	12m ROW is adopted in general. Required acquisition of 67 ha of land for ROW and 11.6 ha for spoil bank. 367 households will be affected.
Widening	N/A	Hill side only	Both sides as appropriate
Cut Grade	N/A	Same across the entire strech	Decide based on classification of rock and soil.
Surplus soil	N/A	Significant	Minimized
Landslide	High risk	High risk (no slope protection measures proposed)	Landslide sites identified and slope protection measures proposed
Congestion in built-up area	Continue to deteriorate		

Impact on forest	N/A	Larger due to the need of disposing greater volume of surplus soil	Minimized by balancing cut and fill. Candidate sites for spoil bank proposed.
Safety	Existing risks remain unresolved	No information	Proper traffic signs and safety facilities to be installed
Road-side amenities	N/A	KM stone, bus bay etc.	KM stone, bus bay, public toilet etc.
Environmental quality	Continue to deteriorate due to higher emissions caused by poor road condition	Greater traffic volume may cause higher emissions	Greater traffic volume may cause higher emissions

Source: JICA Study Team

The proposed project has two sections (85km – 95km and 101km to 148km) and avoids intervention with densely built-up section of Tura town. Preliminary design and concept of Tura bypass have been proposed in DPR report with additional proposal for ROB/flyover to smoothen traffic flow in a major intersection in the town. However, the proposed ROB/flyover passes through areas known as Christian Compound, which accommodate sensitive and important facilities such as church, school and hospital and there is already anti-ROB/flyover sentiment among local population. As such, it is found that the potential benefits of ROB/flyover cannot justify negative impacts associated with it, particularly in places where Christianity is deeply rooted in the life of local people. Measures to mitigate congestions in Tura is required in the long-term, but it is recommended that a more detailed study be carried out to identify optimal route for bypass and ROB/flyover with respect to environmental and social impacts. Hence, the bypass and ROB/flyover have been dropped from the scope of the preparatory study and EIA.

11.7.7 Scoping of Environmental Impact

Building on the generic Scoping Matrix (Table 11.4), Scoping Matrix for NH51 widening and improvement has been prepared as below. Items for which larger negative impacts are expected as compared with the generic scoping are highlighted.

Sl.	**Item**	**Scoping Result**			**Rational of Assessment**
		P	**C**	**O**	
Natural Environment					
1.1	Climate/ Meteorological	D	D	D	P: No impact is expected as no engineering work is carried out at this stage.

	Phenomena				C/O: The impacts on micro-climate and micro meteorological phenomena are negligible because the project-related structures will not disturb wind path.
1.2	Topography	D	B-	D	P: No impact is expected as no engineering work is carried out at this stage.
					C: Changes in topographic conditions are expected due to the requirement of cutting filling work. Balancing the volume of cutting and filling is recommended to minimize the volume of spoil soil.
					O: Topographic condition will be stable after the completion of construction work which include slope protection and slope stabilization.
1.3	Geology	D	D	D	P/C/O: No impact is expected as the project does not alter geological condition of the area.
1.4	Soil Erosion	D	B-	B+/B-	P: No impact is expected as no engineering work is carried out at this stage.
					C: Soil erosion is expected particularly during the monsoon period. Construction work should avoid the monsoon period.
					O: Poor condition of drainage causes soil erosion in existing road. The project is expected to improve the condition and thus reduce the risk of soil erosion, but measures for slope protection and stabilization and prevent soil erosion, particularly during the monsoon period, must be in place and regularly monitored.
1.5	Hydrology	D	B-	B-	P: No impact is expected as no engineering work is carried out at this stage.
					C: Construction work may cause minor, temporary impacts on hydrology.
					O: Cutting and/or filling may result in changes in local hydrology. New drainage and culvert will be installed, taking into account the likely water flow in the area.
1.6	Groundwater	D	D	D	P: No impact is expected as no engineering work is carried out at this stage.
					C: The project does not envision the use of groundwater and thus no impact is expected. However, appropriate measures should be undertaken to properly manage effluent during construction.
					O: No impact is expected during the operation stage.
1.7	Ecosystem, Flora, Fauna and Biodiversity	D	B-	B-	P: No impact is expected. No unique/endangered species have been identified during assessment.
					C: The project will not affect pristine ecosystem as the work will be carried out along the existing road. However, construction work will affect mountain ecosystem and local flora and fauna including jhum and plantation.
					O: Increases in traffic volume will have negative impact ecosystem and flora and fauna along the road.
1.8	Protected Areas/Forest	D	B-	B-	P: The targeted section of NH54 does not traverse or border with national parks or protected forest.
					C: By the construction work, some of the forest (including plantation and village forest) area will be affected.

					O: Increases in emissions due to greater traffic volume will negatively affect forest and surrounding ecosystem.
1.9	Coastal Zone	D	D	D	P/C/O: No impacts are expected, because the alignment is far away from the coastal zone and the planned alignment will not pass the tidelands and the mangrove forests which are peculiar to the coastal region.
1.10	Landscape	D	D	B+	P: No impact is expected since the project at this stage does not alter existing condition.
					C: Changes in landscape during the construction work will be minor and temporary. The project should explore possibilities to utilize scenic/view points along the road to strengthen tourism potential in north eastern region of India.
					O: Improved road network facilitates access to scenic places and tourist attractions, thereby positively contributing tourism in the region. Bus bay and other road amenities also help improve aesthetic conditions of the road.
1.11	Natural Disaster	D	B-	B+	P: No impact is expected since the project at this stage does not alter existing condition.
					C: Many areas of the road are prone to landslide and thus appropriate measures should be in place during the construction work to avoid accidents. Construction during the monsoon period is risky and should be avoided.
					O: Slope protection/stabilization measures and drainage are expected to significantly reduce the risk of natural disaster.
Living Environment (Pollution Control)					
2.1	Air Pollution	D	B-	B-	P: No impact is expected since the project at this stage does not alter existing condition.
					C: Some negative impacts are expected due to operation of construction equipment and vehicles. One of these is the dust incidental to earthwork especially during the dry season.
					O: Air pollution is expected to increase due to increase traffic volume on the road.
2.2	Offensive Odor	D	D	D	P/C/O: No impact is expected as the project does not involve the use of chemical and other materials that may cause offensive odor.
2.3	Water Pollution	D	B-	B-	P: No impact is expected since the project at this stage does not alter existing condition.
					C: Turbid water due to the earthworks, bridge pier construction work and wastewater effluents from construction workers' camps/yards are expected to pollute the surrounding rivers/canals to some extent.
					O: Some impacts on water quality in surrounding water bodies are expected due to water discharge from road users and wastewater from maintenance activities.
2.4	Bottom Sediment Contamination	D	B-	D	P: No impact is expected.
					C: The project involves construction of new small bridges. Silt-trap will be used to avoid construction materials such as cement and sand being washed out during construction work.
					O: Some wastewater will be generated from maintenance activities along the road, the impacts on bottom sediment from the wastewater will be negligible.

2.5	Soil Contamination	D	D	D	P: No impact is expected as no engineering activity will be carried out at this stage
					C: Impacts on soil from deposition of pollutants from construction materials in the construction site are expected to be small. Since there is no major industrial activity along the road, it is unlikely that soil along the road is already polluted.
					O: No impact is expected except for the risk of accidental spillage of oil and lubricant, which will be managed by proper safety measures.
2.6	Ground Subsidence	D	D	B+	P/C: No impact is expected as existing conditions will not be altered.
					O: The project will improve subsidence/damaged area of existing road and will install measures to prevent future subsidence.
2.7	Noise/ Vibration	D	B-	B-	P: No impact is expected.
					C: Noise and vibration are generated by operation of construction equipment and vehicles, although they are temporary. Construction schedule should take into account the location of schools, hospitals and religious facilities that require silence in part of the day.
					O: Noise and vibration level are likely to increase due to greater traffic volume along the road. Specific measures may be required to minimize impacts on schools, hospitals and religious facilities.
2.8	Sunshine Obstruction	D	D	D	P/C/O: No impact is expected.
2.9	Wastes/Hazardous Materials	D	B-	B-	P: No impact is expected.
					C: Waste from construction workers' camps are expected to be generated. Waste generated from construction and demolition work may include hazardous materials that must be treated before final disposal.
					O: Waste will be generated from road users and workers of maintenance works.
Social Environment					
3.1	Involuntary Resettlement	A-	D	D	P: The project will result in large-scale involuntary resettlement, particularly in built-up areas near Tura and Dalu where structures exist in both sides of the road. Minimizing the resettlement should be the priority for road design.
					C: Resettlement will be completed before construction begins and thus no resettlement is expected during operation
					O: No impact is expected, as relocation will be completed before construction begins.
3.2	Land Use	A-	A-	D	P: Land acquisition and involuntary resettlement are likely to cause changes in existing land use pattern.
					C: The project will be carried out along the existing road, and as such, changes in land use associated with construction work are relatively minor, and land clearance for construction yards and workers' camps is temporary.
					No impact is expected as sufficient slope protection/stabilization measures to protect land use.
3.3	Utilization of Local	D	A-	D	P: No impact is expected.

	Resources				C: Mass-scale use of local resources such as sand and quarrying for the construction activities may obstruct there utilization by the local people for other purposes.
					O: No impact is expected as use of local resources is not expected during operation.
3.4	General, Regional /City Plans	D	D	D	P: No impact is expected.
					C: No impact is expected.
					O: Better infrastructure network may trigger influx of outsiders and economic development in the region.
3.5	Social Institutions and Local Decision-making Institutions	D	D	D	P/C/O: No impact is expected as there will be no change in social institutions and local decision-making institutions such as village councils and women groups
3.6	Social Infrastructure and Services	A-	A-	B+	P: Communal facilities such as public hall may be affected by the project, which negatively affect social infrastructure and services.
					C: Access to social infrastructure and services may be temporarily affected due to construction of construction yard and accommodation for workers as well as traffic jams due to the operation of construction vehicles.
					O: The project is expected to improve access to social infrastructure and services by providing better road network.
3.7	Local Economy and Livelihood	A-	A-	D	P: Loss of income source and livelihood due to involuntary resettlement are expected to negatively affect the local economic and livelihood.
					C: Loss of income source and livelihood due to involuntary resettlement are expected to negatively affect the local economic and livelihood. On the other hand, construction work will have positive impact on local economy by creating employment and business opportunities in the project area.
					O: The project will have positive impact on local economy as improved road network ensures more stable supply of essential goods. In the long-term, this will lead to regional economic development with more job and business opportunities.
3.8	Unequal Distribution of Benefit and Damage	A-	A-	D	P: Land acquisition and involuntary resettlement will lead to unequal distribution of benefits and damage between groups who are directly affected by the project and who are not.
					C: While resettling households bear much of the damage, others may even enjoy benefits from new business opportunities created by construction work, resulting in unequal distribution of benefit and damage.
					O: No impact is expected as the project is an improvement of an existing road and the road will continue as before to accrue benefits to those along the road.
3.9	Local Conflicts of Interest	D	D	D	P/C/O: No impact is expected as the project is an improvement of an existing road and structures/services will be equally restored
3.10	Water Usage, Water Rights and Communal Rights	D	D	D	P/C/O: No impact is expected as rain water is used for both household and agricultural use

3.11	Cultural and Historical Heritage	C-	D	D	P: The targeted roads do not traverse or runs near major ruins and/or cultural heritage.
					C/O: No impact is expected as the project will not affect cultural and historical heritages
3.12	Religious Facilities	A-	A-	D	P: Several memorial stones located along the road may be affected. Small religious facilities in built-up areas may also be affected.
					C: Roadside religious facilities may be affected by noise and vibration during construction and operation due to construction work and greater traffic volume.
					O: No impact is expected as sufficient noise control measures will be implemented.
3.13	Sensitive Facilities (ex. hospital, school, precision machine factory)	B-	B-	D	P: Small community facilities (public halls etc.) may have to be relocated incase road widening is implemented within the built-up area.
					C: Noise and vibration during construction work may affect school and hospitals but the impacts are expected to be minor.
					O: Greater traffic volume is expected to increase noise and vibration level, but adequate mitigation measures will be implemented.
3.14	Poor People	A-	A-	D	P: Given the limited coping capacity of the poor, it is necessary to assess their vulnerability and develop appropriate mitigation measures to be included in rehabilitation plan.
					C: The poor may bear disproportionally higher burden due to their limited coping capacity, although they can be benefited from employment opportunities during construction work.
					P: No impact is expected. In the long-term, economic development in the region is likely to benefit the poor.
3.15	Ethnic Minorities/ Indigenous People	A-	A-	D	P/C/O: Tura-Dalu section of NH51 is mainly inhabited by Garo people, registered Scheduled Tribe in India, with distinct culture and language. Preparation of RAP and livelihood restoration plan, therefore, must take into account this factor.
3.16	Gender	D	C-	B+	P: No impact is expected.
					C: Equal opportunity should be sought for employment during construction work. Prevailing social and cultural norms must be carefully studied to avoid gender-related conflict.
					O: Better road condition is expected to reduce the burden of girls and women who carry water and fuel wood and improve their safety.
3.17	Children's Rights	D	D	D	P: No impact is expected.
					C/O：Child labor is unlawful according to article 24 of Indian Constitution. Only adult is eligible for potential employment opportunity created by the project.
3.18	Public Health (sanitation and infectious diseases)	D	B-	B-	P: No impact is expected.
					C: Influx of construction workers is likely to increase the health risk, particularly that of STD and HIV/AIDS. The risk of malaria should be properly managed in construction work in areas where malaria is prevalent.
					O: An increase in traffic volume and road users may have negative impact on public health.

3.19	Occupational Health and Safety (OHS)	D	B-	B-	P: No impact is expected. C: Occupational health and safety of construction work should be properly managed through adequate Environment Management Plan. O: Maintenance and repair work should take into account the occupational health and safety of the workers.
Others					
4.1	Accidents	D	B-	B+/B-	P: No impact is expected as the project at this stage does not alter existing condition. C: Increase of risks of accidents associated with construction activities is expected due to the operation of heavy equipment and vehicles. O: Risks of accidents is expected to increase due to greater traffic volume and speed. On the other hand, installment of accident-prevention measures (such as mirrors at curves) will reduce the risk of accidents.
4.2	GHG emissions	D	B-	B+/B-	P: No impact is expected. C: The use of construction machines and operation of vehicles will result in an increase in GHG emissions, though the impact is small and short-term. O: The GHG emission will increase due to an increase in traffic volume. The project is expected to improve the resilience of road against climate change by factoring long-term climate change (changes/increase in precipitation etc.) into the road design.

Note: P: Pre-Construction; C: Construction; and O: Operation
A: Significant impact is expected (+: Positive impact, -: Negative impact),
B: Some impact is expected (+: Positive impact, -: Negative impact),
C: Extent of impact is unknown, further examination will be required (+: Positive impact, -: Negative impact),
D: No impact is expected,

Source: JICA Study Team

11.7.8 Anticipated Environmental Impact and Mitigation Measures

The proposed project will have both positive and negative impacts on the surrounding environment during different stages of the project planning and implementation. For the assessment of impacts, the baseline information has been supplemented by the field visits and the primary surveys of the various environmental components carried out during the study.

Natural Environment

(1) Climate

Pre-Construction and Construction Phase

Since the proposed project is only widening and strengthening to 2 lane road, no change in the macroclimate i.e. precipitation, temperature and wind is envisaged. However, there will be localized, temporary impact due to vegetation removal and the creation of paved surface for road. There may be an increase in daytime temperature around alignment due to loss of vegetation. The impact will be more prominent at locations where the cutting of trees is in clusters.

Operation Phase

During operation phase, increased traffic plying will lead to increase in temperature levels locally along the carriageway though it will be insignificant and temporary.

(2) Topography and geology

Pre-Construction and Construction Phase

The change in topography (that of existing) is envisaged to some extent at various places along the entire length of the road while developing 2 lane standard. The change in topography will also happen due to operation of borrow areas. The construction of material handling yards and labor camps will also alter the existing topography temporarily.

Operation Phase

During the operation phase, there will be probable induced developments in the form of tourism and commercial establishments along the highway. During monsoon, the change in topography will also be visible due to landslide and damage to side slope and breast wall. The benefits in the form of land leveling and tree plantations in the vicinity of the project road shall enhance the local aesthetics.

Mitigation Measures

During construction phase, the existing vegetation including shrubs and grasses along the route (except within the strip directly under embankment or cutting) will be properly maintained. The borrow areas shall be operated and closed as per the specifications for road and bridge construction manual of MORTH. The borrow areas shall be filled with the rejected waste/material, spoil and then finally a layer of topsoil shall be spread over it before carrying out plantation and turfing.

During operation phase, maintenance of embankment will be carried out to avoid soil erosion. The slope protection/ retaining wall if damaged due to land slide will be repaired promptly. The slope protection will also be established/strengthened regularly through plantation of shrubs and vegetation.

(3) Soil Erosion

Pre-Construction and Construction Phase

Site preparation will involve demolition of building, clearing of brushwood, tree removal and temporary re-routing of utilities. This brings risks of erosion to the exposed ground and topsoil. The soil erosion in construction stage may take place at the slope of the embankments, construction sites of cross drainage structures, at borrow areas and at construction sites which will be cleared.

Operation Phase

The soil erosion in operation stage may take place during operation at side slopes of road and near the approaches to bridges and interchanges. The risk is higher during monsoon.

Mitigation Measures

To control roadside soil erosion, turfing with grasses and shrubs will be carried out in accordance with the recommended practice in IRC guidelines. At the locations of steep slopes near crossings of highway with major rivers suitable protection measures such as stone pitching will be adopted. The surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and fill material operations shall be limited to the extent practicable. The contractor will provide immediate permanent erosion control measures to prevent soil erosion that will adversely affect construction operations, damage adjacent properties or cause contamination of nearby streams or other watercourses, village ponds or water bodies etc. The green belt will be developed simultaneously along with construction activities to control the erosion process.

During the operation phase, the slope protection measures like sodding, turfing shall be done and monitored regularly. The green belt will be monitored and replantation for the loss of plants species will be done immediately. The side ditch on road is designed as concrete lined ditch for all section of cut side to prevent damage from water runoff.

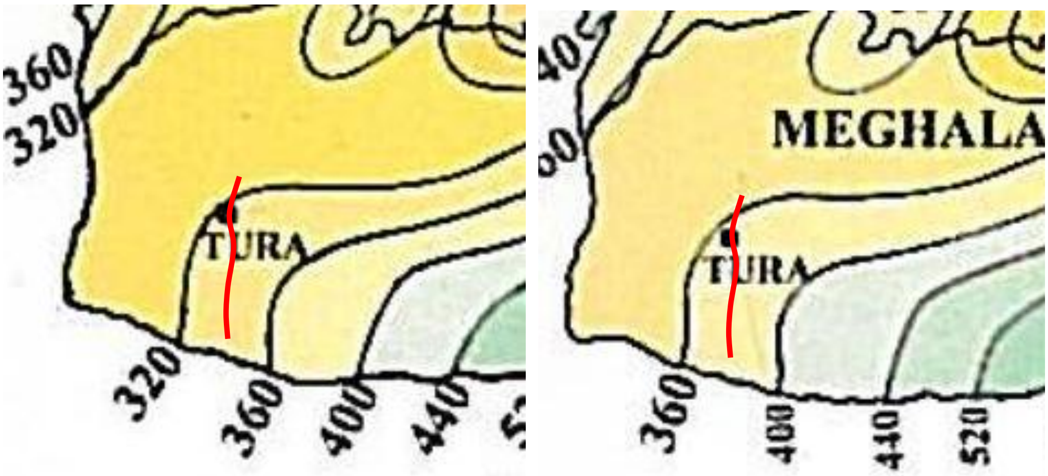
(4) Hydrology

The long-term rainfall intensity is modeled as shown below, which have informed the design of drainage and culverts.

Table 11.57 Rainfall intensity for each section in NH-51

From	To	25Years- 24hours Rainfall intensity (mm)	50Years- 24hours Rainfall intensity (mm)
KP90 of NH51, Tura	KP148, Dalu	360mm	400mm

Source: JICA Study Team



Source: ATLAS of Statewise Generalised ISOPLUVIAL (Return Period) Maps of Eastern India (Part – II)

Figure 11.23 Detailed isopluvial map with project location for NH51 for 25 Years (L) and 50 Years (R)

Pre-Construction and Construction Phase

Potential impact on hydrology will be minor, as the project does not involve diversion or re-routing of existing water resources. However, the existing drainage will be slightly obstructed during the construction period, but for a limited period. Hence, change in natural drainage pattern is very insignificant from the present state of the project.

Operation Phase

The projects may marginally lead to increased run-off during operational stages due to increase in impervious surface and sediment will be accumulation in nearby water bodies.

Mitigation Measures

The new drainage system is designed by based on hydrological calculation result. Based on obtained location of water crossing and water discharge, dimension and locations for drainage system are determined. For cross drainage structure, appropriate culvert type is selected by taking account of economy, construction workability, and maintenance ability. Comparison of different culvert types is shown below. In principle, pipe culvert is used where the water discharge is comparably small. BOX culvert is proposed where the water discharge is comparable large.

(5) Groundwater

No tunnel is proposed in this project and as such, the project will not affect groundwater level or quality in the area. If contractor propose to use water from under surface water source, however, permission from the Water Resource Department and Local Administration is mandatory. The contractor is expected to properly manage effluents and waste water during the construction stage to avoid potential influence to the groundwater.

(6) Ecosystem, Flora, Fauna and Biodiversity

The main impact on flora involves the removal of trees and grubbing of vegetative cover for construction and a clear zone within the Right of Way (ROW) and for spoil bank. Widening of the 1-lane to 2 lanes would have negative impact on plant species by way of cutting the trees and shrubs for construction activities. The types of impacts on flora can be as follows:

- Loss of trees;
- Loss of canopies;
- Compaction of vegetation, and
- Pollution and dust accumulation on vegetation.

A detailed field observation of the study area was done in June and August 2015. Extensive study was done in four locations/spots. They are chosen as a site that feature different ecological characteristics of the project area. The observations are enumerated below.

1) Paddy Field (KM post 144-145)

In the paddy field land preparation was going on and seeding was done for transplantation of rice seedlings. Small fishes like Channa spp., Colisa spp., Puntius spp., Noemacheilus spp. Rasbora spp., Crane and Indian common crow were seen in the rice field.

2) Amongpara Village Forest (KM post 125-126)

It is a vast area with diverse floral vegetation. The commonly seen species are Albizza spp., Ammora spp., Artocarpus heterophyllus, Bambuseae, Bauhinia spp., Bombax ceiba, Colocasia spp., Dalbergia, Ficus spp., Gmelina spp., Lagerstroemia spp., Mimosa pudica, Musa spp., Paederia scandens, Phoebe spp, Phlogacanthus tubiflorus, Shorea robusta, Tectona grandis, Terminalia spp.. Cuscuta reflexa and few species of epiphytic orchids like Rhynchostylis retusa, Cleisostoma simondii were also found. Bryophytes and liverworts were also seen in the trunk of old trees. In certain areas of the community forest the natural vegetation was cleared and teak, areca plantation was done.

3) Jhum Cultivation (KM post 119)

Terrestial observation was carried out in the area. Floral species of Dactyloctenium aegyptium, Manihot esculenta, Matricaria discoidea, Mimosa pudica, Musa spp., Oryza sativa, Taraxacum officinale, Urochloa mutica, Zea may. Faunal species of Hirudinea and Rhopalocera were observed. Mixed cropping of maize, banana, rice and tapioca was carried out.

4) Rubber, Areca Plantation (KM post 107-109)

In many areas of the community forest the natural vegetation were cleared and commercial plantation of rubber and areca nut was carried out on the slopes. The lower canopy was covered with grasses. Cashewnut were also commercially cultivated in many pockets throughout the road. Sparrow, butterfly, lizards, owl, common monkey, golden langur, red jungle-fowl, Indian black baza, thick-billed green pigeon, cobra were encountered during the field survey. Sound of Gryllidae was heard in abundance. There is a citrus garden of the Department of Agriculture and Ganol Ecopark. During the field survey it was noticed that shifting cultivation/ ‘Jhum’ practice is very common and in many areas the forest/natural vegetation are cleared and secondary monoculture of cashewnut (Sal (Shorea robusta), Teak (Tectona grandis) are established. Rice, maize, banana, pineapple cultivation are done in pockets. Several species of bamboo (Bambuseae spp.), stretch for long distances forming thickets of secondary vegetation.

As above, there is no unique faunal community within the project area. No endangered or threatened species were reported in the area close to the project highway. In addition to the efforts to minimize the scale of forest clearing and impacts associated with construction activity, following measure will be taken care during construction phase to avoid collision of some wild as well domestic animals:

- It is suggested that regular monitoring by the forest department should be done;
- Anti-poaching measures during construction phase should be strengthened to check violation of existing regulations;
- Side barriers will be provided to avoid collision of animals in forest area; and
- Animal under passes will be provided at various suitable locations to avoid accident.

Mitigation Measures

The tree plantation felled will be replaced and compensated according to the Compensatory Afforestation Policy under the Forest Conservation Act, 1980. Apart from trees earmarked for feeling, no additional tree clearing within the ROW will be allowed. All construction workers should adhere to this rule.

Plantation of shrubs and under trees in the median shall be undertaken to prevent the glare of the vehicles coming in the opposite direction. Construction vehicles, machinery and equipment will move or be stationed in the (ROW) to prevent compaction of vegetation. While operating on temporarily acquired land for traffic detours, storage, material handling or any other construction related or incidental activities, it will be ensured that the trampling of soil will be avoided.

Construction of road will involve removal of topsoil and cutting resulting in clearing of vegetation cover and felling of trees. However such impacts will primarily occur at the project site during initial period of the construction phase and will be minimized through adoption of mitigation measures. It is recommended that the lost trees will be compensated at 1:3 ratio. The site of compensatory afforestation will be specified by the Forest Department during the process of obtaining forest clearance. As per its guidance, the project proponent will plant saplings (types and number to be specified) at designated location (either degraded forest or vacant/abandoned jhum area).

Following measure will be taken during construction phase.

- It is suggested that regular monitoring by the forest department should be done. In keeping view of likely increase in vehicular emissions in the future, the monitoring should include the assessment of impact due to greater air pollution;
- A suitable landscaping plan for the project road has been prepared to enhance the ecological status of the area;
- It was noticed, that the project road did not have tree cover at few locations (Jhum lands) tree plantation at these location will enhance the aesthetics as well as reduce the pollution level of the area; and
- Initiative should be taken to remove the impacted small girth size trees with the help of Forest Department and replanted them at designed place. Though cost involvement against this type of work can be high, it will save the life of growing plants.

(7) Landscape

No site of significant scenic value has been identified along the targeted section of NH51. However, road and traffic markings to be installed in accordance with IRC:35-1997 will ensure smooth and orderly flow of traffic and contributes to better aesthetic condition of the road by reducing congestion.

Buses standing indiscriminately on the carriageway to drop or pick-up passengers can seriously affect capacity of the roadway, besides being a source of accidents. It is, therefore, desirable that on all busy non-urban highways, consideration should be given to the construction of bus lay-byes of suitable design at required locations to ensure orderly movement of the through traffic. For convenience of tourists, it is also proposed that bus bay will be equipped with amenities including public toilets and bazar shed.

(8) Natural Disaster

Slope along NH51 is covered by very loose quaternary alluvium. It is concerned that slope failure and erosion have frequently occurred on cut slope along NH51. Therefore, such loose soil slope shall be cut with 1:1.2 gentler than IRC standard for landslide prevention as shown below. The cut slope shall be greened by seeding and mulching consisting of jute netting including seeds which cover all over the slope and prevent erosion by rain water. \

Frequency and intensity of heavy rain is likely to increase due to climate change. In the project area, an increase of annual rainfall is predicted to be 5-10% for the period from 2021 to 2050. The design of various components of the road (slope protection, drainage etc.) takes into account likely effect of climate change. With increase of the rainfall frequency and intensity, river water and groundwater level are expected to be high, which could cause inundation and damage to the road facilities. Therefore, spring water points have been carefully studied and subsurface drainage is proposed where necessary. Flood marker was checked in site reconnaissance and interview survey for the disaster countermeasure design to inform the road design. The table below shows adaptation measures for climate change taken into consideration in this road design.

Table 11.58 Adaption Measures for Climate Change in NH51

Factor	Design Policy considering Adaptation
Side Slope	· Retaining wall is built all along the road. · Slope protection work is constructed on some weathered and loosen slopes. · Cut slope is covered with vegetation works to prevent erosion and collapse. · Replacement of subgrade and subsurface drainage are planned as countermeasure against sinking.
Embankment	· Drain filter is sandwiched in embankment. · Flood level is confirmed in site reconnaissance and interview survey near river bank in south of NH51.
Bridge & Drainage System	· Rainfall intensity is carefully determined based on the authorized data : ATLAS of Statewise Generalised ISOPLUVIAL MAPs of Eastern India published by Indian Meteorological Department. The isopluvial value from higher edge of counter range is applied. · The capacity of all structures is determined to be capable for the discharge of 50 years return period.
Pavement	· Super elevation is installed properly. · Pavement material is examined not to rise over 60 °C on the surface.
Road Sign	· Wind load and visibility is taken into consideration.

Source: JICA Study Team

Living Environment

(1) Air Pollution (

Being a rural area without a major industrial activity, there are not major sources of air pollution along the project road except for vehicular traffic13. As shown in the table below, it is evident that

13 The level of air pollution is expected to be higher in central Tura, which is outside the scope of this project. The proposal for Tura bypass currently under consideration will contribute to mitigate the pollution level by reducing congestion within Tura town.

concentrations of all pollutants are well within the prescribed limits of the National Ambient Air Quality Standards.

Table 11.59 Results of Ambient Air Quality Monitoring

Station Code	Date	Parameters				
		Respirable Suspended Particulate Matter (as PM10 (μg/m3)	Suspended Particulate Matter (μg/m3)	Sulphur Dioxide (as SO_2) (μg/m3)	Oxides of Nitrogen (as NO_2) (μg/m3)	Lead (as Pb) (μg/m3)
AAQ1	5/30-5/31	75	190	22	24	0.05
	6/1-6/2	70	165	22	24	0.06
	6/2-6/3	72	185	22	24	0.07
	6/11-6/12	68	179	22	23	0.08
	6/12-6/13	77	168	22	23	0.05
	6/18-6/19	71	155	18	21	0.03
	6/20-6/21	52	164	19	23	0.03
	6/25-6/26	68	165	17	23	0.06
	6/27-6/28	72	188	20	23	0.04
	6/29-6/30	69	176	22	25	0.04
AAQ2	5/30-5/31	75	190	22	24	0.05
	6/1-6/2	65	155	23	25	BDL
	6/2-6/3	52	130	21	23	BDL
	6/11-6/12	59	148	22	25	BDL
	6/12-6/13	50	134	17	21	BDL
	6/18-6/19	47	150	12	17	BDL
	6/20-6/21	39	140	15	23	BDL
	6/25-6/26	48	130	19	22	BDL
	6/27-6/28	44	136	14	18	BDL
	6/29-6/30	75	190	22	24	0.05
AAQ3	5/30-5/31	78	170	24	26	0.03
	6/1-6/2	75	185	24	26	0.05
	6/2-6/3	68	160	21	23	0.06
	6/11-6/12	70	185	22	24	0.04
	6/12-6/13	70	155	20	28	0.06
	6/18-6/19	70	170	19	21	BDL
	6/20-6/21	70	170	19	21	0.05
	6/25-6/26	70	170	19	21	0.05
	6/27-6/28	69	166	20	24	0.06
	6/29-6/30	78	170	24	26	0.03
CPCB Limit		**100**	**200**	**80**	**80**	**1.0**

Source: JICA Study Team

Pre-Construction and Construction Phase

The short-term and localized degradation of air quality will occur from dust generation due to procurement and transport of raw materials from quarries and borrow pits, site clearance, use of heavy vehicles, machinery/ equipment, stone crushing handling and storage of aggregates and generation of fine particulate matter (smoke) in asphalt processing. Dust would be generated from haulage of materials and detouring of traffic on non-permanent, temporary pavement etc.

Hot mix plants contribute substantially to the deterioration of air quality due to emissions of oxides of Sulphur, Hydrocarbons and particulate matter. During the construction period, temporary impacts include generation of Odor from construction activities as well as from construction camps. During construction of road, the movement of different types of construction machinery and vehicle will be increased. This in other way increases the fuel consumption.

From the results of the ambient air quality monitoring conducted along the road, it is noticed that the monitoring parameters are within the standards as prescribed by the Central Pollution Control Board The concentration of the air pollutants will further increase during construction period but for limited period only. The impacts on air quality during construction will be mostly localized and concentrated within the ROW. The impacts due to dust generation may felt downwind of the site rather than the site itself due to local wind pattern.

Operation Phase

The project road is mostly passing through the rural areas with alluvial soil. Dust generation due to movement of vehicles is envisaged along the project road, but not in significant amount. Due to increase in speed and volumes of vehicular traffic on the project corridor, marginal increase in the air pollutant levels is expected but not significant. Widening of road will attract larger community to use this corridor which in-turn increase the fuel consumption and has direct impact on national economy and local ecosystem.

Mitigation Measures

The hot mix plants, crushers and the batching plants will be sited at least 500 m in the downwind direction from the nearest settlement. All precautions to reduce the level of dust emissions from the hot mix plants, crushers and batching plants will be taken up. The hot mix plant will be fitted with dust extraction system. Asphalt and concrete plants will be operated in conformity with government pollution control legislation, and located away from the settlements as far as possible. All vehicles, equipment and machinery used for construction will be regularly maintained to ensure that the pollution emission levels conform to the SPCB norms. Regular monitoring of particulate Matter at crusher sites, during the construction, will be conducted. Regular water sprinkling will be done on the cement and earth mixing sites, asphalt mixing site and temporary service and access roads. After compacting the earthwork, water will be sprayed to prevent dust emission. The vehicles delivering construction material will be covered to avoid spilling. Planting of trees/vegetation on the periphery of the construction site will be taken up.

During the operation stage of the project, vehicular emissions of critical pollutants (RSPM, CO, HC, SO_2, and NO_x) will be monitored and roadside tree plantation will be maintained. Over the long-term, projected increase in traffic volume, particularly ones of heavy trucks, may pose health threat in roadside community. The peak hourly estimated traffic volumes for the years 2020 and 2035 have been considered to project future air quality scenarios to provide an indication of long-term variations in air quality. The future level of air pollution, modeled based on the projected increase in traffic volume indicates that the level of pollution (CO and NOx levels) will remain below the standard during the projected period (2035). Nevertheless, mitigation measures such as introducing speed limit and other measures to control congestion in built-up area may be necessary in the longer term. Also, local communities should be well informed of the risk of air pollution. Awareness raising campaign may include distribution of facemask to mitigate risk of air pollution and other information kit.

(2) Water Pollution

There are no major pollution sources in the area and water quality along the road is good as per the report by Public Heath Engineering Department, Shillong. In order to find out existing condition, monitoring of ground and surface water quality was carried out in February 2011 (dry season) during the DPR preparation. The data from seven sites for ground water testing (KM post 93+950, 115+200 and 142+450) and four surface water monitoring show that water quality is fair within the desirable limits.

Water quality for pre-monsoon and monsoon period the project area has been analyzed by collecting surface water sample along the road in June and July 2015. Analysis of the samples shows that the water is alkaline in nature (pH <8), is soft in the area and the Hardness is below the permissible limit. Chloride concentration is well below the desirable limit in all locations. Sulphate and Nitrate concentrations are low and within the permissible limit and thus indicate low degree of organic pollution. Iron levei is higher than the desirable standard, reflecting local soil condition in the area.

Table 11.60 Ground and Surface Water Quality

Parameters	**Duragre locality (south of Tura)**	**River at around halfway between Tura and Dalualu**	**Tibapara locality (noth of Dalu)**	**Dalu**	**Limits IS: 10500**
	GW1	**SW1**	**GW2**	**SW2**	
Temperature	32.1	32.1	32.3	32.1	
pH	7.49	7.46	7.03	7.64	6.6 to 8.5
Color (Hazen unit)	<5	<5	<5	<5	-
Odor and smell	Agreeable	Agreeable	Agreeable	Agreeable	
Suspended Solid (mg/l)	24	17	33	2.0	-
BOD (mg/l)	Nil	Nil	Nil	Nil	-
COD (mg/l)	Nil	Nil	Nil	Nil	-
Total Hardness (mg/l)	68	24	80	20	300
Calcium (mg/l)	25.65	6.41	11.22	4.81	75
Magnesium (mg/l)	0.97	1.94	5.83	1.94	30
Electric Conductivity	174.6	85.7	126.9	73	-
Chloride (mg/l)	8.11	2.02	6.08	2.02	250
Sulphate (mg/l)	4	5.71	33.52	3.24	200
Nitrate (mg/l)	1.2	1.51	0.37	0.37	45
Fluoride (mg/l)	0.17	0.12	0.04	0.19	1
Total Dissolved solid (mg/l)	110	54	80	46	500
Iron (mg/l)	33.52	4.07	2.0	0.1	0.3
Coliform Organism / 100 ml	Absent	Absent	Absent	Absent	

Note: GW stands for groundwater, SW stands for surface water
Source: JICA Study Team

<u>Pre-Construction and Construction Phase</u>

The Tura-Dau section of NH51 traverses one small stream, and passes through paddy area near Dalu. Road projects may marginally lead to increased run-off during construction stages, which will increase sediment accumulation in nearby water bodies. Though most of the natural watercourses are perennial in nature, the impacts due to the increased run-off would be negligible due to the project road. During construction, the disposal of solid and liquid waste from labor camps, fuel and lubricant spills or leaks from construction vehicles, pollution from fuel storage and distribution sites and that from hot-mix plants is likely to affect water quality unless adequate mitigation measures are designed. The existing drainage will be slightly obstructed during the construction period, but for a limited period. Hence, change in natural drainage pattern is very insignificant from the present state of the project.

Use of water for construction activities such as compaction, suppression, concrete work may pose pressure on local water supplies; the demand would be met from surface water bodies like ponds, canal and rivers. Municipal water supply will be used only for drinking purposes (for construction camps), if available and if permitted by the local municipal authority. No local/municipal water supply would be used for construction purpose.

Operation Stage Impacts

Road projects may marginally lead to increased run-off during operational stages due to increase in impervious surface and sediment will be accumulation in nearby water bodies. Though most of the natural watercourses are non-perennial in nature, the impacts due to the increased run-off would be negligible due to the project road and will be restricted only during monsoon and early part of post-monsoon seasons.

In the operation stage, pollutants from vehicles, and accidental fuel spills may make their way into the receiving environment. The major pollutants of concern are suspended solids, oil and grease, lead etc. All the rivers present at this road section are non-perennial surface water bodies. No adverse direct impact on the water quality (both underground and surface water bodies) is expected during the operation period. The change in natural drainage pattern is very insignificant from the present state of the project.

Mitigation Measures

To avoid contamination of the various water bodies and drainage channels, construction work close to the canals or other water bodies will be avoided, especially during monsoon period. All necessary precautions will be taken to construct temporary or permanent devices to prevent water pollution due to increased siltation and turbidity. All wastes arising from the project will be disposed off, as per the

State Pollution Control Board norms, so as not to block the flow of water in the channels. The wastes will be collected, stored and taken to approve disposal sites.

To avoid contamination of the water body and drainage channels from fuel and lubricants, the vehicles and equipment will be properly maintained and re-fuelled only at designated places. The slopes of embankment leading to water bodies will be modified and re-canalized so that contaminants do not enter the water body. Oil and grease traps will be provided at fuelling locations, to prevent contamination of water.

Discharge of oil and grease is most likely from construction vehicle parking area, vehicle repair area and workshops. An oil interceptor shall be provided to ensure that all wastewater flows into the interceptor prior to its discharge. The device has a chamber for separation of oil and water and can handle 200 L/hour of wastewater. The oil float appearing on the surface is removed by periodic cleaning once a week by skimming off the oil film from the surface.

The sewage system (including septic tanks and soak pits) for construction camps will be properly designed and built so that no water pollution takes place to any water body or watercourse. The workplace will have proper medical approval by local medical, health or municipal authorities. The contractor will make arrangements for water required for construction in such a way that the water availability and supply to nearby communities remain unaffected. Due to the non-availability of water required for construction, if a new tube-well is to be bored, prior sanction and approval by the Central Ground Water Board (CGWB) will be obtained. Wastage of water during the construction will be minimized.

(3) Bottom Sediment Contamination

It is proposed that one 6m long bridge will be replaced with the new one and the super-structure of seven small bridges will be replaced. During engineering work of the bridges over the rivers, sediment pollution may occur. As one of the mitigation measures, silt fencing will be provided to restrict runoff into the water during construction phase.

(4) Soil Contamination

Pre-Construction and Construction Phase

The contamination of soil during construction stage is primarily due to construction and allied activities. The soil contamination may take place due to solid waste from the labor camps set- up during construction stage. This impact is significant at locations of construction camps; stockyards, hot mix plants, etc. The sites where construction vehicles are parked and serviced are likely to be contaminated because of leakage or spillage of fuel and lubricants. The contamination of soils can also occur at the site of hot-mix plants from leakage or spillage of asphalt or bitumen. At the site of batching plants, because of spillage of cement, leakage of curing agents the soil contamination can occur. The contamination of soil may take place due to dumping of solid waste in unscientific manner, leaching of fuel/oil & grease from workshops, petrol stations and DG sets.

Operation Stage Impacts

During the operation stage, soil pollution due to accidental vehicle spills or leaks is a low probability but potentially disastrous to the receiving environment, should they occur. These impacts can belong term and irreversible depending upon the extent of spill.

Mitigation Measures

At construction yards, the vehicles/equipment will be maintained and re-fuelled in such a fashion that oil/diesel spillage does not occur and contaminate the surrounding soil. It will be ensured that the fuel storage and re-fuelling sites are kept away from drainage channels and important water bodies. At the washdown and re-fuelling areas, “Oil Water Separators” shall be provided. All spills and discarded petroleum products shall be disposed off in accordance to the Hazardous Waste Management and Handling Rules. Fuel storage and re-fuelling areas will be located at least 500 m from all water bodies near the road alignment. The fuel storage and re-fuelling areas shall not be located on agricultural lands or productive lands to avoid topsoil contamination. The earthwork will be carried out strictly in accordance with the design so that no excess earth is borrowed. The construction waste generated will be reused in the construction of highway.

Bituminous waste will be used after milling and in case bituminous waste is required to be disposed off it shall be disposed in secured way by providing 50 mm tick clay layer. The solid waste generated during construction phase which includes municipal waste both organic & inorganic in nature which shall be stored/treated/disposed off in accordance with Municipal Solid Waste (Management & Handling) Rules. The hazardous waste may include oil waste, biomedical waste, E-waste etc. This shall be disposed off in accordance with the Hazardous Waste (Management, Handling & Transboundary Movement) Rules, Biomedical Waste (Management and Handling) Rules and E-Waste (Management and Handling) Rules respectively.

In the operation stage, the petrol pumps & vehicle washing area located along the ROW will be monitored regularly for any spillages and corrective remedial measures like spread of sand, provision of oil & greases separators for passing wash water of petrol pumps & vehicle washing area before diverting it to water bodies shall be done regularly. The solid waste generated from the way side amenities will include Municipal Waste both organic and inorganic, hazardous waste (like used batteries), will be treated in accordance with Municipal Solid Waste (Management & Handling) Rule and Hazardous Waste (Management, Handling & Transboundary Movement) Rules.

(5) Ground subsidence

Many road subsidence sites have been identified in the slope inventory survey, which was assumed to occur due to consolidation of loosen subsurface soil and high groundwater level except for embankment sliding. Replacement of subgrade with 1.0m thick and subsurface drainage is planned as countermeasures of sinking, which will significantly improve the existing condition.

(6) Noise and vibration

Noise is an important environmental attribute in all road projects because vehicular traffic is a source of noise pollution. During DPR preparation, noise level monitoring was carried out in six locations in February 2011 (dry season). Apart from the areas near Tura and Dalu town, the project road mostly passes through open forest and plantation and thus noise is not a major issue and the monitoring result were within the limit prescribed by PCPB. The monitoring for pre-monsoon and monsoon seasons has been carried out as part of the preparatory study in three locations. The nose level near school in Dalu town is within the limit of residential area (55dB for daytime and 45dB for nighttime, but slightly above the limit for silence zone (50dB for daytime and 40dB for nighttime), indicating the need of proper noise level mitigation measures around sensitive facilities. The figures in other locations are within the limit.

Table 11.61 Ambient Noise Level

Sr. No.	Location	Ambient Noise Level Leq.dB(A)					
		Day Time (07.00 AM to 11.00 PM)			Night Time (10.00 AM to 12.00 PM)		
		L_{min}	L_{max}	L_{eq}	L_{min}	L_{max}	L_{eq}
Monitoring 1. Date: May 30, 2015 to May 31, 2015							
1	GK Sangma Petrol Pump	70	52	60	58	46	47
2	Near Woodland school, Barengapara, Dalu	71	53	58	55	44	46
3	Forest Gate, Chokpot, Tura	68	51	57	53	47.2	38.5
Monitoring 2. Date June 29, 2015 to June 30, 2015							
1	GK Sangma Petrol Pump	70	46	52	54	41	43
2	Near Woodland school, Barengapara, Dalu	70	46	51	54	40	42
3	Forest Gate, Chokpot, Tura	69	50	52	53	40	40
Standard for commercial area for residential area for silence zone		-	-	65 55 50	-	-	55 45 40

Source: JICA Study Team

Pre-Construction and Construction Phase

During the construction, the major sources of noise pollution are movement of vehicles transporting the construction material to the construction yard and the noise generating activities at the yard itself. Mixing, casting and material movement are primary noise generating activities in the yard and will be uniformly distributed over the entire construction period. Construction activities are expected to produce noise levels in the range of 80 - 95 dB (A). The major work will be carried out during the daytime. The noise levels in the project area during the construction stage will be intermittent and temporary in nature. Typical noise levels associated with the various construction activities and construction equipment are presented below.

Table 11.62 Typical Noise Levels of Construction Equipment

Construction Equipment	Noise Level dB(A)
Bulldozer	80
Front end loader	72-84
Jack hammer	81-98
Crane with ball	75-87
Crane	75-77
Bulldozer	80
Backhoe	72-93
Front end loader	72-84

Cement & Dump trucks	83-94
Jack hammer	81-98
Scraper	80-93
Welding generator	71-82
Grader	80-93
Roller	73-75
Concrete mixer	74-88
Concrete pump	81-84
Concrete vibrator	76
Paver	86-88
Truck	83-94
Tamper	74-77
Air compressor	74-87
Pneumatic tools	81-98

Source: U.S. Environmental Protection Agency, noise from Construction Equipment and Operations. Building Equipment and Home Appliance. NJID. 300.1. December 31, 1971

At the moment, noise level is within the desired level. The noise level will be increased during construction period, which have significant impact for a limited period on the surrounding environment. The noise levels in the working environment are compared with the standards prescribed by Occupational Safety and Health Administration (OSHA-USA) which in-turn are being enforced by Government of India through Model rules framed under the Factories Act. The acceptable limits for each shift being of 8 hour duration, the equivalent noise level exposure during the shift is 90 dB(A). Hence noise generated due to various activities in the construction camps may affect workers, if equivalent 8 hour exposure is more than the safety limit. ACGIH (American Conference of Government Industrial Hygienists) proposed an 8 hour Leq limit of 85 dB(A). Exposure to impulses or impact noise should not exceed 140 dB(A). The workers in general are likely to be exposed to an equivalent noise level of 80-90 dB(A) in an 8 hour shift for which all statutory precautions as per laws should be taken into consideration.

Operation Stage Impacts

During the operation stage of the project, reduction of vehicular engine noise (as a result of reduced congestion from earlier, smoother flow of traffic due to 2 separate lanes), vehicular body noise (as a result of reduced development roughness) and reduction of blowing of horns will bring the noise levels down, but as volume of traffic, mainly heavy duty traffic will be increase in future due to rapid development and industrialization along the road corridor this may increase noise. The noise prediction at different scenarios indicate that the noise levels can be exceeding the Noise standards of

55 dB(A) for daytime and 45 dB(A) for night time at several receptor locations without barrier scenario.

Mitigation Measures

The high noise levels will cause discomfort to local residents and workers. Following mitigation measures shall be adopted to keep the noise and vibration levels under control.

- The plants and equipment used for construction will strictly conform to Central Pollution Control Board (CPCB) noise standards. Vehicles, equipment and construction machinery shall be monitored regularly with particular attention to silencers and mufflers to maintain noise levels to minimum;
- Workers in the vicinity of high noise levels must wear ear plugs, helmets and should be engaged in diversified activities to prevent prolonged exposure to noise levels of more than90dB(A);
- In construction sites within 150 m of human settlements, noisy construction will be stopped between 10 PM and 6 AM except in case of laying of cement concrete pavement for which lower working temperature is a requirement;
- Hot mix plant, batching or aggregate plants shall not be located within 500 m of sensitive land use as schools and hospitals;
- Near to the sensitive receptors such as hospitals and schools, noise barriers such as earth, concrete, wood, metal or double-glazing of windows for façade insulation shall be used;
- Phase demolition, earthmoving and ground-impacting operations so as not to occur in the same time period. Unlike noise, the total vibration level produced could be significantly less when each vibration source operates separately
- Construction machinery will be located away from the settlements;
- Careful planning of machinery operation and scheduling of operations can reduce the noise levels. Use of equipment, emitting noise not greater than 90 dB(A) for the eight-hour operations shift and locating of construction yards at a distance of at least 500 m from any residential areas can be adhered to;
- Use of noise shields to construction machinery and provision of earplugs to the heavy machine operators are some of the mitigation measures, which should be followed by the contractors during the civil works;

- The noise control measures include limitations on allowable grades. Open-graded asphalt and avoidance of surface dressings to reduce tire noise in sensitive areas. Maintenance of proper road surface repairs also helps in reducing noise levels;
- Use of air horns should be minimized on the highway during nighttime. During daytime use of horns should be restricted at few sensitive locations. This can be achieved through the use of sign boards along the roadside;
- Future development along the road should follow correct land use norms so that sensitive receptors are not located along the road, specifically along the bypasses; and
- Development of greenbelt along the main road can also bring about considerable reduction in noise levels. The area available on both sides of the road should be used to develop green belt comprising selected species of trees with high canopy to provide added attenuation of noise

(7) Wastes/Hazardous Materials

Types of construction waste which are expected to be generated include asphalt chunks, chunks of concrete, surplus soil, construction scrap materials and organic waste generated by construction workers. The amount and percentage composition of construction waste will depend on the final design and the schedule of the construction, and thus generic mitigation measures proposed in EMP should be updated once the final ROW drawing is completed. All other construction wastes are also planned to comply with relevant Center or State laws pertaining to waste management.

Table 11.63 Required Volume for Spoil Bank

Highway No.	Sec.	Item	Unit	Volume of Generated Soil	Coefficient of Compation	Volume of Compacted Soil	Required Volume of Spoil Bank
				Cu.m		Cu.m	Cu.m
NH51	1	Cut Soil	cu.m	41,840	0.9	37,656	37,656
		Fill Soil	cu.m			0	
	2	Cut Soil	cu.m	77,562	0.9	69,806	29,177
		Fill Soil	cu.m			40,629	
	3	Removed Soil for Replacement	cu.m			201,600	201,600
	Total						268,433

Source: JICA Study Team

The volume of surplus soil is estimated as below. Candidate locations with sufficient and necessary conditions for spoil bank construction have been screened with following criteria:

- ❖ To minimize transport of surplus soil, spoil bank should be located at every 5km distance along NH-51 with following condition;
  - Ground shape with concavity topography
  - Less ground gradient than 22 degree which is assumed as average angle of spoil bank slope with necessary steps
  - No built-up area
  - No national sanctuary area
- ❖ To be able to construct the spoil bank in less than 30m height

Based on the above criteria, 9 locations along the stretch of NH-51 have been identified for spoil spoil bank construction with the total capacity of about 342 cu.m. The list of each candidate site is shown below.

Table 11.64 List of Spoil Banks

No.	Section	Sta.	Capacity of Spoil Bank
			Cu.m
1	Sta. 85-94	88+000	47,120
2	STA.101-143	105+805	4,620
3		110+000	86,190
4		110+550	58,260
5		119+340	16,856
6		124+800	77,440
7		130+800	15,526
8		135+420	22,806
9		139+100	12,883
Total in NH-51			341,701

Source: JICA Study Team

Socio-Economic Environment

(1) Involuntary Resettlement

As per the preliminary ROW design, 367 households (173 households whose houses will be affected and 194 households whose businesses will be affected) will be affected by the project. The total number of people is 1,820. Out of these, 319 households (161 households whose houses will be affected and 158 households whose businesses will be affected) will have to be relocated. The remaining 48 will be partially affected but relocation will not be necessary. More details about resettlement impact, resettlement policy and proposed compensation package can be found in the RAP report.

(2) Land Use

The project does not lead to large-scale change in land use as the engineering work will be constrained mostly along the existing road. On the other hand, construction of spoil bank is likely to cause changes in land use pattern, potentially affecting existing agricultural and plantation activities. In particular, several plantation is located by the road and installment of retaining walls, embankment and slope protection measures not only affect the land but potentially alter long-term productivity by changing micro-level hydrology. This issue should be taken into account when the compensation for agricultural land/plantation next to existing road is finalized by District Collector.

(3) Utilization of Local Resources and Local Economy and Livelihood

Significant volume of local resources such as sand may be used for construction work. This could cloud out the use of such resources for other purposes in the short-term. In the long-term, the better road network may attract new business, possibly from outside the state with detrimental impact on local business/traders. While the project overall will have significant positive impacts on the local and regional economy, the better transport network may put some groups at risk at least in the short and medium-term. This is of particular concern because Dalu is at the border with Bangladesh. For example, if the travel time is reduced thanks to the improved road condition, truck drivers may stop taking rest in Dalu or other places, negatively affecting local businesses in the project area. These potential high-risk groups should be identified in the preparation of R&R plan to ensure that they will not be in a disadvantaged position due to the project.

(4) General, Regional /City Plans

The project will create new opportunities for village and block-level development planning. In particular, the construction of spoil bank will create large area of flat land where such surface is a scarce commodity. The development of spoil bank, therefore, should be coordinated with the village/block development plan so that the land will benefit the community.

(5) Social Institutions and Local Decision-making Institutions

Being a tribal state, block and village council and traditional community leaders called Nokma have significant influence on decision-making process in the area. As such, their support and cooperation is critical in smooth implementation of the project, particularly activities related to resettlement. The implementation of EMP as well as RAP/R&R should be built on existing social institutions and will be best guided by local people, rather than outside experts.

(6) Social Infrastructure and Services

For most people residing along NH51, the highway is the only route of access to social infrastructures such as schools and hospitals. Construction activity is likely to cause temporary disturbance to their access to such infrastructure and service and therefore, schedule and timing of the engineering activity should be developed in consultation with the local community. When road blockage is necessary, e.g. for blasting, the local community should be informed in advance so that they can make alternate plan accordingly.

(7) Unequal Distribution of Benefit and Damage and Local Conflicts of Interest

Roadside location offers critical advantages for local business (tea stalls, restaurant, petty shops). Resettlement from roadside to inner part o the village may significantly undermine the viability of these businesses, and therefore, business owners to be affected may be worse off compared with farmers to be relocated. Likewise, allocation of plot in resettlement site may become a source of conflicts among affected households who wish to be relocated to more advantageous plots. Sound arbitration and conflict resolution mechanism by local leaders should be in place for smooth implementation of RAP and R&R activity.

(8) Water Usage, Water Rights and Communal Rights

Irrigation is not practiced along the project area and thus water is not likely to become a source of conflicts in the course of project implementation.

(9) Cultural and Historical Heritage

No sites of cultural or historical significance have been identified along the project road.

(10) Religious and Sensitive Facilities

The project will not affect religious facility, but the access to churches may be impaired during the construction stage. Given the significance of religious belief in the area, access to these facilities, particularly Sunday mass, should not be disturbed by construction activities. Similarly, more stringent standard for noise and vibration and air quality should be adopted where sensitive facilities such as school and hospitals are located.

(11) Poor People

The baseline survey has identified gap between official poverty level and poverty level as reported by the people. R&R activity should take into account the limited coping capacity of the local community and develop measures that leads to sustainable income generation of the affected people, rather than one-off payment of compensation and assistance.

(12) Ethnic Minorities/ Indigenous People

In the state of Meghalaya, the tribal (Scheduled Tribe: ST) population constitutes about 85% of the total population. Most of affected people belong to Garo tribe except for Dalu town with sizable Bengali community. Majority of the affected people also belong to ST, and hence they are not minority. While tribal groups in project area holds traditional culture, including shifting cultivation in forest called jhum, they freely interact and share their sources of water, folklore, food, infrastructure and other belongings with the non-ST and other tribal population within and outside community. This is clear from the fact that Bengali and Garo community along NH51 co-exist peacefully without ethnicity-related tensions. Moreover, ST population in project area is not isolated from outside and they are open to new ideas such as family planning and formal education.

(13) Gender

Tribal and non-tribal women in North East States enjoy a relatively higher position in the society than what their non-tribal counterparts do, which is reflected in their high literacy rate. Garo women are largely involved in household work, collection of forest produce, firewood collection, cultivation and other agricultural activities and thus they will be affected in a way that is different from their male counterpart. In order to ensure that affected women will not be disadvantaged, a dedicated chapter on gender issue is included in this RAP in which options to facilitate women's participation in project implementation and various opportunities to be created by the project is discussed.

(14) Public Health and Occupational Health and Safety

The same measures as NH54 will be adopted for mitigating negative impacts on public heath and occupational heath and safety issues (Table 11.30).

Other Issues

(1) Accidents

<u>Construction Phase Impacts</u>

The project will improve the road safety through design measures identified during the various road surveys. Road safety will be enhanced in the project through engineering (design), enforcement (safety measures, signage, etc.) and education. The issue of road safety is one of the key issues that may surface in construction stage. During the construction stage, dismantling of structure, cutting of trees, haulage material obstructing vision, spillage of lubricants on road making it slippery is generally the cause of road accidents. Similarly, in operation stage, increase in traffic and increase in speed would tend to increase in accidents. In spite of these, the social benefits from the project are quite significant.

It is likely that there will be some concern of safety for highway users during construction period, as haulage of material and other equipment would restrict movement of vehicles. Highway patrolling system with ambulance facility and crane will render assistance to users in distress and disabled vehicles which in-turn will improve the safety level.

<u>Operation Phase Impacts</u>

The proposed project implementation would improve the road safety for the highway users as well as locals living by the side of the road. In operation stage, increase in traffic and increase in speed would tend to increase in accidents. In-spite of these, the social benefits from the project are quite significant. In operation phase, increase in vehicle speed may cause thereof to the safety of pedestrians and for cattle for crossing road.

Mitigation Measures

Street furniture known as road studs, blinker or cat's eye include equipment installed on road or roadside to assist visibility of road alignment/structures. They are retro-reflective safety devices used in road marking. Generally, it consists of two pairs of reflective glass spheres set into a white rubber dome, mounted in a cast-iron housing. This is the kind that marks the centre of the road, with one pair of devices showing in each direction. A single-ended form has become widely used in other colors at road margins and as lane dividers.

Since the NH51 is located in mountainous region, hair-pin bends are unavoidable from the viewpoint of cost and environmental impact. Design speed of 20km/h is applied for hair-pin bends, while design speed of 30km/h is adopted in general. Small horizontal curves such as R20m-R25m are used in steep terrain to avoid large-scale earthwork and/or demolition of houses. At those sub-standard sections, securing traffic safety by applying combination of facilities shall be considered.

In hair-pin bends, it is difficult to secure overtaking sight distance and thus, the section shall be designated as no-overtaking section. In order to inform that to drivers, the double centre line with marking of pair of solid lines is applied. Cats eyes to delineate road alignment are to be installed on the centre line and lane edges so that drivers will be able to identify the direction he should go before entering into the curve. Furthermore, traffic signs and guard rails shall be properly equipped to avoid hazardous accidents. In the locations where the existing bridges are to be utilized with rehabilitation works, carriageway width becomes narrower than that of earthwork sections due to the difference in shoulder width. It is, therefore, proposed to install facilities that notify drivers the decrease in carriageway width and existence of concrete curb.

In built-up areas near Tura and Dalu, there are a lot of buildings, shops or houses at roadside as well as pedestrians going along the sidewalk and crossing the road. Furthermore, more road facilities such as bus stops are necessary than rural sections. Therefore, drivers have to handle much information on roads/traffic and decide their maneuvers in a short time at built-up areas. In order to assist road users in obtaining information, appropriate traffic signs and road markings shall be provided properly.

(2) GHG emissions

There is a possibility of increased GHG emission due to the operation of heavy vehicles as well as traffic jams incidental to the construction works, this impact will be temporary. On the other hand, it is expected that the GHG emission will be increase due to increase traffic volume. The increase will be mitigated by keeping good road conditions which will reduce consumption of extra fuel and congestion, thereby mitigating GHG emissions over time.

11.7.9 Environment Management Plan

Based on the assessment above, environment mitigation and enhancement measures during different stages of the project have been developed as shown below.

Table 11.65 Environmental Management Plan for Pre-Construction Stage

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
P1	Relocation of Project Affected Persons (PAP) and	• All requirements of the RAP shall be complete before start of construction stage. The activities broadly include acquisition of land and structures, relocation of utilities, payment of compensation and provision assistance[14]	All areas	Before construction begins	NGOs, , NHIDCL, Village Council (Nokma), District Revenue authorities,	PIU, SC
P2	Removal of vegetation	• Minimize the scale of vegetation clearing by factoring vegetation/forest cover in the final design of the road alignment process • Removal of trees to be carried out after forest clearance is obtained • Reforestation/replantation of trees at a term as instructed by the Forest Dept. • Activity shall be supervised to avoid poaching of animals	All areas	Before construction begins	PIU, Contractor	PIU, SC

14 More details to be found in RAP report.

P3	Setting up construction camps	• Camps shall be located at least 500m away from the nearest built-up area. • Sewage system for a construction laborer's camp shall be designed, built and operated so that no pollution to ground or adjacent water bodies/ watercourses takes place. Garbage bins shall be provided in the camps and regularly emptied and the garbage disposed off in a hygienic manner, to the satisfaction of the relevant norms and the Engineer. • In relation to underground water resources, the contractor shall take all necessary precaution to prevent interference with such water resources. • All relevant provisions of the Factories Act, 1948 and the Building and other Construction Workers (regulation of Employment and Conditions of Service) Act, 1996 shall be adhered to.	All construction campsite identified by the contractor and approved by SC	During Establishment, Operation and Dismantling of Such Camps.	Contractor	PIU, SC
P4	Setting up hot mix plants	• Hot mix plants and batching plants shall be located sufficiently away from habitation and agricultural operations. • Where possible such plants will be located at least 1000m away from the nearest habitation.	All hot-mix and batching plants	During Erection, Testing, Operation and Dismantling of Such Plants.	Contractor	PIU, SC

P5	Finalizing sites for surplus soil dumping	● Location of dumping sites shall be finalized. The sites shall meet following conditions: i) dumping does not impact natural drainage courses; ii) no endangered/rare flora is impacted by such dumping	All areas identified as potential dumping sites	During mobilization	Contractor	PIU, SC
P6	Identification of hazard-prone locations	● The contractor shall identify locations sensitive to landslides (in addition to the ones that area already identified) and shall duly report these to the Supervision Consultant (SC) and to PIU/PWD.	All area	During mobilization	Contractor	PIU, SC

Source: JICA Study Team

Table 11.66 Environmental Management Plan for Construction Stage

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
Soil						
C1	Soil Erosion in Borrow Pits	● The depth of borrow pits shall be restricted so that sides of the excavation shall have a slope not steeper than 1:4, from the edge of the final section of the bank.	On approved locations of borrow pits.	Construction Stage	Contractor and Supervision Consultant	PIU
C2	Loss of top soil in Borrow pits	● Agricultural fields or productive land shall be avoided for borrowing earth. If unavoidable topsoil shall be preserved and used for tree plantation.	On approved locations of borrow pits.	Construction Stage	Contractor and Supervision Consultant	PIU

C3	Compaction of Soil	• Construction equipment and vehicles shall be restricted to move only within designated area to avoid compaction of productive soil.	Throughout corridor.	Construction Stage	Contractor and Supervision Consultant	PIU
C4	Soil erosion in embankments	• Pitching shall be done for slope stabilization as per the IRC guidelines	At the places of embankments	Construction Stage	Contractor and Supervision Consultant	PIU
C5	Contamination of soil from fuel and lubricants	• Construction vehicles and equipment shall be operated and maintained in such a manner so that soil contamination due to its spillage shall be minimum. • Fuel storage shall only be done on wasteland and will be kept away from drainage channels and natural water bodies.	Near Labor camp and sites of installation of Construction machineries.	Construction Stage	Contractor and Supervision Consultant	PIU

C6	Contamination of land from construction waste and quarry materials	• Debris generated due to the dismantling of the existing pavement structure and the cutting of the hillside for the widening shall be suitably reused in the proposed construction, such as for fill materials for embankments. • Debris and other material obtained from existing embankment shall be dumped in approved landfill site already identified by concerned agency. All spoils shall be disposed off as desired and the site shall be fully cleaned before handing over. • Construction waste including non-bituminous and bituminous waste shall be dumped in approved landfill site identified by State Pollution Control Board (SPCB). All spoils shall be disposed off as desired and the site shall be fully cleaned before handing over.	Solid waste dump Site identified and approved by SPCB. Throughout the area	Construction Stage	Contractor and Supervision Consultant	PIU
C7	Loss of top soil in land acquisition	• Topsoil shall be stripped, stored and shall be laid on ground for landscaping purpose.	Throughout the area	Construction Stage	Contractor and Supervision Consultant	PIU
Water						

C8	Contamination of water by fuel/ oil spillage of vehicle	• Construction vehicles / equipment shall be operated and maintained in such a manner to avoid contamination of water bodies due to oil spillage. • Fuel storage shall only be done on wasteland and will be kept away from drainage channels and natural water bodies.	Near labor camp and sites of installation of Construction machineries.	Construction Stage	Contractor and Supervision Consultant	PIU
C9	Contamination of stagnant water body by fecal matters from labor camp.	• Labor camp shall not be allowed near any of the water bodies. • The proper sanitation facilities shall be provided.	Preapproved locations away from the water bodies.	Construction Stage	Contractor and Supervision Consultant	PIU
C10	Deposition of dust in open wells near construction site	• The mouth/opening of the well shall be covered with suitable material during any of the construction activity so as to prevent dust entering in the well.	All the wells along the project corridor.	Construction Stage	Contractor and Supervision Consultant	PIU
C11	Using drinking water for construction purpose	• The contractor shall make arrangements for water required for construction in such a way that water availability and supply to nearby community is unaffected. • Wastage of water shall be kept minimum during construction.	At respective planned construction sites	Construction Stage	Contractor and Supervision Consultant	PIU
C12	Hand pump close to road may get affected in widening	• All the Hand pumps shall be relocated to suitable alternate place.	At the respective locations	Construction Stage	Contractor and Supervision Consultant	PIU
C13	Well may get affected in widening	• All the Wells shall be relocated at alternate site.	At the respective locations	Construction Stage	Contractor and Supervision Consultant	PIU
C14	Altering flow of Natural drains	• Drain shall be channelized with Slope protection - Gabion Structure.	At the respective locations	Construction Stage	Contractor and Supervision Consultant	PIU

C15	Sanitation of waste disposal in construction camps	• The construction of camps will be done with sufficient buffer from habitation. • At construction sites and labor camps sufficient no of latrines will be provided. • The sewage generated from the camps will be properly disposed off so that it does not affect water bodies	Wherever labor camp is located	Construction Stage	Contractor and Supervision Consultant	PIU
Air						
C16	Emission from construction vehicles and machinery.	• All vehicles, equipment and machinery shall be selected to meet recognized international and national standards for emissions and shall be maintained and operated in a manner that ensures relevant air, noise and discharge rules. • Only unleaded petrol and low sulphur diesel or sulphur free diesel shall be used as fuel for vehicles, equipment and machinery.	Wherever the hot mix plant and batching plant is setup.	Construction Stage	Contractor and Supervision Consultant	PIU
C17	Air pollution from various plants affecting settlements	• The asphalt plants, crushers and batching plants shall not be sited at least 500 m in leeward direction from nearest human settlement	Locations near Settlement	Construction Stage	Contractor and Supervision Consultant	PIU
C18	Air pollution may exceed the limits prescribed by Central Pollution Control Board.	• Regular monitoring or air quality parameters during the construction period as envisaged in the Environmental Monitoring Plan.	Locations given in Environmental Monitoring Plan.	Construction Stage	Contractor and Supervision Consultant	PIU

C19	Vehicles will generate dust and suspended particles.	• The dust generated by vehicles on site shall be arrested using a water tanker fitted with sprinkler capable of applying water uniformly with a controllable rate of flow to variable widths of surface but without any flooding.	Wherever the plants are setup and sensitive locations as suggested in monitoring plan.	Construction Stage	Contractor and Supervision Consultant	PIU
Noise						
C20	Noise levels from vehicles. Asphalt plants and equipment	• The plants and equipments used for construction shall confirm to CPCB norms. • Vehicles and equipments used shall be fitted with silencer. • Any vehicle and machinery shall be kept in good working order and engines turned off when not in use. • All equipments and plants shall strictly be placed away from educational institutes and hospitals. • Regular monitoring of noise parameters (Leq) during the construction period as envisaged in the Environmental Monitoring Plan.	Wherever the plants are setup.	Construction Stage	Contractor and Supervision Consultant	PIU
C21	Noise from blasting operations	• Blasting as per Indian Explosives act will be carried out. • People living near such blasting operation sites shall be informed before the operational hours. • Workers at blasting sites shall be provided with earplugs.	At the sites where the blasting is required and in quarry sites	Construction Stage	Contractor and Supervision Consultant	PIU

C22	Noise barriers	● Construction of noise barriers in the form of walls and vegetation at Sensitive locations.	All along the corridor wherever the sensitive locations like schools, hospitals and other community places are located.	Construction Stage	Contractor and Supervision Consultant	PIU
Flora and Fauna						
C23	Tree cutting for widening	● Three trees shall replace each tree cut for the purpose. ● The Engineer shall approve such felling only when the NHIDCL receives a "clearance" for such felling from the DOF, as applicable. ● Trees felled shall be replaced as per the compensatory afforestation criteria in accordance with the Forests (Conservation) Act, 1980.	Throughout the project area	Construction Stage	Contractor and Supervision Consultant	PIU
C24	Damage or Loss of Important Flora	● During construction, at any point of time, if a rare/ threatened/endangered flora species is found, it shall be conserved in a suitable manner in consultation with authorities. The Engineer shall approve detailed conservation processes, plans and designs as well as associated modification in the project design.	Throughout the project area.	Construction Stage	Contractor and Supervision Consultant	PIU
Health and Hygiene						

C25	Health hazard to workers due to bad water and sanitation	• At every workplace, good and sufficient potable water (as per IS 10500) supply shall be ensured to avoid water-borne diseases and to secure the health of workers. • Adequate drainage, sanitation and waste disposal shall be provided at workplaces. • Preventive Medical care shall be provided to workers.	Wherever labor camp is setup	Construction Stage	Contractor and Supervision Consultant	PIU
C26	Health hazard to workers by various construction activity	• Personal protective equipment shall be provided to worker as per the Factories Act.	Throughout the project area	Construction Stage	Contractor and Supervision Consultant	PIU
C27	Health/ social hazard, sexual harassment to female workers	• Segregation of male and female areas in labor camp shall be executed.	Wherever labor camp is setup	Construction Stage	Contractor and Supervision Consultant	PIU

C28	Hygiene at Construction Camps	• The Contractor during the progress of work will provide, erect and maintain necessary (temporary) living accommodation and ancillary facilities for labor to standards and scales approved by the resident engineer. • These shall be provided within the precincts of every workplace, latrines and urinals in an accessible place, and the accommodation, separately for each for these, as per standards set by the Building and other Construction Workers (regulation of Employment and Conditions of Service) Act, 1996. There shall be adequate supply of water, close to latrines and urinals. • All temporary accommodation must be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking and washing. The sewage system for the camp must be properly designed, built and operated so that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place. Compliance with the relevant legislation must be strictly adhered to. Garbage bins must be provided in the camp and regularly emptied and the garbage disposed off in a lined landfill sites. Construction camps are to be sited away from vulnerable people and adequate health care is to be provided for the work force.	Wherever labor camp is setup	Construction Stage	Contractor and Supervision Consultant	PIU

C29		● On completion of the works, the whole of such temporary structures shall be cleared away, all rubbish burnt, excreta or other disposal pits or trenches filled in and effectively sealed off and the whole of the site left clean and tidy, at the Contractor's expense, to the entire satisfaction of the Engineer.				
C30	Abandoned Quarry will accumulate water and act as a breading ground for disease vectors.	● Reclamation measure shall be adopted with garland of trees around the periphery. The quarry dust and waste shall be used for refilling. The remaining portion should be covered with trees.	All quarry locations.	Construction Stage	Contractor and Supervision Consultant	PIU
Safety						
C31	Safety of vehicles plying on road while the construction activity is going on.	● Prior arrangement/traffic diversion for safe passage of vehicles shall be made with proper direction and signage at the construction site. ● Detailed Traffic Control Plans shall be prepared and submitted to the Site Engineer/ Project Director for approval 5 days prior to commencement of works on any section of road. The traffic control plans shall contain details of temporary diversions, details of arrangements for construction under traffic and details of traffic arrangement after cessation of work each day.	Throughout the project area	Construction stage	Contractor and Supervision Consultant	PIU

C32	Risk from Operations	• The Contractor is required to comply with all the precautions as required for the safety of the workmen as far as those are applicable to this contract. • The contractor shall supply all necessary safety appliances such as safety goggles, helmets, masks, etc., to the workers and staff. The contractor has to comply with all regulation regarding safe scaffolding, ladders, working platforms, gangway, stairwells, excavations, trenches and safe means of entry and egress.	All construction sites	Construction stage	Contractor and Supervision Consultant	PIU
C33	Risk from Electrical Equipment	• Adequate precautions will be taken to prevent danger from electrical equipment. No material or any of the sites will be so stacked or placed as to cause danger or inconvenience to any person or the public. • All necessary fencing and lights will be provided to protect the public. All machines to be used in the construction will conform to the relevant Indian Standards (IS) codes, will be free from patent defect, will be kept in good working order, will be regularly inspected and properly maintained as per IS provisions and to the satisfaction of the Engineer.	All construction Site	Construction stage	Contractor and Supervision Consultant	PIU

C34	Risk at Hazardous Activity	• All workers employed on mixing asphaltic material, cement, lime mortars, concrete etc., will be provided with protective footwear and protective goggles. Workers, who are engaged in welding works, would be provided with welder's protective eye-shields. Stone-breakers will be provided with protective goggles and clothing and will be seated at sufficiently safe intervals. • The use of any herbicide or other toxic chemical shall be strictly in accordance with the manufacturer's instructions. The Engineer shall be given at least 6 working day's notice of the proposed use of any herbicide or toxic chemical. A register of all herbicides and other toxic chemicals delivered to the site shall be kept and maintained up to date by the Contractor. The register shall include the trade name, physical properties and characteristics, chemical ingredients, health and safety hazard information, safe handling and storage procedures, and emergency and first aid procedures for the product. This should comply with Hazardous Material Act.	All construction sites	Construction stage	Contractor and Supervision Consultant	PIU

C35	Risk of Lead Pollution	• Nobody below the age of 18 years and no woman shall be employed on the work of painting with products containing lead in any form. No paint containing lead or lead products will be used except in the form of paste or readymade paint. • Facemasks will be supplied for use by the workers when paint is applied in the form of spray or a surface having lead paint dry rubbed and scrapped	All construction sites	Construction stage	Contractor and Supervision Consultant	PIU
C36	Risk caused by Force' Majure	• All reasonable precaution will be taken to prevent danger of the workers and the public from fire, flood, drowning, etc. All necessary steps will be taken for prompt first aid treatment of all injuries likely to be sustained during the course of work.	All construction Site	Construction stage	Contractor and Supervision Consultant	PIU

C37	Risk from Explosives	• Except as may be provided in the contract or ordered or authorized by the Engineer, the Contractor shall not use explosives. Where the use of explosives is so provided or ordered or authorized, the Contractor shall comply with the requirements of the following Sub-Clauses of this Clause besides the law of the land as applicable. • The Contractor shall at all times take every possible precaution and shall comply with appropriate laws and regulations relating to the importation, handling, transportation, storage and use of explosives and shall, at all times when engaged in blasting operations, post sufficient warning flagmen, to the full satisfaction of the Engineer. • The Contractor shall at all times make full liaison with and inform well in advance and obtain such permission as is required from all Government Authorities, public bodies and private parties whatsoever concerned or affected or likely to be concerned or affected by blasting operations.	Place of use of Explosives	Construction stage	Contractor and Supervision Consultant	PIU

C38	Malarial risk	• The Contractor shall, at his own expense, conform to all anti-malarial instructions given to him by the Engineer, including filling up any borrow pits which may have been dug by him	All construction sites, particularly beyond Lunglei district	Construction stage	Contractor and Supervision Consultant	PIU
C39	First Aid	• At every workplace, a readily available first aid unit including an adequate supply of sterilized dressing material and appliances will be provided.	At the construction site /labor camp	Construction stage	Contractor	PIU
Disruption to Users						
C40	Loss of Access	• At all times, the Contractor shall provide safe and convenient passage for vehicles, pedestrians and livestock to and from side roads and property accesses connecting the project road. Work that affects the use of side roads and existing accesses shall not be undertaken without providing adequate provisions to the prior satisfaction of the Engineer. • The works shall not interfere unnecessarily or improperly with the convenience of public or the access to, use and occupation of public or private roads, railways and any other access footpaths to or of properties whether public or private.	Throughout the project area, particularly in built-up areas	During Construction.	Contractor	Engineer

C41	Traffic Jams and Congestion	• Detailed Traffic Control Plans shall be prepared and submitted to the Site Engineer/ Project Director for approval 5 days prior to commencement of works on any section of road. The traffic control plans shall contain details of temporary diversions, details of arrangements for construction under traffic and details of traffic arrangement after cessation of work each day. • Temporary diversion (including scheme of temporary and acquisition) will be constructed with the approval of the designated Engineer. While approving temporary diversion construction, the Engineer will seek endorsement from the PIU. • Special consideration shall be given in the preparation of the traffic control plan to the safety of pedestrians and workers at night. • The Contractor shall ensure that the running surface is always properly maintained, particularly during the monsoon so that no disruption to the traffic flow occurs. As far as possible idling of engines shall be avoided to curb pollution. • The temporary traffic detours shall be kept free of dust by frequent application of water, if necessary.	Throughout Corridor	During Construction.	Contractor	Engineer

C42	Traffic Control and Safety	• The Contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as may be required by the Engineer for the information and protection of traffic approaching or passing through the section of the highway under improvement. • All signs, barricades, pavement markings shall be as per the MORTH specification. Before taking up construction on any section of the highway, a traffic control plan shall be devised to the satisfaction of the Engineer as per EMP. Excavated pits shall be filled to avoid falling of animals/ human beings.	Throughout the project area	During Construction.	Contractor	Engineer
Environment Enhancement						
C43	Hand pumps enhancement/relocation for ground water recharging	• Hand pumps within Right of Way shall be enhanced/relocated.	At the respective locations along the corridor.	Construction Stage	Contractor and Supervision Consultant	PIU
C44	Roadside landscape development	• Avenue plantation of foliage trees mixed with flowering trees, shrubs and aromatic plants shall be carried out where ever land is available between ditches and Right of Way.	Throughout the corridor	Construction Stage	Contractor and Supervision Consultant	PIU
C45	Providing better bus bays	• Bus shelters shall be provided at given locations	As per traffic plan	Construction Stage	Contractor and Supervision Consultant	PIU

C46	Better sitting arrangements where small space is available	• Designed sitting arrangements shall be provided.	As per the design	Construction Stage	Contractor and Supervision Consultant	PIU
C47	Landscaping of junctions	• All rotary junctions shall be landscaped suitably	As per landscape design at the respective locations	Construction Stage	Contractor and Supervision Consultant	PIU
C48	Abandoned Quarry will accumulate water and act as a breeding ground for disease vectors.	• The abandoned quarry locations shall be planted suitably as the plan	Wherever quarries are located and abandoned	Construction Stage	Contractor and Supervision Consultant	PIU

C49	Erosion of embankments, shoulders, side slopes, and pavement leading to deterioration and affecting stability and integrity of road	• Earth works specifications will include provision for stable slope construction, compacting and laying out turf including watering until ground cover is fully established • Proper construction of Breast wall and retaining wall at the locations identified by the design team to avoid soil erosion • The measures proposed for slope stabilization are: Discharge zones of drainage structures (culverts and minor bridges) provided with riprap • Construction in erosion and flood prone areas will not be in monsoon /season. • Side slopes will be kept flatter wherever possible, and in case of steeper slopes it will be supported by the retaining wall. • In order to avoid soil erosion from uphill side the drain along the breast wall will be constructed in the entire length. The breast wall will be constructed at the chainages identified by the design team.	At the respective locations throughout the project area.	Construction Stage	Contractor and Supervision Consultant	PIU

Source: JICA Study Team

Table 11.67 Environmental Management Plan for Operation Stage

Sl. No	Environmental Impacts/Issues	Mitigation Measures	Location	Time Frame	Responsibility	
					Implementation	Supervision
O1	Water quality degradation due to road-run-off	• Silt fencing, oil & grease traps, etc. shall be provided at sensitive water bodies to ensure that the water quality is not impaired due to contaminants from road run-off • Monitoring shall be carried out as specified in the Monitoring plan	As specified in the monitoring plan	As per monitoring plan	PIU, SPCB	PIU
O2	Soil and water contamination from accidental spills	• Contingency plans to be in place for cleaning up of spills of oil, fuel and toxic chemicals	All area	Plan to be developed at state/district level by early operation stage	PIU, Local Government Bodies	PIU
O3	Traffic safety	• Traffic control measures including speed limits to be enforced strictly. • Local government bodies and development authorities will be encouraged to control building development along the highway.	All area	Throughout operation stage	PIU, Local Government Bodies	PIU

O4	Accidents involving hazardous materials	● Compliance with the Hazardous Wastes (Management and Handling) Rules, 1989 including: ✓ For delivery of hazardous substances, permit license, driving license and guidance license will be required. ✓ These vehicles will only be harbored at designated parking lots. ✓ In case of spill of hazardous materials, the relevant departments will be notified at once to deal with it with the spill contingency plan.	All area	Manual/guideline to be prepared during early operation stage	PIU	PIU
O5	Roadside tree plantation	● Trees planted along the corridor shall be maintained for a period of three years. Maintenance works include, watering of the saplings, replacement of the bamboo fence every year for 3 years and all necessary measures for survival of the sapling.	All area	Immediately from the planting of sapling	NGO	PIU

Source: JICA Study Team

11.7.10 EMP Implementation Cost

Based on the above, the cost for implementation of EMP is estimated as below.

Table 11.68 Budget for EMP Implementation

Item	Detail	Unit	Unit	Quantity	Total (Rs)
I. Monitoring					
Air	Monitoring near hot mix plant locations approved by the Engineer as per NAAQS ,2009 CPCB	No.	5,000	80	400,000
Water	At locations specified in the monitoring plan as per IS 10,500 & IS 2296	No.	5,000	60	300,000
Noise	At equipment yards as directed by Engineer as per CPCB guideline 1989	No.	2,000	80	160,000
Flora and Fauna	Monitoring of impact on biodiversity	No.	50,000	24	1,200,000
Sub-Total (I)					2,060,000
II. Afforestation	Compensatory afforestation, in accordance with Forest Conservation Act (1980) as per guideline provided in EMP	No.	200	50,000	10,000,000
Sub-Total (II)					10,000,000
III. Institutional Cost					
Expert fees	Lump sum				6,000,000
Staff training	Lump sum				1,500,000
Ext. monitoring	Lump sum				2,000,000
Information disclosure	Lump sum				500,000
Sub-Total (III)					10,000,000
Sub-Total (I+II+III)					22,060,000
Contingency (10%)					2,206,000
Total					**24,226,000**

Source: JICA Study Team

11.7.11 Environment Monitoring Plan

To ensure effective implementation of the EMP, it is essential that an effective monitoring plan be designed and carried out. The environmental monitoring plan provides such information on which management decision may be taken during construction and operational phases. It provides basis for evaluating the efficiency of mitigation and enhancement measures and suggest further actions that need to be taken to achieve the desired effect. The monitoring includes: i) Visual observations; ii) Selection of environmental parameters at specific locations; and iii) Sampling and regular testing of these parameters.

Monitoring methodology covers the following key aspects: Components to be monitored; parameters for monitoring of the above components; monitoring frequency; monitoring standards; responsibilities for monitoring; direct responsibility, overall responsibility; and monitoring costs. Environmental monitoring of the parameters involved and the threshold limits specified are discussed below.

Ambient air quality
Ambient air quality parameters recommended for monitoring road transportation developments are PM10, PM 2.5, Carbon Monoxide (CO), Oxides of Nitrogen (NO_X), Sulphur Dioxide (SO_2) and Lead (Pb). These will be monitored at designated locations starting from the commencement of construction activity. Data should be generated at all identified locations in accordance to the National Ambient Air Quality Standards, 2009. The location, duration and the pollution parameters will be monitored and the responsible institutional arrangements are detailed out in the Monitoring Plan.

Water quality
The physical and chemical parameters recommended for analysis of water quality relevant to road development projects are pH, total solids, total dissolved solids, total suspended solids, oil and grease, COD, chloride, lead, zinc and cadmium. The location, duration and the pollution parameters to be monitored and the responsible institutional arrangements are detailed in the Environmental Monitoring Plan. The monitoring of the water quality is to be carried out at all identified locations in accordance to the Indian Standard Drinking Water Specification – IS 10500: 1991.

Noise
The measurements for monitoring noise levels would be carried out at all designated locations in accordance to the Ambient Noise Standards formulated by Central Pollution Control Board (CPCB) in 1989. Noise should be recorded at an “A” weighted frequency using a “slow time response mode” of the measuring instrument. The location, duration and the noise pollution parameters to be monitored and the responsible institutional arrangements are detailed in the Environmental Monitoring Plan

The monitoring plan for the various performance indicators of the project in the construction and operation stages is summarized below.

Table 11.69 Environmental Monitoring Plan

Sl. No	Item	Project Stage	Parameters	Guidance	Standards	Location	Frequency	Duration	Responsibility	
									Implementation	Supervision
M1	Air	Construction	SPM, RSMP, SO_2, NOx, CO, HC	• Dust sampler to be located 50m from the plan in the downwind direction. • Use method specified by CPCB for analysis	Air (P&CP) Rules, CPCB, 1994	Hot mix plant/ batching plant	Twice a year for three years	Continuous 24 hours	Contractor through approved monitoring agency	PIU
M2		Construction	SPM, RSPM	• Dust sampler to be located 50m from the earthworks site downwind direction. Follow CPCD method for analysis	Air (P&CP) Rules, CPCB, 1994	Stretch of road where construction is underway	Twice a year for three years	Continuous 24 hours	Contractor through approved monitoring agency	PIU
M3		Operation	SPM, RSMP, SO_2, NOx, CO, HC	• Use method specified by CPCB for analysis	Air (P&CP) Rules, CPCB, 1994	Sampling location specified in EIA report	Twice a year for one year	Continuous 24 hours	PIU	PIU
M4	Water	Construction	pH, BOD, COD, TDS, TSS, DO, Oil & Grease and Pb	• Sample collected from source and analyze as per Standard Methods for Examination of Water and Wastewater	Water quality standards by CPCB	Sampling locations specified in EIA report	Twice a year for three years		Contractor through approved monitoring agency	PIU
M5		Operation	pH, BOD, COD, TDS, TSS, DO, Oil & Grease and Pb	• Grab sample collected • from source and analyze as per Standard Methods for Examination of Water • and Wastewater	Water quality standards by CPCB	Sampling locations specified in EIA report	Twice a year for one year		PIU	PIU

M6		Operation	Cleaning of drains and water bodies	● Choked drains, water bodies undergoing siltation and subject to debris disposal should be monitored under cleaning operations	To the satisfaction of the engineer (PWD)	All area	Post-monsoon		PIU	PIU
M7	Noise	Construction	Noise levels on dB (A) scale	● Free field at 1m from the equipment whose noise levels are being determined	Noise standards by CPCB	At equipment yard	Once every 3 Month (max) for three years, as required by the engineer	Reading to be taken at 15 seconds interval for 15 minutes every hour and then averaged	Contractor through approved monitoring agency	PIU
M8		Operation	Noise levels on dB (A) scale	● Equivalent Noise levels using an integrated noise level meter kept at a distance of 15 m from edge of Pavement	Noise standards by CPCB	At maximum 15 locations listed in EIA report for noise monitoring locations	Thrice a year for 1 years	Readings to be taken at 15 seconds interval for 15 minutes every hour and then averaged.	PIU	PIU
M9	Soil erosion	Construction	Turbidity in Storm water; Silt load in ponds, water courses	● Visual observations during site visits	As specified by the engineer / Water quality standards	At locations of stream crossings and at locations of retaining wall and breast wall	Pre-monsoon and post-monsoon for three years		Contractor	PIU

M10		Operation	Turbidity in Storm water; Silt load in ponds, water courses	• Visual observations during site visits	As specified by the engineer / Water quality standards	As directed by the engineer	Pre-monsoon and post-monsoon for one year		PIU	PIU
M11	Construction camp	Construction	Monitoring of: 1.Storage Area; 2. Drainage Arrangement 3. Sanitation in Camps	• Visual Observations and as directed by the engineer	To the satisfaction of the engineer and Water quality standards	At storage area and construction workers' camp	Quarterly during construction stage		PIU	PIU
M12	Afforestation	Construction and operation	Plant survival	• The success of tree planting. Monitor the rate of survival after six months, one year and 18 months in relation to total numbers of trees planted		All area	Minimum three years after planting		NGO	PIU

Source: JICA Study Team

11.7.12 Land Acquisition and Resettlement

The project requires land acquisition for proposed widening and other work including slope protection and stabilization. For a project involving involuntary displacement of 400 or more families en masse in plain areas, or 200 or more families en masse in tribal or hilly areas, the National Rehabilitation and Resettlement Policy 2007 (NRRP, 2007) requires the administrator for Rehabilitation and Resettlement (R&R) to undertake a Baseline Survey and Census for identification of the persons and families likely to be affected (Sec.6.2). This will be carried out by the State Government, who is responsible for rehabilitation once the final ROW is determined based on the additional topographic survey. Meanwhile, this RAP report has been prepared based on the preliminary design with the aim of informing the R&R related discussion between State Government and NHIDCL to ensure that land acquisition and involuntary resettlement for this project be carried out in a manner that is consistent with the JICA Guidelines for Environmental and Social Considerations.

In the state of Meghalaya, the tribal (Scheduled Tribe: ST) population constitutes some 86% of the total population. In West Garo Hills District where the targeted section of NH51 is located, the share of ST population is 73.7%. While tribal groups in project area holds traditional culture centered on the Nokma, or traditional village leader, and social system of inheritance, they freely interact and share their sources of water, folklore, food, infrastructure and other belongings with the non-ST and other tribal population within and outside community. This is particularly evident in the section near Bangladesh border where ST population and Bengali group co-exist peacefully without ethnicity-related tensions. Moreover, ST population in project area is not isolated from outside and they are open to new ideas such as family planning and formal education. Given that the mainstream population of the area is tribal, elements of an Indigenous People Plan (IPP) as described in the World Bank OP4.10 have been incorporated into this report. No separate IPP has been prepared for this project.

11.7.13 Legal Framework for Land Acquisition and Resettlement

The Land Acquisition Act 1894 has so far served as the base policy document on which the State Government passes resolution to acquire land for different projects. This act is superseded by new act (Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement

Act, 2013), which took effect on January 1st, 2014. Being a tribal State, the management of land in Meghalaya as defined under the Sixth Schedule of Indian Constitution is under the Autonomous District Councils. Based on this stipulation, the State Government of Meghalaya has not adopted the LARR 2013. In keeping view of the requirements under JICA guidelines, the resettlement policy and entitlement proposed in this RAP report will be adopted in this project. Other applicable acts, notifications, and policies relevant in the context of the project are the same as ones discussed for NH54 project in Section 11.5.13.

11.7.14 Scale of Land Acquisition and Resettlement

(1) Demographic Profile

The baseline survey has identified and surveyed 367 households (173 households whose houses will be affected and 194 households whose businesses will be affected). The total number of people is 1,820. Out of these, 319 households (161 households whose houses will be affected and 158 households whose businesses will be affected) will have to be relocated. The remaining 48 will be partially affected but relocation will not be necessary. The average household size is 4.9, ranging from the maximum thirteen to the minimum one person. The social categories of affected households per three development blocks are shown below. Except for Dalu block near the border with Bangladesh, almost all affected households belong to ST (Garo tribes). The Development Block has been the basic unit of the survey but it can be divided further into smaller locality. The number of such affected localities in each block are as follows: Dalu – 15; Gambegre – 23; and Rongram – 10.

Table 11.70 Block-wise Social Category of Affected Households

Block	ST	SC	OBC	General	Prefer not to answer	Total
Dalu	103	2	17	33	7	162
Gambegre	75	0	0	0	3	78
Rongram	116	0	1	2	8	127
Total	**294**	**2**	**18**	**35**	**18**	**367**

Source: Baseline Survey

The result of religious affiliation overlaps closely with the respondents' social category. The result confirms that Christianity is the dominant religious belief among Garo people while population near Bangladesh border follows Hindi.

Table 11.71 Block-wise Religious Affiliation of Affected Households

Block	Christian	Hindu	Muslim	Prefer not to answer	Total
Dalu	103	53	2	4	162
Gambegre	75	1	0	2	78
Rongram	117	6	1	3	127
Total	295	60	3	9	367

Source: Baseline Survey

Educational Attainment of household heads is shown below. Being a sensitive question, the share of "no answer" is rather high, but no respondents had difficulties in reading the questionnaire form and communicating with the surveyors for elaborating their answers15.

Table 11.72 Educational Attainment of Household Heads

Educational Attainment	Dalu	Gambegre	Rongram	Total
Below Elementary	16	6	9	16
Completed Elementary	29	16	18	29
Below High School	4	8	13	4
Completed High School	31	6	23	31
Not completed college	8	8	10	8
Graduate and above	8	2	17	8
No Answer	71	32	37	71
Total	**167**	**78**	**127**	**167**

Source: Baseline Survey

(2) Vulnerability

The vulnerability was screened based on the definition of the vulnerable in the NRRP 2007. The NRRP 2007 defines vulnerable persons as disabled, destitute, orphans, widows, unmarried girls, abandoned women or persons above 50 years of age, who are not provided or cannot immediately be provided with alternative livelihood, and who are not otherwise covered as part of a family (para 6.4 (v), NRRP 2007).

15 The literacy rate of Meghalaya is 75.8% as per Census 2011.

According to Reserve Bank of India, the share of the poor in Meghalaya is 12.5% in rural area and 9.3% in urban area in 2012[16]. However, the survey found that over 40% of respondents consider themselves as BPL household, which may reflect their real coping capacity against negative impacts. Also, the project should take into account the fact that 35% of households are headed by women, when the details of the Rehabilitation Plan is developed to ensure women's participation.

Table 11.73 Vulnerability Status of Affected Households

Block	Total HH	Women-headed HH	HH head over 50	Disabled in HH	Widow in HH	Below Poverty Line*
Dalu	167	43	55	1	2	92
Gambegre	78	37	33	2	0	30
Rongram	122	49	25	0	1	29
Total	**367**	**129**	**113**	**3**	**3**	**151**

Note: BPL figure is based on self-judgment of respondents and may not be accurate.
Source: Baseline Survey

(3) **Land Ownership Status of Affected Households**

Land ownership in North East States including Meghalaya can be broadly classified into following categories:

- Private Land with Land settlement certificates (LSC): Land holding of the owners is certified with Land Settlement Certificate;
- Periodic Patta: A prescribed Land Settlement document setting agricultural land periodically whereby an individual has entered an agreement with the Government to pay land revenue and taxes at the rate legally assessed or imposed in respect of the land so leased out;
- Village Council Pass (or Garden Pass): Issued by Village Council which have traditionally acted as certificates of land ownership for agricultural purposes within the Council's territory; and
- Government Land: land owned by Government

The land ownership status of affected households is shown below.

16 Number and Percentage of Population Below Poverty Line, Reserve Bank of India, Sep 16, 2013 (accessed August 11, 2015), https://www.rbi.org.in/scripts/PublicationsView.aspx?id=15283

Table 11.74 Land Ownership Status of Affected Household

Ownership Status	Dalu	Gambegre	Rongram	Total
LSC	55	30	16	101
Periodic Patta	41	9	54	104
Village Council Pass	16	7	3	26
Government Land	41	12	28	81
No Answer	9	20	26	55
Total	**162**	**78**	**127**	**367**

Source: Baseline Survey

(4) Occupation and Income of Affected Households

Tea stalls, restaurant and petty shops are major primary occupation of the respondents. This reflects the fact that the target section of NH51 is located near international boarder (where trick drivers takes rest) and near busy area of Tura town.

Table 11.75 Primary Occupation of Household Heads

Block	Agriculture	Shop[1]	Business	Government	Misc[2]	Retired/ Unemployed
Dalu	16	101	7	9	6	7
Gambegre	4	43	9	4	1	3
Rongram	4	101	5	20	1	10
Total[3]	**24**	**245**	**21**	**33**	**8**	**20**

Note: [1] Tea stall, restaurant, petty shop; [2] Driver, cottage industry (craft); [3] This does not add up because several respondents answered more than one primary occupations while a few others did not answer this question.
Source: Baseline Survey

Monthly income of affected households has been summarized below. It is found that most of households with monthly income below Rs 2,500 reside in Gambegre block, which is more rural part of the section between Dalu and Tura.

Table 11.76 Monthly Household Income

Educational Attainment	Dalu	Gambegre	Rongram	Total
2,500 and below	2	5	1	8
2,501 – 5,000	40	10	22	72
5,001 – 10,000	49	23	33	105
10,001 – 20,000	31	6	22	59
20,001 – 50,000	13	7	19	39
50,001 and above	2	3	2	7
No Answer	25	24	28	77
Total	**162**	**78**	**127**	**367**

Source: Baseline Survey

(5) **Gender**

Tribal and non-tribal women in North East States enjoy a relatively higher position in the society than what their non-tribal counterparts do, which is reflected in their high literacy rate. Garo women are largely involved in household work, collection of forest produce, firewood collection, cultivation and other agricultural activities and thus they will be affected in a way that is different from their male counterpart. In order to ensure that affected women will not be disadvantaged, a dedicated chapter on gender issue is included in this RAP in which options to facilitate women's participation in project implementation and various opportunities to be created by the project is discussed.

(6) **Cut-off Date**

The preliminary cut-off date for land acquisition is 6th July 2015, which is the completion date of the baseline survey, and was informed to the project affected households during the survey. Formal cut-off date for the Project will be announced to project affected villages/households through Notification during the final inventory survey after the final ROW drawing is developed.

(7) **Impact on Affected Households and Structures**

As discussed above, the project shall impact 376 households. Of these households, 173 households will have their housing structures affected17 by the project and 194 households whose business structures such as tea stalls and petty shops will be affected by the project. Out of 173 households, 161 households will have to be resettled while 12 households will be partially affected. Meanwhile, 148 business structures will have to be relocated whereas 36 such structures will be partially affected18. Types of affected structures per block are shown below. Based on the baseline survey, about 75% of the affected households and business are considered as titleholder (i.e. in possession of LSC, periodic patta, village council pass)[19].

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17 This includes house-cum-commerce in which a single structure is used both as resident and for commercial purpose.
18 This is based on the preliminary ROW design and will have to be verified once the final ROW drawing is established.
19 Based on the baseline survey. For those who did not answer to the question about land-holding status, the share of title holder and non-titleholder is assume to be the same as the group who answered the question.

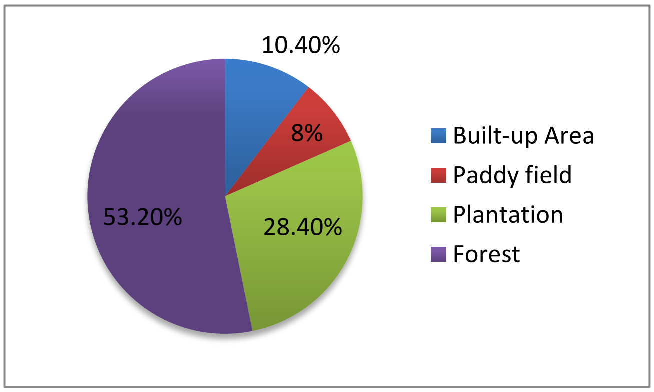
Table 11.77 Type of Affected Structures per Block

Block	Housing	Shop[1]	Workshop	Public Str.[2]	Total
Dalu	53	88	5	1	147
Gambegre	35	31	1	0	67
Rongram	51	73	0	1	125
Total[3]	**139**	**192**	**6**	**2**	**339**

Note: [1] Tea stall, restaurant, petty shop; [2] Well and Toilet; [3] This does not matches to the number of affected households and businesses because there are cases where a single structure is shared by multiple households. Also, there are several street vendors without structures to be affected by the project.
Source: Baseline Survey

(8) **Impact on Land**

The project requires additional land area of 78.6 h, out of which 67 ha is required for widening and improvement work and 11.6 ha is needed for disposing surplus soil. The candidate locations for surplus soil disposal have been identified during the preliminary design and the budget for disposal, including measures to prevent soil erosion, have been included in the project cost. However, the sites will have to be verified after the additional topographic survey and in consultation with affected community as well as State/District Government. The breakdown of land to be acquired by type based on the field survey and satellite data is shown below.



Source: JICA Study Team

Figure 11.24 Breakdown of Affected Land to by Type

(9) **Impact on Trees and Crops**

Plantations of Areca nut, rubber and cashew as well as wild trees along the road will be affected by the project. Toward the end of the section near Dalu, the road also runs through paddy area. Other affected trees include fruit bearing trees (Banana, Mango, Jackfruit, other citrus fruit, etc.) and bamboo. Since the ROW drawing for the widening and improvement is yet to be finalized, the counting exercise of affected trees has not been carried out at this stage. This will be carried out after the final ROW drawing is prepared based on the additional topographic data. Meanwhile, the budget for compensating trees and crops has been provisionally estimated based on the affected area (approximately 28.6 ha. based on the estimate shown in section 5.3) and weighted average price of trees/crops identified during the survey[20].

11.7.15 Resettlement Policy

The resettlement policy to be applied for NH51 project is the same as the one adopted for NH54 project discussed in Section 11.5.15.

11.7.16 Entitlement Matrix

The Entitlement Matrix has been developed in accordance with the principles adopted and analysis of initial identification of project impacts. The Entitlement Matrix recognizes and lists various types of losses associated with the project and provides the basic tools and guidelines for preparation of compensation and resettlement packages.

20 Weighted average price of tree/crops is derived as follows. 1) derive average price of tree/crop based on the Basic Schedule Rate (e.g. bamboo: 10-200; banana: 100-200; jackfruit 2,500-3,000; Tea: 100-1,900); 2) estimate the average number of such trees/crops per ha.; and 3) multiply 1 and 2 to obtain estimated cost for compensation.

Table 11.78 Entitlement Matrix

Type of Loss	Occupant of Property	Unit of Entitlement	Entitlement	Details of Entitlement
Agricultural land	Titleholder	Household	Compensation at Replacement value and Assistance	h) Land for land, if available. Or cash compensation for the land at replacement cost[21], which will be determined by District Collector. i) If the compensation amount is less than the replacement cost mentioned above, the difference amount will be paid as Assistance. j) If the residual land is unviable for agriculture, PAPs hall have the following three options: ● Compensation for affected land and continue on the remaining unaffected plot of land; or ● If eligible person surrenders the residual plot, then compensation and assistance given for the entire plot of land; or ● Replacement land, if so wished by eligible persons, subject to availability of land that is at least equally productive k) Resettlement allowance of Rs. 50,000/- will be provided to those who do not get land for land, irrespective of the size of land. l) Subsistence Grant equivalent to Rs. 3000 (MAW: Minimum Agricultural Wage) per month for 6 months. m) In case of severance of cultivable land, an additional grant of 10% shall be paid over and above the amount paid for land acquisition. n) Four (4) months' notice to harvest standing crops shall be given. However, if notice cannot be given then compensation for these crops shall be paid at market value

21

	Periodic Patta Holder/ Temporary Village Pass Holder		Assistance	e) Land for land, if available; if not, replacement value of land as determined by District Collector shall be given to land owners/holders. f) Resettlement allowance of Rs. 50,000/- will be provided to those who do not get land for land, irrespective of the size of land. g) Subsistence grant equivalent to Rs. 3,000.00 per month (MAW) for 6 months. h) Four (4) months' notice to harvest standing crops shall be given. However, if notice cannot be given then compensation for these crops shall be paid at market value.
Non- agricultural vacant land (Homestead, Commercial and others)	Titleholder	Household	Compensation for structure at Replacement Cost plus assistances	g) Replacement cost for structure at latest Basic Schedule of Rates (BSR) without depreciation with a minimum of Rs. 1,50,000.00 h) Two (2) months' notice for removal of structure i) In case of partially affected structures and the remaining structure continues to be viable, in such case an additional assistance equivalent 25% of replacement cost will be paid towards repair/restoration of Structure j) Right to salvage materials from the demolished structure k) For the displaced eligible persons whose remaining structure is unviable, the following shall be payable ● Subsistence grant of Rs. 3,000/- per month for a period of twelve (12) months from the date of displacement ● One time resettlement allowance of Rs.50,000/- ● Transportation cost of Rs. 50,000.00 for shifting family, building materials, domesticated animals etc. ● Lumpsum Assistance amount of Rs. 7,500/- for re-establishing other basic facilities such as electricity connection, water supply pipeline ● All fees, taxes and other registration charges incurred for the replacement structure l) Compensation in the form of residential / commercial plot at resettlement site if so opted by 15 or more PAPs on payment and free of cost for vulnerable groups will be provided. The size of the plots will be equal to the area lost or minimum of 35 m^2 for house and 15 m^2 for shop.

	Periodic Patta Holder/ Temporary Village Pass Holder			For land ● Subsistence grant equivalent to Rs. 3,000.00 per month of MAW for 6 months. ● Four (4) months' notice to harvest standing crops/trees shall be given. However, if notice cannot be given then compensation for these crops shall be paid at market value For structure ● Replacement cost for structure at latest Basic Schedule of Rates (BSR) without depreciation with a minimum of Rs. 1,50,000.00 ● Two (2) months' notice for removal of structure ● Right to salvage materials ● Lump sum Transportation cost of Rs.50,000
Loss of Plants/Trees	Owner/Occupant	Household	Compensation	Revenue Department or Special Committee to determine the current cost. For perennial fruit bearing trees such as Pineapples, Jackfruits, etc.), average productivity of such trees will be taken as 20 years.
Loss of Cattle shed, poultry shed or any other shed for domestic animals	Owner/Occupant	Household	Compensation	Rs. 600 per m^2 for Thatched roof and Rs. 1000 per m^2 for GCI sheet roof (to be paid as per revised/latest available updated basic schedule of rates for buildings). In case of non-revision, 10% premium per year will be added to the latest rate available.
Loss of residence/ commercial unit	Tenant	Household	Assistance	d) The amount of deposit or advance paid by the tenant to the landlord or the remaining amount at the time of expropriation (this will be deducted from the payment to the landlord) e) Subsistence grant of Rs. 3,000/- per month for a period of twelve (12) months from the date of displacement f) Lump sum shifting allowance of Rs. 15000/-
Loss of kiosk	Owner/occupant	Household	Assistance	c) Lump sum shifting allowance of Rs. 7500/- d) Right to salvage materials from the existing structure

Loss of employment	Wage earner	Household	Assistance	d) Economic Rehabilitation Grant equivalent to twenty-five (25) days of Minimum Agricultural Wages (MAW) per month for a period of three months. e) Priority work opportunities in the project construction work f) Rs. 20,000/- towards vocational/skill improvement as per choice.
Loss of Livelihood (losing commercial unit, losing agricultural land and with balance land below MEH)	Titleholder/ Periodic Patta holder/ Village Pass holder	Household	Assistance	f) Priority work opportunities in the project construction works. g) Rs. 20,000/- towards vocational/skill improvement as per choice. The amount will cover daily stipend equivalent to MAWfor the duration of training and shall also cover costs towards boarding, lodging, transportation, etc.
Additional support to vulnerable groups	Titleholder/ Periodic Patta holder/ Village Pass holder	Household	Assistance	One time additional financial assistance of Rs. 25,000/- as Economic Rehabilitation Grant towards income generation
Loss of Jhum /Fallow land)	Village	Village	Compensation at 'replacement value'	Replacement value for the common property transferred/acquired shall be paid to Village Council and the amount will be utilized through participatory planning by the villagers within 6 months from date of release of payment. PIU shall monitor its utilization
Loss of Common Property Resources	Village	Village	Enhancement of community resources	Replacement /Restoration or augmentation of existing infrastructure and provision of additional infrastructure facilities based on identified need
Loss of Access	Village	Village	Alternate access	Provision of access path(s), steps, footpaths at identified locations in consultations with community

Temporary and unforeseen impacts.	Affected entity	Household	Mitigation measures in line with principles of resettlement policy framework	Unforeseen and temporary impacts during construction will be documented and dealt with on case by case basis through the GRM in accordance with the principles laid down in the resettlement policy framework

Source: JICA Study Team

11.7.17 Grievance Redress Mechanism (GMS)

The Grievance Redress Mechanism (GMS) involves formation of Grievance Redress Committee (GRC). The main objective is to provide a step-by-step process of registering and addressing the grievances with respect to land acquisition. It is expected that this mechanism will ensure redress of disputes through participative process.

The first tier of GMS takes place at village/block level and involves physical verification and certification upon receipt of any grievance such as inaccurate measurement of impacted asset, loss of access, damage to structures and/or crops during construction. The verification and certification will be carried out by the RAP implementation agency, Nokma and/or members of Village Council in presence of PAPs who file the grievance, and appropriate documentation would be done. Response would be provided to the concerned PAP within 7-10 days of receipt of grievance. Financial implications of any changes would be presented to the GRC for consideration and approval.

The second tier of resolution will be undertaken by the GRC. A district-level GRC will be formed by the Project Authority within one month from the date of mobilization of RAP implementation agency at site. The GRC will comprise Project Director, NHIDCL; PWD; Deputy Commissioner of West Garo Hills; representatives of the concerned Village Council or his/her authorized representative, PAPs and RAP implementation agency. Grievances of PAPs in writing will be brought to GRC for redress by the RAP implementation agency. The RAP implementation agency will provide necessary assistance to PAPs in presenting his/her case before the GRC. The GRC will respond to the grievance within 7 days. The GRC will meet once in 15 days but may meet more frequently, depending upon the number of such cases. However, after convening the first GRC meeting, it will not hold any meeting till such time any grievance is brought to the GRC for redressal. Grievances brought to the GRC shall be redressed within a time period of one month (30 days) from the date of receipt of grievance. The decision of the GRC will not be binding to PAPs. In other words, decision of the GRC does not bar PAPs taking recourse to court of law.

11.7.18 Institutional Arrangement

As per Indian regulatory framework, activities related to resettlement and rehabilitation will be carried out by the State Government. Given the autonomous characteristics of West Garo Hills District, however, it is proposed that the district council as well as Nokma, traditional village leaders, also play a major role in implementing RAP. At the moment, NHIDCL has regional offices in Guwahati, Assam, and for this project, it is expected that a project office (Project Implementation Unit: PIU) to be set up in Tura. A dedicated NHIDCL staff (or expert hired by NHIDCL) will work closely with State and district officials as well as Nokma to ensure that implementation of RAP is in line with JICA Guidelines for Environmental and Social Considerations. Institutional arrangement includes provisions to strengthen the capacity of PIU and PWD with regard to land acquisition and implementation of RAP and management of other social issues. The project institutional arrangement is shown below.

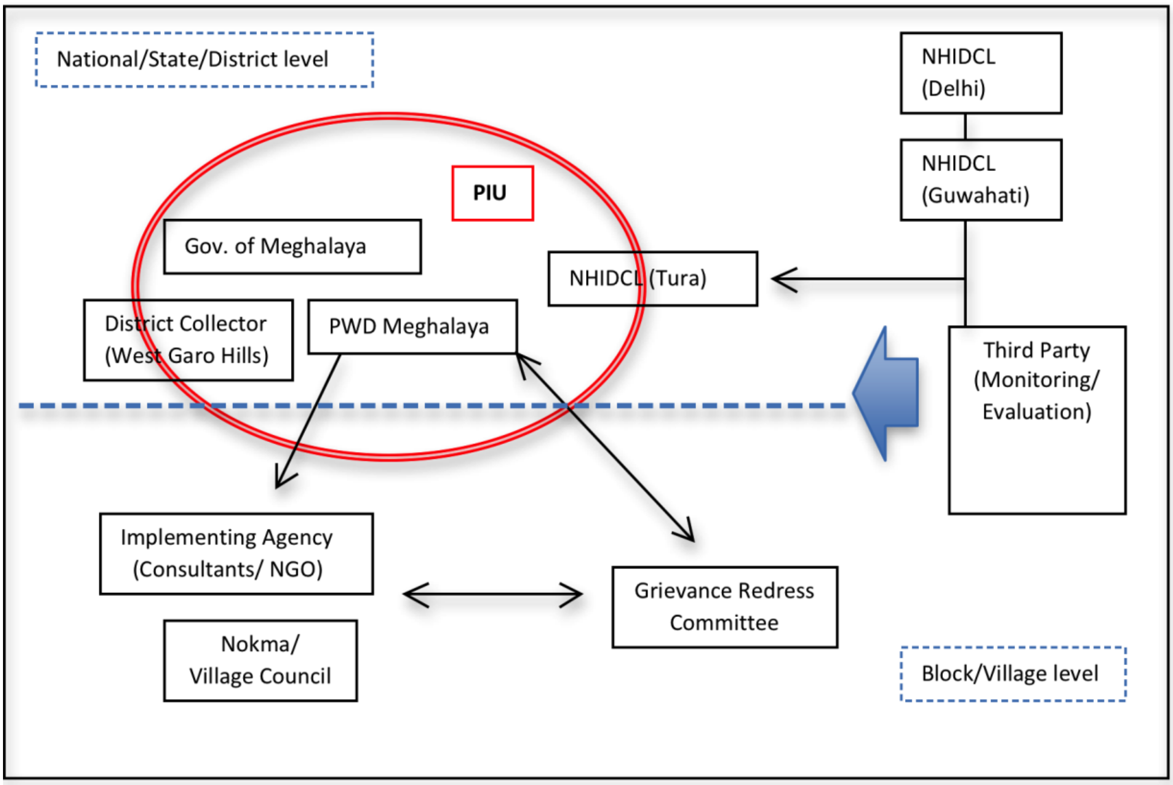


Figure 11.25 Institutional Arrangement for RAP Implementation

11.7.19 Monitoring and Evaluation

Monitoring and evaluation are important activities of any infrastructure development project, and even more so for projects involving involuntary resettlement. It helps make suitable changes, if required during the course of RAP implementation and also to resolve problems faced by the PAPs. Monitoring is periodical checking of planned activities and provides midway inputs, facilitates changes, if necessary, and provides feedback to project authority for better management of the project activities. On the other hand, evaluation assesses the resettlement effectiveness, impact and sustainability. In other words, evaluation is an activity aimed at assessing whether the activities have actually achieved their intended goals and purposes. Thus monitoring and evaluation of RAP implementation are critical in order to measure the project performance and fulfillment of project objectives.

The summary of various monitoring and evaluation activities to be carried out on course of project implementation is summarized below.

Table 11.79 Summary of Monitoring Activity

Type	Frequency	Prepared by	For	Report Contents
Internal RAP Monitoring	Quarterly	PIU	NHIDCL/ State Government	10-15 page report (plus supporting documentation) summarizing progress against the RAP; outline of any issues and agreed related actions; summary schedule of grievance status; minutes of any stakeholder or affected people consultations or meetings
External Monitoring	Harf-yearly	Expert Panel	NHIDCL/ State Government	25-35 page report (plus supporting documentation) summarizing assessment of progress towards living standard restoration, livelihood restoration; compliance of JICA Guidelines; discussions of any RAP issues of concern; identification of any areas of non-compliance and agreed corrective actions; and summary or resettlement status.
Completion Audit	One-off	Expert Panel	NHIDCL/ State Government	RAP Completion Audit to verify NHIDCL has complied with undertakings defined by the RAP and that land acquisition and compensation has been completed in accordance with JICA Guidelines

Source: JICA Study Team

11.7.20 Rehabilitation Plan

The socio-economic survey of the PAPs (see details in chapter 4) indicates that the main sources of income in the project influence area are agriculture and small business enterprises. The population has limited capacity to benefit from the livelihood opportunities created under the development projects or any government sponsored program. One of the key principle of the RAP is to ensure that the livelihood of PAPs will be improved, or at least restored compared with pre-project level. The project will provide income restoration opportunities by way of skill development training and linkage with the on-ongoing government schemes for this purpose. The Rehabilitation Plan will therefore aim to support PAPs to regain their previous living standards by creating income generation opportunities as well as improving PAPs capacity to benefit from the various economic opportunities developed by the project. The Rehabilitation Plan will be developed and implemented by Meghalaya State Government in the course of this project, and the detail of the plan should be tailored with inputs from stakeholders in a later stage of the project. Keeping JICA and World Bank policies in perspective, however, following options and principle are proposed for inclusion to the Rehabilitation Plan.

<u>Shared market place</u>
While the road widening and improvement proposed under the project are expected to facilitate trade across borders, these roads also may have the potential to boost local level trade and improving linkages of the villages in the interiors with the local and regional markets. At the same time, relocation is likely to cause negative impact on households along the road who have benefited from the roadside location suitable for business. It is recommended that project creates benefit sharing

arrangements with communities along the project roads and build capacity for increasing the production and trade potential, for example, through construction of common market place in a convenient location along the road where community members can buy and sell agricultural goods and engage in small businesses.

Backyard Poultry
Many households rear chicken for their own consumption but rarely doing it commercially. Small marketing effort may work to the benefit of the producer.

Support for expanding plantation
Insufficient supply of saplings is a barrier for initiative towards better methods of farming. Productivity of cashew, rubber and other plantations along NH51 can be enhanced through supply of quality saplings.

Proposed TOR for NGO/Consultants/University to be involved in the implementation of R&R activities, including development and finalization of Rehabilitation Plan is included in Appendix of the RAP report. Implementing Agency with support from PIU will assist PAPs in making a choice for feasible income generation activities. Market feasibility study and training need assessment shall be undertaken by the Implementing Agency to devise feasible and practical Rehabilitation Plan that matches to PAPs needs and local context.

11.7.21 Resettlement Budget

The resettlement budget comprise estimated value of compensation for land, structures, trees, various resettlement assistances, cost of CPRs, institutional cost, contingency, hiring of RAP implementation agency, HIV/AIDS awareness generation, capacity building, external monitoring and evaluation consultant, among others. The total resettlement cost for the project road is estimated at about Rs. 454,300,000.

The resettlement and rehabilitation budget has been estimated based on the information, data collected from field and other secondary sources. The budget shall be updated and adjusted as per the market rate of various items as the project continues. The compensation amount for assets shall be determined by the land acquisition officer of the project to be hired for the implementation of RAP. The breakdown of budget for different components is provided below.

Table 11.80 Resettlement Budget

Item	Unit	Unit Cost	Quantity	Total (Rs)
I. Compensation				
Land (construction)	ha.	500,000	67	33,500,000
Land (surplus soil)	ha.	400,000	11.6	4,640,000
Rural area multiplier	*the land price will be double for compensation of rural area land as per LARR 2013			38,140,000
Structure	Sq. m	4,000	3,000	12,000,000
Public toilet, water point	No.	50,000	5	250,000
Crops	No.			45,000,000
Solatium	*100% of compensation as per LARR 2013			178,530,000
Sub-Total (I)				312,060,000
II. Allowance				
Moving allowance	Household	50,000	330	16500000

Subsistence allowance	Household	18,000	380	6840000
Assistance to vulnerable	Household	20,000	200	4000000
Training	Household	20,000	380	7600000
Sub-Total (II)				34,940,000
III. Implementation				
Expert fees	Lump sum			7,000,000
Staff training	Lump sum			1,000,000
External monitoring	Lump sum			2,000,000
Information disclosure	Lump sum			1,000,000
Livelihood restoration	Lump sum			10,000,000
Sub-Total (III)				21,000,000
Sub-Total (I+II+III)				368,000,000
Contingency (10%)				36,800,000
Total				**404,800,000**

Source: JICA Study Team

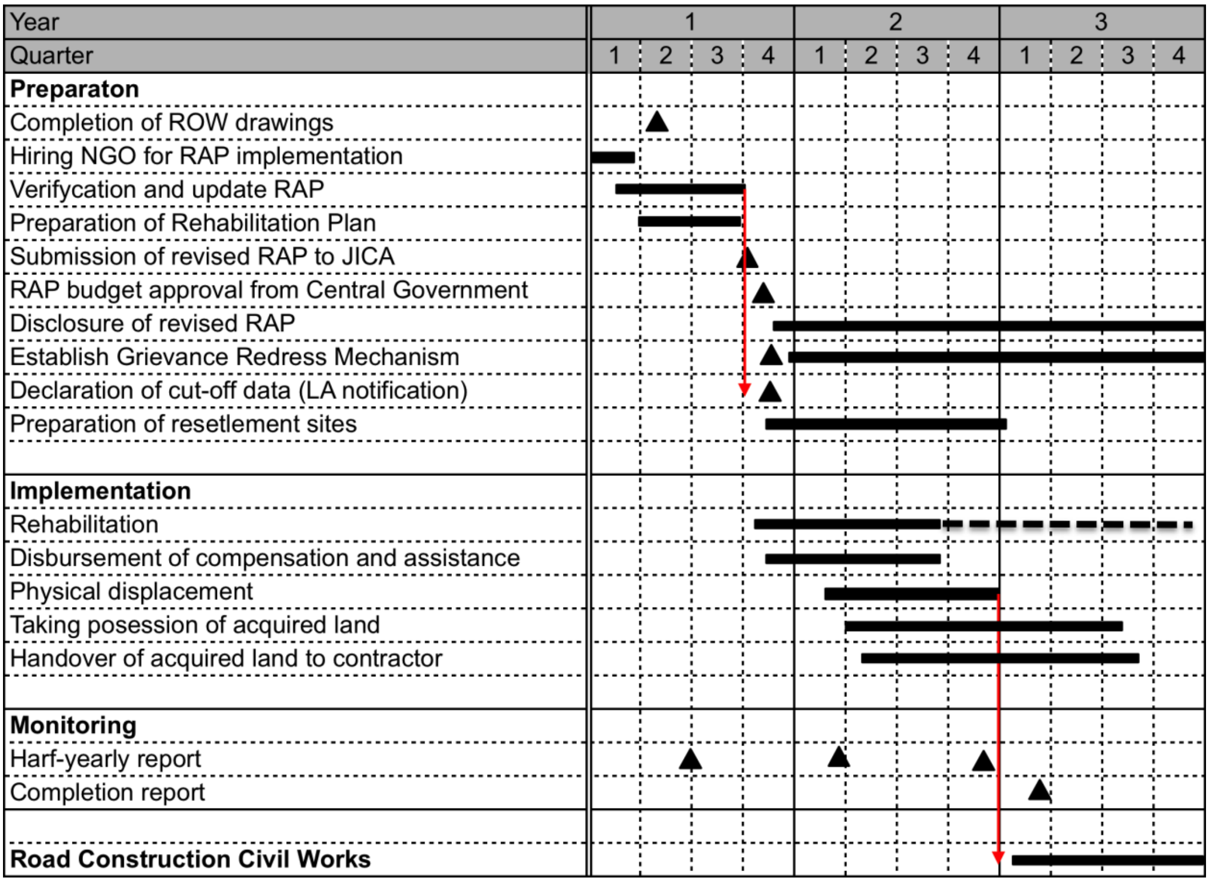
11.7.22 Resettlement Schedule

The implementation of RAP consists of following major activities:

- Deployment of required staffs (at PIU and village/block level);
- Information dissemination activities by holding consultations, distributing leaflets containing salient features of resettlement policy and entitlement matrix in Garo language;
- Verify and update the list of PAPs and their status through Detailed Measurement Survey (DMS), list and measure all property and assets affected and their estimation;
- Preparation of micro plan (RAP implementation at village/block level);
- Disburse of R&R assistance to PAPs, which may include preparation and distribution of identity card and opening of back account;
- Relocation and rehabilitation of CPRs; and
- Preparation for relocation of PAPs

Considering the long rainy season prevalent in the project area and whole state, approximately a period of 5-6 months (May - October) is not available for construction works. The RAP implementation period is proposed to be 24 months, but this needs to be scheduled in a manner so that initial activities such as verification, measurement etc. can be completed during the dry period. The other activities such as preparation of micro plan, approval, disbursement and other necessary documentation can be completed during the rainy season. RAP implementation activities to be carried and respective agencies likely to be involved for each activity are presented below.

Table 11.81 Resettlement Schedule



Source: JICA Study Team

11.7.23 Stakeholder Consultations

Stakeholder consultation is an important method of involving various stakeholders particularly, local community with reference to the proposed development initiatives. Consultations provide a platform to participants to express their views, concerns and apprehensions that might affect them positively or negatively. This process is of particular importance for this project given the high ST share among the affected population. The World Bank OP 4.10 on Indigenous Peoples emphasizes “a process of free, prior, and informed consultation (FPIC) with the affected Indigenous People’s communities at each stage of the project, and particularly during project preparation, to fully identify their views and ascertain their broad community support for the project." Consultations for this project adopted the following framework to ensure a process of FPIC.

a) Conduct appropriate gender and intergenerationally inclusive consultations with the Project Affected Peoples’ communities, the Affected Peoples' Organizations (village council, women's groups, etc.), and other local civil society organizations (NGOs) identified by the Affected Peoples' communities;
b) Use consultation methods appropriate to the social and cultural values of the Affected Peoples’ communities and their local conditions (including using local languages, allowing time for consensus building, and selecting appropriate venues) and give special attention to the concerns of women and their access to development opportunities and benefits; and
c) Provide the Affected Peoples’ communities with all relevant information about the project

(including an assessment of potential adverse effects of the project) in a culturally appropriate manner.

The purpose of consultations was to inform people about the project, take note of their issues, concerns and preferences, and allow them to make meaningful choices. It ensured participation of potential project affected persons (PAPs), local community and other stakeholders. People in general were informed in advance through invitation letter and phone calls, and allowed to participate in a free and fair manner. During these consultations, PAPs were informed about the project, likely scale of resettlement, its resettlement policy, including compensation based on full replacement cost, resettlement assistance, schedule, and grievance mechanism. Consultations provided meaningful contributions with regard to appropriate compensation, sufficient allowance for resettlement, livelihood restoration, reducing adverse impacts, address safety issues, etc. Most stakeholders expressed their needs for compensation at a full replacement cost and some stakeholders expressed their concerns regarding assistance for relocation; however, no objections were raised concerning the implementation of the project and to compensations based on replacement cost during both stakeholder consultations and door-to-door census surveys. The following sections present details of the consultations.

(1) 1st Round Consultations with Communities

The initial briefing was made to every village representatives (Nokma) prior to the commencement of the baseline survey. MLCU team as well as Environmental and Social Expert of the Study Team visited villages along the targeted section of NH51 to inform them of the project, seek their support to the survey, and to verify the validity of the survey questionnaire. The first round of consultations was held in conjunction with the baseline survey. Initially, it was planned that one consultation meeting to be held in each development block at this stage. However, after such meeting in Rongram Block, there were requests from the PAPs to hold follow-up meetings for community members so that more members can be engaged in the process. Responding to this request, two additional meetings were held in Rongram block, providing opportunities for more stakeholders to voice their opinions about the project. The details of the meeting are summarized below.

Table 11.82 Summary of 1st Round of Consultation Meetings

Block	Date	Venue	Number of Participants
Dalu	May 21st, 2015	Multi-facility Building, Dalu	17
Gambegre	May 22nd, 2015	Bharat Nirman Rashtriya Gram Seva Kendra, Darakgre Bazar	36
Rongram	June 26th, 2015	Circuit House, Tura	11
Follow-up meeting 1	June 29th, 2015	Chibgral Community Hall	67
Follow-up meeting 2	July 4th, 2015	Rongkohn School	74

Source: JICA Study Team

Table 11.83 Participation Details of 1st Round of Consultation

District	Date	Total No. of Participants	Representation (No.) from		
			Govt. Dept.	Nokma/ Vilalge Rep	Affected Persons

Dalu	May 21st, 2015	17	2	11	4
Gambegre	May 22nd, 2015	36	2	11	23
Rongram	June 26th, 2015	11	3	8	0
Follow-up meeting 1	June 29th, 2015	67	2	4	61
Follow-up meeting 2	July 4th, 2015	74	2	0	72

Source: JICA Study Team

The consultation meetings were attended mainly by village representatives (Nokma and Village Council members), who then shared the meeting contents with other members in the village. To ensure sufficient participation of PAP during consultation, village representatives who attended from each locality agreed to shared the meeting contents with other members in the village and share their feedback, if any.

At the outset, PWD and village representative introduced the consultant’s team with the participants and stated the broad objective of such consultations. The MLCU team and Environment and Social Expert of the Study Team provided brief description about the project, highlighting importance of consultations with likely project affected persons, local community and other stakeholders. Design concepts (e.g. minimize surplus soil, install proper slope protection) with preliminary alignments were also informed and explained. Expected benefits and likely anticipated adverse impacts as well as resettlement policy framework as per JICA Guidelines for Environmental and Social Considerations were conveyed as well. The consultations were held in local language (Garo) with assistance from a local person who helped in interpretation as well as preparation of transcripts. The proceedings of the consultations were audio recorded as part of documentation process. A summary of consultations on various issues is presented below:

- The community people mentioned about their grievances and experiences of not getting any compensation from the Government during previous road improvement projects and land acquisitions. Villagers without any land documents also raised their concerns about compensation payments.
- Nevertheless, broad community support for the project was observed in all the villages in view of the expected benefits of road construction. Fair compensation and resettlement and rehabilitation assistance for land, structures and other assets likely to be affected will be essential for winning community’s support to the project.
- Some shopkeepers mentioned that these shops are their sole/major source of income and thus noted it would be helpful if they would be allowed to shift their shops from one side of the road to the other during construction activity.
- A few Nokmas voiced concern about the Sima (pillar) of the Nokmas which abutted the road and noted that there are certain rituals and the expenses to be paid in shifting such ‘Simas’.
- The need for proper retaining walls have been highlighted. There are cases in previous road improvements where their lands were acquired and encroached upon during the construction phase without proper retaining wall, which cause many difficulties such as soil erosion.


Photo 11.2 Consultation at Gambegre Block (L) and Rongram Block (follow-up meeting 2) (R)

(2) **2nd Round Consultations with Communities**

The second round of consultation meetings with communities was planned to be held in August to share the result of the baseline survey with the community and discuss entitlements and other matters related to land acquisition and resettlement. Due to prolonged heavy rain in the project area since mid-August, however, such meetings could not be held as of August 28th, and is planned to be held in the first week of September.

CHAPTER 12 PROJECT EVALUATION

「本章はワーキンググループ当日までに配布致します。」

CHAPTER 13　CONCLUSIONS AND RECOMMENDATIONS

「本章はワーキンググループ当日までに配布致します。」

Appendix - 1: Past Traffic Data on Project Road Network/ Sections

No.	Road Section	Survey Location/ Chainage	Survey Date	Total PCUs	Cars	Buses	LCVs	Trucks	MAV	M/ Cycles	Cycles	Animal Cart	Agri. Tractor	Others
1	**NH 54, Aizawl – Tuipang, Mizoram, 389 km**	Aizawl/ Km 169	Jan - June 2004	**5191**	786	64	586	807	130	645	1	0	1	0
		Vairengte/ Km 43	Jan - June 2004	**1950**	378	93	450	203	2	0	0	0	0	0
		Silt Lawgtla/ Km 72	Jan - June 2004	**1769**	942	30	163	164	0	0	0	0	0	0
		Hnathiar/ Km 172	Jan - June 2004	**981**	117	98	138	100	14	0	0	0	0	0
	From DPR NH 54, MORTH	Hnahthial/ Km 179	Feb. 2010	**775**	108	23	65	59	63	80	0	0	0	0
	From DPR NH 54, MORTH	Dawn/ Km 209	Feb. 2010	**1378**	330	23	88	219	25	154	0	0	0	0
	From DPR NH 54, MORTH	Hrangchal Kawn/ Km 225	Feb. 2010	**1270**	404	25	135	161	2	192	0	0	0	0
2	**NH 62, 'Dudhanal-Dalu, Meghalaya, 150 Km**	Dainadur/ 20 Km	July - Dec. 2003	**3709**	61	58	56	1057	0	67	30	10	20	0
		Barengapara/ 199 Km	July - Dec. 2003	**613**	169	31	68	35	2	102	149	0	2	0
		Siju/ 121 Km	Jan - June. 2005	**1420**	66	35	33	367	4	55	25	0	9	0
		Baghmara/ 141.200 KM	Jan - June. 2005	**2953**	723	91	760	61	2	736	478	0	4	0
		Barengapara/ 199 Km	Jan - June. 2005	**593**	149	31	68	35	2	102	149	0	2	0
		Karukol/ KM 121	07th - 14th March - 2006	**1658**	63	22	99	422	2	108	35	2	4	0
		Konegittim/ Km 141	04th - 11th March - 2006	**2215**	411	27	457	280	2	273	44	2	3	0
		Dimapara/ Km 199	04th - 11th March - 2006	**948**	182	30	47	57	2	151	304	23	3	0
3	**NH 51, Tura - Dalu, Meghalaya, 60 Km**	Krishna/ 21.820 Km	Jan - June. 2005	**2720**	702	150	125	115	0	530	735	34	9	20
		Mankachar. 97.295 KM	Jan - June. 2005	**13766**	9730	285	380	171	0	4074	5	0	9	4
		Tura/ 117 Km	Jan - June. 2005	**838**	228	54	96	59	0	173	45	0	0	4
		Tura/ 146 Km	Jan - June. 2005	**1535**	275	60	334	72	0	236	355	0	0	15
		Bajengdoba/ Km 22	04th - 11th March - 2006	**1316**	291	88	126	121	0	373	45	0	0	0
		Rongram/ Km 83	04th - 11th March - 2006	**1688**	454	72	266	143	0	365	15	0	0	0
		Babupara/ Km 97	04th - 11th March - 2006	**13972**	8551	338	844	241	2	4756	3	2	3	0
		13 mile/ Km 117	04th - 11th March - 2006	**1212**	188	61	93	195	0	174	58	0	0	0
		Dalu/ Km 146	04th - 11th March - 2006	**1850**	374	30	21	147	0	446	1381	0	0	0
	DPR NH 51, MORTH	Km 93	2010	**3675**	1177	335	258	238	1	712	0	0	7	0
	DPR NH 51, MORTH	Km 104	2010	**1095**	607	48	35	0	0	583	0	0	0	0
	DPR NH 51, MORTH	Km 144	2010	**1565**	679	49	58	81	4	781	0	0	0	0
4	**NH 40, Shillong – Dawki, Meghalaya, 80 Km**	Nongpoh/ 7 Km	Jan - June. 2005	**12896**	3427	337	119	2465	36	360	644	0	23	26
		Shillong/ 47 Km	Jan - June. 2005	**16413**	2488	1364	250	3122	7	83	20	0	2	0
		Shillong/75 Km	Jan - June. 2005	**30235**	4977	2493	774	5310	9	1080	142	0	8	0
		Shillong/ 82 Km	Jan - June. 2005	**30261**	5833	2209	541	5287	0	1570	75	0	68	0
		Shillong/ 102 Km	Jan - June. 2005	**7214**	736	277	247	1281	272	271	120	0	3	0
		Shillong/ 129 Km	Jan - June. 2005	**1207**	220	123	117	142	0	24	8	0	0	0

No.	Road Section	Survey Location/ Chainage	Survey Date	Total PCUs	Cars	Buses	LCVs	Trucks	MAV	M/ Cycles	Cycles	Animal Cart	Agri. Tractor	Others
		Byrnihat/ 7 Km	06th - 13th March - 2006	**18991**	3888	418	403	4008	134	720	328	1	8	11
		Umran. 47 Km	08th - 15th March - 2006	**15628**	2933	324	139	3814	4	83	1	1	1	0
		Mawlai Noungkwar/ 75 Km	07th - 14th March - 2006	**19703**	5587	691	374	3535	74	774	134	0	20	0
		Umshyrpi/ 82 Km	17th - 24th March - 2006	**9398**	5629	435	250	530	0	996	1	0	0	0
		Umtyngar/ Km 102	07th - 14th March - 2006	**5674**	1173	226	377	905	94	181	30	0	3	0
		Pynursla/ Km 129	07th - 13th March - 2006	**2502**	1089	129	163	250	0	62	0	0	0	0
5	**NH 53, Imphal – Jiribam, Manipur, 220 Km**													
6	**NH 39, Imphal - Kohima, Manipur/Nagaland, 125 Km**	Senapati / 260 Km	20th - 27th March - 2006	**3460**	1381	139	354	277	27	285	53	0	2	0
		Kangpokpi / 275 Km	20th - 27th March - 2006	**1672**	289	143	104	228	8	90	22	1	3	0
		Chingmeirong / 317.400 Km	21st - 28th March - 2006	**24507**	7325	719	1560	1695	6	8605	6307	5	16	1
		Canchipur / 326 Km	21st - 28th March - 2006	**10390**	2945	478	769	447	2	5104	1833	2	5	0
		Pallel / 366 Km	20th - 27th March - 2006	**3321**	760	149	209	233	2	882	1121	4	13	0
		Tengnoupal/ 390 Km	20th - 27th March - 2006	**1603**	300	145	41	179	0	213	236	5	1	0
	NH 39, Nagaland State	Medziphema/ Km 130	July - Dec. 2004	**13766**	1080	1002	480	2885	0	157	453	0	0	0
	NH 39, Nagaland State	Kohima/ Km 164.500	July - Dec. 2005	**10942**	836	762	330	2429	0	28	47	0	0	0
	NH 39, Nagaland State	Kohima/ Km 182	July - Dec. 2006	**15186**	1276	1422	464	2976	0	40	0	0	0	0
	NH 39, Nagaland State	Kohima/ Km 199	July - Dec. 2007	**11218**	858	920	327	2352	0	88	19	0	0	0
10	**NH 37, Koliabhomora Bridge near Tezpur. Assam, 2.5 Km**	Jakhalabanda/ 325 Km	18th - 25th Feb - 2006	**7216**	1163	410	388	1052	86	250	1077	2	4	0
		Behora, Numaligarh/ 402 Km	20th - 27th March - 2006	**9592**	1526	616	481	1158	240	709	1043	1	11	2

Source: NHAI Web Site

Appendix - 2: Zoning & Zone Codes for RSI Analysis

Zone No	Description	District	State
1	Dhuburi, Golakganj, South Salmara, Patakata, Mankachar, Laughrabita, Fakirganj Gouripur, Tamarhat, Bilasipara, Salkocha, Chapar, Sapatgram, Agamani, Basbari, Bagripari	Dhuburi	Assam
2	Kokrajhar, Gossaigaon, Haltugaon, Detnia, Garubhasa, Raimana, Kochugaon, Patgaon, Ranikhata, Sidli, Anguri bazar, Bijni, Agrong, Kunda, Amtika, Deosri, Saralpara	Kokrajhar	
3	Jogighopa,Bongaigaon, Abhayapuri, North salmaria	Bongaigaon	
4	Lakhipur, Chunara, Agia, Kadomiola, Rangjuli, Dhupdhara, Khutal, Tiplai, Dalgoma, Kharmousa, Gaolpara, Pancharatna, Dudhnai, Krishnai	Gaolpara	
5	Baghbor, Bohari, Balikuri, Sorbhog, Raha, Houli, Burikhamar, Sarthebari, Bhawampur, Barbang,Hazuwa,Kunguri,Patacharkuchi,Tarabari, Nalbari,Tihu,Mukalmuva,Tamulpur,Dhamdhama,Barma,Jagar,Belsor,Subhankhata	Barpeta, Nalbari	
6	Boko, Chhaygaon, Ranigodam, Bhodhpur, Barduwar, Palasbari, Guwahati, Noonmati, Khetri, Dispur, Sonapur, Paltanbazar, Jalukbari, Hazo, Kamalpur,Rangia	Kamrup	
7	Kalaighor,Dalgaon,Mangaldai,Mazbath,Udalguri,Paneri,Nalbari,Rawta, Marigaon,Nakhola,Jagiroad,Mayong,Aujari,Dharamtul	Darrang, Marigaon	
8	Minser,Khainduli,Minser, Sirtiso, Baitha longso, Baut bazar, Hang hahai, Haflong, Gunjong, Mahur, Maibong, Darangibra, Malanpa, Bagha,Langting, Garampani, Langding	Karbi Anglong, North Chacharhills	
9	Dhalai, Silcha, Udarband, Lakhipur, Rajabazar, Katogora, Barakhola, Lalsang, Kumbhir, Dwarband	Cachar	
10	Karimgang, Sonbill, Ratabari, Anipur , Patarkhandi, Abdullapur, Chargola, Neelambazar	Karimgang	
11	Hylakandi, Badarpur, Lala, Katlichara	Hylakandi	
12	Kampur, Jamunamukh, Singinarigaon, Raha, Barrozpiya, Khatetali, Lamding, Lankha, Murajhar, Moudanga, Mikirgaon, Dhing, Bardhoa, Nagaon, Rupohi, Samaguri, Kalyabor, Silghat, Jakhalbanda ,Salana,Misa	Nagaon	
13	Tezpur, Dhekiajuli, Singri, Bihuguri, Rangpara, Balipara, Bindukuri, Gohpur, Helem, Dirji, Beheli, Viswanath, Jamaguri, Gamani	Sonitpur	
14	Diphu, Dhansipi, Dhangiri, Paklagaon, Burakek, Howraghat, Dengaon, Bokajal, Jengpata, Erdankrams, Sarhed, Kalyani, Barphatar, Jangpeta, Merapani, Saruphatar, Rengmapathar, Barugaon, Golaghat, Garampani, Barjan, Bokhakhat, Dergaon, Numaligaon, Dhansirimukh	Karbianglong, Golaghat	
15	Northlakhimpur,Bihipuria,Diju,Dulahatgaon,Dhakuakhana,Phatalipum,Jagaldubhi,Makhova,Dhemaji,Jonai,Silapathar,Sonarigaon	Lakhimpur,Dhemaji	
16	Jorhat,Teok,Anguri,Narmija,Sibsagar,Kokilamukh,Neemati,Maryani,Anguri,Nazira,Sonari,Barhat, Dibrughar, Tinsukiya, Digboy, Margerita, Dandama, Bardubi, Sadiya, Bordubi	Jorhat, Sibsagar, Dibrughar, Tinsukiya	
17	Dalu, Barengapara, Dingkajhora, Adugachol, Rembigiri, Rongohugiri, Rongram,Dadenggiri,Rongmachokgiri,Phulbari, Tura, Selsella, Garobadha, Adugiri, Akongrre, Dobasipara, Anabagre, Chenguburigri, Rongbakre	West Garo Hills	Meghalaya
18	Zikzak, Genapara, Kherapara, Jongohetpara, Batasing, Mankachar	West Garo Hills	
19	Barengapara, Baghmara, Songmong, Ringkhap, Chokpat, Chengbagiri, Wacholgiri	South Garo Hills	
20	Rongra, Wagekona, Agatchikona, Badimbari, Taraibari, Nolbari, Rangasora	south Garo Hills	
21	WilliamNagar,Renggiri, Balsrigittim, Sampalgre, Songsak, Samanda, Resubelpara, Bangsi, Dhamra	East Garo Hills	
22	Dynadubi,Chibogh,Dumboo, Rongjeng,Cheran, Bajengdonba, Thikrikila, Raksamgre, Ajagar pahar	East Garo Hills	

Zone No	Description	District	State
23	Panikunda, Sangaik, Riangdo, Patharkhnang	West khasi Hills	
24	Nongstoin,Phlangmauupra,Jakrem,Mawkyrwat, Rambrai, Nongkhlaw, Mawdob ,Mairang	West khasi Hills	
25	Shella,Balat,Mawsynram,Mawphlang, Mylliem,Laitlyngkoi	East Khasi Hills	
26	Barapani,Shillong,Mawlyngkneng, Nongroug,Pynursla, Serrarim,Sohra, Pamramda, Wakhaliar, Mawdon	East Khasi Hills	
27	Nartiang,Nongbah,Thadlaskein,Laskein,Barato	Jaintia Hills	
28	Jowai,Dauki,Jarain,Amlaren,Lakadong, Sutnga, Khliehriat, Shangpung	Jaintia Hills	
29	Barhnhat, Umling, Donmatia, Umsing, Nongpoh, Margang, Diwon, Ksehkima Bazar, Mawhati, Kyrdem	Ri Bhoi	
30	Bahadurpara,Kanchanpur, Sakhan, Serhmun, Gunamanipara,Rabiraipara, Chaumanu, Purba Chammanu, Jagannathpur, Kulai	Dhalai	Tripura
31	Ambasa,Manu, Kanchanpur, Dab bari, Michiuria, Dhumaccata, Karatichara, Halhali,Kamalpur,Salema	Dhalai	
32	Sakhan,Phuldungsei,Vangmuri, Damchera, Kanhmun, Narendra nagar, Luimavi, Piplachara, Bhungtuem, Kailashnagar,Dharmanagar,Unakoti,Fatikrai,Kumarghat	North Tripura	
33	Khowai,Kalyanpur, Ganki, Chebri, Raj anagr, Sidhai,Chnadrasachubari,Ranirbazar,Narayanpur, Teliamura, Uttar Gakul nagar, Taidu	West Tripura	
34	Agartala, Takarjala, Jambai, Bisalgarh, Barjala, Melaghar, Sonamura, Jatrapur, Kathalia	West Tripura	
35	Sipahijala, Udaipur, Nagraibari, Ampibazar, Sabedabari, Mogiabari, Matraibari	South tripura	
36	Puranrajbari Rajh nagar, Chauddragram, radha nagar, Krishna pur, Laogangbazar,Lungthung,Manubazar,Sabrum, Palangphabari, Tirthamukh	South tripura	
37	Belonia,Kakraban,Radhakishorepur, Nutanbazar, Dumbur, Amarpur,Hirapur, Ampibazar ,Sabedabari,Mogiabari,Matraibari	South tripura	
38	Aizawal, Paikhal, Zobawk, Bukpui, Tuirial, Melriat, Muallungthu, Aibawk, Falkawn, Kelsei, Sateek, Seling,Lumtui,Khawthlir, Ruallung, Keifang, Saitual, Rulchawn, Hnaltu,Hrnuntha, Maite, Mualpheng, Lenchim, Tawizo, Hmuntha, Khumtung	Aizawl	Mizoram
39	Neihbawi,Nisapur,Tawkzawi, Sentlawng, Lungdai, Relek, Sairang, Thak,Sialsuk,Thenzawl	Aizawl	
40	Lurgpho,Vancheng,Khawhai, Chekawn,Vantaiphai, Sialsir, Lungchhuan, Bawktlang, North Vanlaiphai, Rawpui, Serchip,Keitnnikawn, Matphai, Keitum, South zote	Serchip	
41	Lunglei,Lungsen,Tiabung,Tuiehong,Hruizam,Laisawrai,Buarpur, Sairep,Tawipui,Thingeal,Chawngte	Lunglei	
42	Saza,Hawlawng,Ramlaitiu, Zotuitlang, Ralvawng, Hawlaung, Zobawk,Leite,Thingsai,Boinu	Lunglei	
43	Saiha, Sangau, Siachangkown, Tiosumpui, Rawmibauk, Phalrrang, Mamte, South Langpher, Langban, Ainak, Tuipang, Zawngling	Chhimtuipui	
44	Serkawn,Kaisi, Theiri, Lower Theiva, Vahal,Tawngkalawng, Phura, Tongkolong, Lehri	Chhimtuipui	
45	Kaladan,Lawngtelai,Saizawh, Shermun, Bungtlang, Diltlang, Uiphum, Mualbn, Kawnpui,Tuidang	Lawngtlai	
46	Champhai,Dilkawn,Lungdar,Khawbung,Farkawn,Tuisen, Ngur,Neihdawn,Kawlkulh,Hnahlan,Saichal	Champai	
47	Phullen,Zawngin,Chiahpui,Phulbuang	Champai	
48	Sabual,Sibutalang,Pukzing,Lallen,Phaileng, Mamith,Tukkalh,Saitlaw,Rengdil,Hriphaw	Mamit	
49	Kolasib,Chhimluang,Bilkhawtlair,Mualvum,Bhuvalpui, Phileng,Darlawn,Ratn,Thingsat	Kolasib	
50	Imphal, KanglaTonghi, Phumlou, Lamshang, Mongjam, Khamran, Kangpokpi, Saparmania, Lhangjol, Keithelmangbi, Samurou, Mayang, Buribazar, Wango, Meijrao, Nambol, Changangai,	West Imphal	Manipur

Zone No	Description	District	State
	Taobungkhok, Ghari		
51	Sagolmang,Yangangpokpi, Waiton, Sawombang, Keibi Heikak Mapal, Paurabi, Phaknang, Nungoi, Lamlai, Kangla sipai, Kharasom	East Imphal	
52	Thoubal,Kakching,Wangjing,Wabagai,Shuganu, Irengbam, Keirak, Kharungpat, Hiyanglam, Kakching, Hangool, Yairipok, poirou Thangkhul, Tulihal, Pechi, Top chinhta, Huikop	Thoubal	
53	Kumbi,Thanga,Moirang,Ningthoukhong,Bishnupur,	Bishnupur	
54	Lunhpou, Deurali, Daili, Tumuyon Khunou, Wilong,Maosongsang,Kanchong, Khridziiphi, New Magaimai	Senapati	
55	Maram,Karong,Tadubi,Gaziphema, Shajouba, Kaibi, Tungham Khullen, Tunhjoy, Saranamai, Tungam Makhufii, Senapati,Khamson,Saikul,Laphulak	Senapati	
56	Tallui,Ukhrul,Humpum,Leishan, Jessami,Chingai,Kuiri, Paorei, Peh, Lunghar, tusam khullan	Ukhrul	
57	Molvailup,Maiti,Mairing,Phungyar,Kamjong,Chassad, Boljang,Kasom,Khullem,Bongubakhullen	Ukhrul	
58	Palel, Kampang, Sebong, Chandel,Chalong,Moreh,Thengnoupal, Chakpikarong,Mombinew,Khongtol	Chandel	
59	Churachandrapur,Mulanil,Hangtam,Thinghat,Molnom,Tonglon,Hanship,Senven,Thanlon,Mongzungkai, Phaiphengmun, Henglep, Tinaong, Parbung, Sangsong	Churachandrapur	
60	Lagairong,Tairenpokpi,Nungbah,Longpi,Oinamlong, Tamenglong, Kataug,Tousem,Phellong,Pobram, Khebuching,Tamei,Tamma,Thouglang,Chaton,Langga	Tamenglong	
61	Ankhasu, Jeikhan, Tuisen, Lower Kharkuplien, upper Kharkhupkien, Jirebam, Nghahmumpai, Kaiphundai	East Imphal	
62	Tasangki,Phikulum,Henima,Meehangbung, Peren, Intanki, Lakema,Pulomi,Vishvema, Sechu, Jaluki, Khonoma	Kohima	
63	Kohima,Tseminyu, Tesophenyu, Ziphenyu, Lazami,Narhema, Zakhama, Tuophema	Kohima	
64	Chimakudi, Dhansiripar, Chumukedima, Dimakur,Nichuguard, Chedumi	Dimapur	
65	Kekrima,Chizami,Chenwesumi,Dhulhami,Kilami,Chipeketemi,Phek, Meluri,Akhegwo	Phek	
66	Rangazubmi,Wokha,Sanees, Longsa, Pangti,Bhandari, Lakhuti, Sakhalu,Zunheboto, Sakhai,Baimbo,Aoehugelime	Wokha, Zunheboto	Nagaland
67	Sirere,Purorr,Cheshorr,Tuensang, Laruri,Sampure,Thonokyu,Panso,Noklak,Chen, Tamlu, Kangching, Ungma,Chungtia,Mokokchung,Chongymsen, Chantogia,Merangkong	Tuensang, Mokokchung	
68	Naginimara,Lapa,Borgan, Kongnyu, Wangla, Mon, Nyasia, Wakching	Mon	
69	Tawang, khat, Jang, Bomdila, Gohaintan, Seppa, Dirji, Noju, Itanagar, Riang, Khereva, Palin, Ziro, Tali, Daporijo, Along, Basar, Karko, Ingkong, Pasighat, Kebang, Komaing, Mariang, Dalbuing, Anini, Roing, Embrongo	Tawang, West Kameng, East Kameng, Lower subansiri, Upper subansiri, Papum pare, West siang, East siang, Upper siang, Dibang valley	Arunachal pradesh
70	Khonsa, Wakka, Pongchau, Changlang, Nampong, Manmao, Namdpah, Tezu, Wakro	Khonsa, Changlang, Lohit	
71	Sikkim, West bengal, Bihar, Jharkhand		States
72	Orissa, Chattisgarh, Andhra Pradesh, Telangana, Tamilnadu, Kerala		States
73	Karnataka, Maharashtra, Gujarat		States
74	Madhya Pradesh, Uttar pradesh, Rajasthan, Haryana, Punjab		States
75	Uttarakhand, Himachal pradesh, Jammu and Kashmir		States

Source: JICA Study Team